Appendix C
Regulatory Framework

Appendix C Regulatory Framework

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Acronyms and Abbreviations

BGEPA	Bald and Golden Eagle Protection Act
CAA	Clean Air Act
CCMP	Comprehensive Conservation Management Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CO	carbon monoxide
CWA	Clean Water Act
CZMA	Coastal Zone Management Act of 1972
DLCD	Oregon Department of Land Conservation and Development
DOGAMI	Oregon Department of Geology and Mineral Industries
DSL	Oregon Department of State Lands
EIS	environmental impact statement
EFH	essential fish habitat
EPA	U.S. Environmental Protection Agency
EO	Executive Order
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FPPA	Farmland Protection Policy Act
FR	Federal Register
FWCA	Fish and Wildlife Coordination Act
GHG	greenhouse gas
HMTA	Hazardous Material Transportation Act
µm	micrometer
MBTA	Migratory Bird Treaty Act
MSA	Magnuson-Stevens Fisheries Conservation and Management Act

NAAQS	National Ambient Air Quality Standards
NEP	National Estuary Project
NH_3	ammonia
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
O_3	ozone
OAR	Oregon Administrative Rules
OCMP	Oregon Coastal Management Program
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
OEM	Oregon Office of Emergency Management
ORS	Oregon Revised Statutes
Pb	lead
P.L.	Public Law
$PM_{2.5}$	particulate matter 2.5 µm or less in diameter
PM_{10}	particulate matter 10 µm or less in diameter
PROJECTS	Programmatic Restoration Opinion for Joint Ecosystem Conservation by the Services
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act
SFC	Southern Flow Corridor
SHPO	State Historic Preservation Office
SO_2	sulfur dioxide

SO_x	sulfur oxides
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service
VOC	volatile organic compound

SECTION 1 Introduction

This document summarizes the regulatory setting for each resource area within the Southern Flow Corridor (SFC) project environmental impact statement (EIS). Under each resource area, relevant regulations and authorities are listed. These regulations often provide the thresholds of significance that are used in the analysis. If a regulation provides a threshold for significance, then that is described in the appropriate section of the EIS.

In compliance with 40 Code of Federal Regulations (CFR) 1502.25, this EIS has been prepared concurrently with and integrated with the environmental impact analyses and related surveys and studies required by other environmental review laws and executive orders. Under each resource topic, the EIS describes the relevant laws and evaluates whether the Proposed Action and the alternatives would be in compliance with those environmental laws and executive orders. This appendix provides additional background information on those laws, regulations, and executive orders.

In compliance with 40 CFR 1506.2, this EIS also includes consideration of state and local laws, regulations, and planning processes and evaluates whether the Proposed Action and the alternatives would be consistent with approved state or local plans and laws. This appendix provides additional background information on those state and local laws, regulations, and plans.

Weblinks have been provided throughout this appendix for each regulation as well as where additional information may be available when possible.

SECTION 2 Biological Resources

Biological resources within the project area are regulated by federal, state, and local laws and policies, described below.

2.1 Federal

2.1.1 Noxious Weed Act

The Noxious Weed Act established a federal program to control the spread of noxious weeds, giving the Secretary of Agriculture the authority to designate plants as noxious weeds by regulation and prohibiting the movement of all such weeds in interstate or foreign commerce except under permit. The Secretary was also given authority to inspect, seize, and destroy products and to quarantine areas, if necessary, to prevent the spread of such weeds. The act also authorized the Secretary of Agriculture to cooperate with other federal, state, and local agencies, farmers associations, and private individuals in measures to control, eradicate, or prevent or retard the spread of such weeds.

Noxious Weed Act	
Citation	7 United States Code (U.S.C.) 2801 et seq.
Regulation	http://www.fws.gov/laws/lawsdigest/FEDNOX.HTML
Additional Information	http://en.wikipedia.org/wiki/Federal_Noxious_Weed_Act_of_1974

2.1.2 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (FWCA) provides the basic authority for U.S. Fish and Wildlife Service (USFWS) involvement in evaluating impacts on fish and wildlife from proposed water resource development projects. It requires that fish and wildlife resources receive equal consideration to other project features. It also requires federal agencies that construct, license, or permit water resource development projects to first consult with the USFWS and the National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS) and the respective state's fish and wildlife agency regarding the impacts on fish and wildlife resources and measures to mitigate these impacts. Under the FWCA, USFWS will prepare an FWCA report that includes an evaluation of impacts on fish and wildlife from the project and required mitigation measures and other recommendations to address these impacts.

Fish and Wildlife Coordination Act	
Citation	16 U.S.C. 661 et seq.
Regulation	http://www.fws.gov/laws/lawsdigest/fwcoord.html
Additional Information	http://www.fws.gov/habitatconservation/fwca.html

2.1.3 Migratory Bird Treaty Act of 1918

The Migratory Bird Treaty Act of 1918 (MBTA) protects selected species of birds that cross international boundaries (i.e., species that occur in more than one country at some point during their annual life cycle). The law applies to the removal of nests, eggs, and feathers. The MBTA (Division E, Title I, Section 143 of the Consolidated Appropriations Act, 2005, Public Law [P.L.] 108–447) amends the MBTA such that non-native birds or birds that have been introduced by humans to the United States or its territories are excluded from protection under the act. It defines a native migratory bird as a species present in the United States and its territories as a result of natural biological or ecological processes.

Migratory Bird Treaty Act of 1918	
Citation	16 U.S.C. 703–712
Regulation	https://www.fws.gov/laws/lawsdigest/migtrea.html
Additional Information	http://www.fws.gov/migratorybirds/regulationspolicies/mbta/mbtintro.html

2.1.4 National Wild and Scenic Rivers System

The National Wild and Scenic Rivers System was created in 1968 to preserve rivers with outstanding natural, cultural, and recreational value in a free-flowing condition.

National Wild and Scenic Rivers System	
Citation	16 U.S.C. 1271 et seq.; P.L. 90–542
Regulation	http://www.gpo.gov/fdsys/pkg/USCODE-2011-title16/pdf/USCODE-2011-title16-chap28-sec1271.pdf https://www.wilderness.net/NWPS/documents/publiclaws/PDF/90-542.pdf
Additional Information	http://www.rivers.gov/

2.1.5 Marine Mammal Protection Act

The Marine Mammal Protection Act prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S.

Marine Mammal Protection Act	
Citation	16 U.S.C. 1361 et seq.
Regulation	http://www.nmfs.noaa.gov/pr/pdfs/laws/mmpa.pdf
Additional Information	http://www.nmfs.noaa.gov/pr/laws/mmpa/

2.1.6 Magnuson-Stevens Fisheries Conservation and Management Act

The Magnuson-Stevens Fisheries Conservation and Management Act (MSA), also known as the Sustainable Fisheries Act (P.L. 104–297), designates essential fish habitat (EFH) for certain commercially managed marine and anadromous fish species. The EFH provisions of the MSA are designed to protect fisheries' habitat of commercially managed species, including anadromous fish species, from being lost because of disturbance and degradation. The MSA requires all federal agencies to consult with the Secretary of Commerce on activities or proposed activities that are authorized, funded, or undertaken by that agency that may adversely affect EFH.

Magnuson-Stevens Fisheries Conservation and Management Act	
Citation	16 U.S.C. 1801 et seq., P.L. 104–297
Regulation	http://www.nmfs.noaa.gov/sfa/magact/
Additional Information	http://www.nmfs.noaa.gov/msa2007/

2.1.7 Clean Water Act

The Clean Water Act (CWA) is the primary federal law protecting the quality of the nation's waters, including lakes, rivers, coastal wetlands, and groundwater. The primary objective of the CWA is to maintain or improve the nation's water quality, in part, by reducing or preventing discharges of both point and nonpoint sources of pollution. The primary principle is that any pollutant discharge into the nation's waters is prohibited unless specifically authorized by a permit; permit review is the CWA's primary regulatory tool. Several sections of the CWA apply to this project: Section 303 (Water Quality Standards and Implementation Plans), Section 401 (Water Quality Certification), Section 402 (National Pollutant Discharge Elimination System [NPDES]), and Section 404 (regulation of discharges of dredge or fill material into waters of the United States, including wetlands per 33 U.S.C. 1344). The U.S. Environmental Protection Agency (EPA) guidelines (40 CFR 230 et seq.) and U.S. Army Corps of Engineers (USACE) regulatory guidelines (33 CFR 320 et seq.) are the substantive environmental criteria used to evaluate permit applications submitted to USACE. The CWA includes provisions for reducing soil erosion to preserve water quality.

Clean Water Act	
Citation	33 U.S.C. 1251 et seq.
Regulation	http://www.epw.senate.gov/water.pdf
Additional Information	http://www2.epa.gov/laws-regulations/summary-clean-water-act

2.1.8 Endangered Species Act

The Endangered Species Act (ESA) provides for the protection of federally listed species and the ecosystems on which they depend.

- Section 7 of the federal ESA (16 U.S.C. 1536) requires federal agencies to consult with the USFWS or NMFS, as appropriate, to ensure actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of threatened or endangered species or result in the destruction or adverse modification of critical habitat.

- Section 9 of the federal ESA (16 U.S.C. 1538) prohibits the "take" of any plant, fish, or wildlife species listed under the federal ESA as endangered unless otherwise authorized by federal regulations. Under the federal ESA, "take" is to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct.

- The "Programmatic Restoration Opinion for Joint Ecosystem Conservation by the Services (PROJECTS) Programmatic (USFWS and NOAA Restoration Center), Oregon, Washington, Idaho" was prepared by NMFS pursuant to Section 7(a)(2) of the ESA and applies to aquatic restoration actions proposed to be funded or carried out by the USFWS and the NOAA Restoration Center in the states of Oregon, Washington, and Idaho.

Additional information may be found at: http://www.habitat.noaa.gov/pdf/2013_12-03_PROJECTS_NWR-2013-10221.pdf

Endangered Species Act	
Citation	16 U.S.C. 1531–1544
Regulation	http://www.fws.gov/endangered/esa-library/pdf/ESAall.pdf
Additional Information	http://www.fws.gov/endangered/laws-policies/

2.1.9 Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (BGEPA) requires measures to prevent the harassment and take of Bald eagles resulting from human activities. The BGEPA provides for the protection of the Bald eagle and the Golden eagle (as amended in 1962) by prohibiting the take, possession, sale, purchase, barter, transport, export, or import of any Bald or Golden eagle, alive or dead, including any part, nest, or egg, unless allowed by permit.

Bald and Golden Eagle Protection Act	
Citation	16 CFR 668
Regulation	http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&sid=9a2c074a271d17db16c4a0fa4ca3d2ba&tpl=/ecfrbrowse/Title50/50cfr22_main_02.tpl
Additional Information	http://www.fws.gov/midwest/midwestbird/eaglepermits/bagepa.html

2.1.10 Executive Order 11988 – Floodplain Management

Executive Order (EO) 11988 – Floodplain Management requires federal agencies to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. EO 11988 prohibits federal agencies from funding activities that have an adverse effect on the 100-year floodplain unless there is no practicable alternative.

Executive Order 11988 – Floodplain Management	
Citation	42 Federal Register (FR) 26951, 44 CFR 9
Regulation	http://water.epa.gov/lawsregs/guidance/wetlands/eo11988.cfm
Additional Information	https://www.fema.gov/environmental-planning-and-historic-preservation-program/executive-order-11988-floodplain-management

2.1.11 Executive Order 11990 – Protection of Wetlands

EO 11990 – Protection of Wetlands requires federal agencies to take action to minimize the destruction or modification of wetlands by considering both direct and indirect impacts to wetlands. Furthermore, EO 11990 requires that federal agencies proposing to fund a project that could adversely affect wetlands consider alternatives to avoid such effects. EO 11990 assures the protection, preservation, and enhancement of the nation's wetlands to the fullest extent practicable.

Executive Order 11990 – Protection of Wetlands	
Citation	42 FR 26961, 44 CFR 9
Regulation	http://water.epa.gov/lawsregs/guidance/wetlands/eo11990.cfm
Additional Information	https://www.fema.gov/environmental-planning-and-historic-preservation-program/executive-order-11990-protection-wetlands

2.1.12 Executive Order 13112 – Invasive Species

EO 13112 Invasive Species requires federal agencies to prevent the introduction of invasive species; provide for their control; and minimize the economic, ecological, and human health impacts that invasive species cause. Specifically, EO 13112 requires that federal agencies not authorize, fund, or implement actions likely to introduce or spread invasive species unless the agency has determined the benefits outweigh the potential harm caused by invasive species and all feasible and prudent measures to minimize harm have been implemented.

Executive Order 13112 – Invasive Species	
Citation	64 FR 6183
Regulation	http://www.gpo.gov/fdsys/pkg/FR-1999-02-08/pdf/99-3184.pdf
Additional Information	http://www.invasivespeciesinfo.gov/laws/execorder.shtml

2.1.13 Pacific Coast Salmon Fishery Management Plan

The Pacific Coast Salmon Fishery Management Plan (Pacific Fisheries Management Council 1997, as amended) guides management of salmon fisheries in federal waters off the coast of Washington, Oregon, and California. The plan covers the coastwide aggregate of natural and hatchery salmon encountered in ocean salmon fisheries and provides management objectives and allocation provisions for Chinook, coho, and pink salmon. The plan also includes identification of EFH for Chinook, coho, and pink salmon in ocean, estuary, and freshwater and contains recommendations for measures to avoid or mitigate for impacts to salmon EFH and a description of the social and economic fishery characteristics.

Pacific Coast Salmon Fishery Management Plan	
Citation	Not Applicable (N/A)
Regulation	N/A
Additional Information	http://www.pcouncil.org/salmon/fishery-management-plan/current-management-plan/

2.2 State

2.2.1 Oregon Removal-Fill Law

Oregon Department of State Lands (DSL) – Oregon Removal-Fill Law requires permits to be obtained before removing or placing fill material in waters of the state to protect public navigation as well as fishery and recreational uses of waters.

Oregon Removal-Fill Law	
Citation	Oregon Revised Statutes (ORS) 196 et seq.
Regulation	http://www.oregonlaws.org/ors/196.795
Additional Information	http://www.oregon.gov/dsl/permits/pages/r-fintro.aspx

2.2.2 Oregon Endangered Species Act

Project activities that may impact or take plant species protected under the Oregon Endangered Species Act require consultation with the Oregon Department of Agriculture and compliance with the no net loss policy for impact mitigation.

Oregon Endangered Species Act	
Citation	ORS 496 et seq.
Regulation	http://www.oregonlaws.org/ors/chapter/496
Additional Information	http://www.dfw.state.or.us/wildlife/diversity/species/threatened_endangered_species.asp

2.2.3 Oregon Noxious Weed Control Law

The Oregon Noxious Weed Control Law authorizes the Oregon Department of Agriculture (ODA) to protect Oregon's natural resources from the invasion and proliferation of exotic noxious weeds, including the implementation of weed control and management projects.

Oregon Noxious Weed Control Law	
Citation	ORS 569
Regulation	https://www.oregonlegislature.gov/bills_laws/lawsstatutes/2013ors569.html
Additional Information	http://www.oregon.gov/ODA/programs/Weeds/OregonNoxiousWeeds/Pages/Law.aspx

2.2.4 Oregon Statewide Planning Goals and Guidelines

Oregon Statewide Planning Goals and Guidelines consist of 19 statewide planning goals that express the state's policies on land use and related topics such as citizen involvement, housing, and natural resources. The goals, adopted as administrative rules, are achieved through local comprehensive planning. State law requires each city and county to have a comprehensive plan and the zoning and land-division ordinances needed to put the plan into effect. The local comprehensive plans must be consistent with the statewide planning goals. This planning system defines specific criteria for the management of estuarine resources (Goal 16), coastal shorelands (Goal 17), beaches and dunes (Goal 18), and ocean resources (Goal 19).

Oregon Statewide Planning Goals and Guidelines	
Citation	Oregon Administrative Rules (OAR) 660-015-0000(1-6, 8-14), OAR 660-015-0005, and 660-015-0010(1-4)
Regulation	http://www.oregon.gov/lcd/pages/goals.aspx
Additional Information	http://www.oregon.gov/LCD/docs/goals/compilation_of_statewide_planning_goals.pdf

2.2.5 Oregon Department of Fish and Wildlife (ODFW) Requirements

ODFW requirements include In-Water Timing Guidelines, Fish Passage, Fish and Wildlife Habitat Mitigation, and compliance with the Oregon Conservation Strategy.

ODFW Requirements	
Citation	Fish Passage: OAR 635-412-0010 through OAR 635-412-0040 Fish and Wildlife Habitat Mitigation: OAR 635-415-0000 through 635-415-0025
Regulation	N/A
Additional Information	In-water Timing Guidelines: http://www.dfw.state.or.us/lands/inwater/Oregon_Guidelines_for_Timing_of_%20InWater_work2008.pdf Fish Passage: http://www.dfw.state.or.us/OARs/412.pdf Fish and Wildlife Habitat Mitigation http://www.dfw.state.or.us/OARs/415.pdf Oregon Conservation Strategy: http://www.dfw.state.or.us/conservationstrategy/

2.3 Local

2.3.1 Tillamook Bay National Estuary Project Comprehensive Conservation Management Plan

The Tillamook Bay National Estuary Project (NEP) Comprehensive Conservation Management Plan (CCMP) was published in 1999 and sets forth a 10-year action plan for the protection and enhancement of Tillamook Bay's natural resources.

Tillamook Bay National Estuary Project Comprehensive Conservation Management Plan	
Citation	N/A
Regulation	N/A
Additional Information	http://www.tbnep.org/comprehensive-conservation-and-management-plan.php

2.3.2 Tillamook County Comprehensive Plan

The Tillamook County Comprehensive Plan (1982-2004) and the implementing Land Use and Land Division Ordinances were prepared and adopted by Tillamook County in compliance with Oregon's Statewide Planning Goals and Guidelines, statutes, and administrative rules. The plan and implementing ordinances provide findings, policies, and regulations that protect resource lands and manage growth in Tillamook County.

The Land Use Plan (Goal 2) establishes the goal of preserving resource lands, including farmlands. Agricultural Lands (Goal 3) describes the importance of farmland to the local and regional economy and sets forth polices for its protection.

Hazards (Goal 7) describes the policies for prevention of soil erosion such as restricting development on slopes of 15 percent or greater. Several policies are established to control erosion, including:

- Maintenance of existing vegetation in critical areas

- Rapid revegetation of exposed areas following construction
- The stabilization of shorelines and stream banks with vegetation and/or riprap
- Maintenance of riparian buffer strips
- Structural accommodation of increased runoff in areas of development
- Seasonal restriction of construction in critical areas
- Setback requirements for construction or structures near slope edge, stream banks, or other areas where erosion hazards may exist
- Any other measures deemed appropriate to deal with site-specific problems

Estuarine Resources (Goal 16) describes the general priorities (from highest to lowest) for management and use of estuarine resources. The priorities include (1) uses that maintain the integrity of the estuarine ecosystem; (2) water-dependent uses requiring estuarine location, as consistent with the overall Oregon Estuary Classification; (3) water-related uses that do not degrade or reduce the natural estuarine resources and values; and (4) non-dependent, non-related uses that do not alter, reduce, or degrade estuarine resources and values.

Coastal Shorelands (Goal 17) describes that lands designated as coastal shorelands are subject to both general priorities for the overall use of coastal shoreland as well as specific use priorities for certain special shoreland areas. General priorities for the overall use of coastal shorelands (from highest to lowest) shall be to (1) promote uses maintaining the integrity of estuaries and coastal waters; (2) provide for water-dependent uses; (3) provide for water-related uses; (4) provide for non-dependent, non-related uses that retain flexibility of future use and do not prematurely or inalterably commit shorelands to more intensive uses; (5) provide for development, including non-dependent, non-related uses, in urban areas compatible with existing or committed uses; and (6) permit non-dependent, non-related uses that cause a permanent or long-term change in the features of coastal shorelands only upon a demonstration of public need.

Goal 17 also establishes the following specific-use priorities for the following areas within coastal shorelands:

1. Major marshes, significant wildlife habitat, coastal headlands, and exceptional aesthetic resources inventoried in the coastal shoreland planning area shall be protected. Uses in these areas shall be consistent with protection of natural values. Such uses may include propagation and selective harvesting of forest products consistent with the Oregon Forest Practices Act, grazing, harvesting wild crops, and low-intensity water-dependent recreation.
2. Shorelands in urban and urbanizable areas and in rural areas built upon or irrevocably committed to non-resource use especially suited for water-dependent uses shall be protected for water-dependent recreational, commercial, and industrial uses.
3. Local governments shall determine whether there are any existing, developed commercial/industrial waterfront areas suitable for redevelopment that are not designated as especially suited for water-dependent uses. Plans shall be prepared for those areas allowing

for a mix of water-dependent, water-related and water-oriented non-dependent uses and shall provide for public access to the shoreline.

4. Shorelands in rural areas other than those built upon or irrevocably committed to non-resource use and those designated in item 1 above shall be used as appropriate for (a) farm uses as provided in ORS Chapter 215; (b) propagation and harvesting of forest products consistent with the Oregon Forest Practices Act; (c) private and public water-dependent recreation developments; (d) aquaculture; and (e) water-dependent commercial and industrial uses, water-related uses, and other uses only upon a finding by the county that such uses satisfy a need that cannot be accommodated on uplands or in urban and urbanizable areas or in rural areas built upon or irrevocably committed to non-resource use.

In addition to the Comprehensive Plan requirements for coastal shoreland boundary identification and coastal shoreland uses and activities, Goal 17 also establishes six implementation requirements dealing with the following areas or features within coastal shorelands:

1. The Oregon Department of Forestry shall recognize the unique and special values provided by coastal shorelands when developing standards and policies to regulate uses of forest lands within coastal shorelands. With other state and federal agencies, the Department of Forestry shall develop forest management practices and policies, including, where necessary, amendments to the Forest Practices Act rules and programs that protect and maintain the special shoreland values and forest uses, especially for natural shorelands and riparian vegetation.

2. Local government, with assistance from state and federal agencies, shall identify coastal shoreland areas that may be used to fulfill the mitigation requirement of the Estuarine Resources Goal. These areas shall be protected from new uses and activities that would prevent their ultimate restoration or addition to the estuarine ecosystem.

3. Coastal shorelands identified under the Estuarine Resources Goal for dredged material disposal shall be protected from new uses and activities that would prevent their ultimate use for dredged material disposal.

4. Because of the importance of the vegetative fringe adjacent to coastal waters to water quality, fish and wildlife habitat, recreational use, and aesthetic resources, riparian vegetation shall be maintained and, where appropriate, restored and enhanced, consistent with water-dependent uses.

5. Land-use management practices and non-structural solutions to problems of erosion and flooding shall be preferred to structural solutions. Where shown to be necessary, water and erosion control structures, such as jetties, bulkheads, seawalls, and similar protective structures, and fill – whether located in the waterways or on shorelands above ordinary high water mark – shall be designed to minimize adverse impacts on water currents, erosion, and accretion patterns.

6. Local government in coordination with the State Parks and Recreation Department shall develop and implement a program to provide increased public access. Existing public ownerships, rights of way, and similar public easements in coastal shorelands, which provide

access to or along coastal waters, shall be retained or replaced if sold, exchanged, or transferred. Rights of way may be vacated to permit redevelopment of shoreland areas, provided public access across the affected site is retained.

Tillamook County Comprehensive Plan	
Citation	N/A
Regulation	http://www.co.tillamook.or.us/gov/ComDev/Planning/compplan.htm
Additional Information	N/A

2.3.3 Tillamook County Land Use Regulations

Tillamook County land use regulations apply to the use of public and private lands in the county and include designation of areas within urban growth boundaries, rural development, farm lands, forest resource management, and coastal zone management in compliance with statewide planning goals.

Tillamook County Land Use Regulations	
Citation	N/A
Regulation	http://www.co.tillamook.or.us/gov/comdev/planning/luo.htm
Additional Information	N/A

2.3.4 City of Tillamook Comprehensive Plan

The City of Tillamook developed its 2012 Comprehensive Plan, which is consistent with the state planning goals. The City of Tillamook Comprehensive Plan (2012) describes Water Resources Protection Overlay Districts to implement the Significant Wetland and Riparian Corridor Resource protections. This overlay district is intended to protect habitat for fish and other aquatic life, protect habitat for wildlife, protect water quality for human uses and for aquatic life, control erosion and limit sedimentation, limit development in significant riparian corridors, and reduce the effects of flooding.

City of Tillamook land use regulations apply to public and private lands within the City of Tillamook and outline land use policies set forth to meet statewide planning goals.

The goal for economic development is to diversify and improve the local economy. Tillamook has identified the following objectives for this goal:

- Objective 1: To improve the economic vitality of the Tillamook area and revitalize the Tillamook City downtown
- Objective 2: To create more and better jobs in Tillamook, raise per capita income, and have the resulting wealth be retained and reinvested in the community so as to create a better quality of life for all

Policies D-50, D-53, D-57, and D-58 address recreation and open space:

- Policy D-50: The city shall conserve open space and protect natural and scenic resources for recreational facilities. Efforts must be taken to maintain and preserve the existing and future environment in and around the community.
- Policy D-53: The park and recreation areas in the city shall be developed to accommodate the growing need for recreational areas in natural settings and shall be identified on the Comprehensive Plan Map.
- Policy D-57: The city shall continue to explore the feasibility of waterfront parks along the Hoquarten Slough and the abandoned railroad right-of-way and extend the park trails.
- Policy D-58: Tillamook City shall cooperate with appropriate agencies in maintaining its recreational vitality.

City of Tillamook Comprehensive Plan	
Citation	N/A
Regulation	http://tillamookor.gov/comprehensive-plan/
Additional Information	N/A

SECTION 3 Water Resources

Water resources within the project area are regulated by federal, state, and local laws and policies, described below.

3.1 Federal

3.1.1 River and Harbors Act

Section 10 of the Rivers and Harbors Act of 1899 prohibits the unauthorized obstruction or alteration of any navigable water of the United States. This section provides that the construction of any structure in or over any navigable water of the United States, or the accomplishment of any other work affecting the course, location, condition, or physical capacity of such waters is unlawful unless the work has been authorized by USACE.

River and Harbors Act	
Citation	33 U.S.C. 403
Regulation	http://water.epa.gov/lawsregs/guidance/wetlands/sect10.cfm
Additional Information	http://en.wikipedia.org/wiki/Rivers_and_Harbors_Act

3.1.2 Clean Water Act

See Section 2.1.7 under Biological Resources.

3.1.3 Safe Drinking Water Act

Under the Safe Drinking Water Act, the EPA sets standards for drinking water quality and oversees the states, localities, and water suppliers who implement those standards.

Safe Drinking Water Act	
Citation	42 U.S.C. 201 et seq.
Regulation	http://www.epw.senate.gov/sdwa.pdf
Additional Information	http://www.epa.gov/ogwdw/sdwa/

3.1.4 National Flood Insurance Act and Flood Disaster Protection Act

National Flood Insurance Act makes flood insurance available. The Flood Disaster Protection Act made the purchase of flood insurance mandatory for the protection of property located in Special Flood Hazard Areas.

National Flood Insurance Act and Flood Disaster Protection Act	
Citation	42 U.S.C. 4001–4128
Regulation	http://www.fema.gov/media-library-data/20130726-1545-20490-9247/frm_acts.pdf
Additional Information	https://www.fema.gov/media-library/assets/documents/7277#

3.1.5 Sole Source Aquifers

Sole source aquifer designation is one tool to protect drinking water supplies in areas with few or no alternative sources to the groundwater resource, and where, if contamination occurred, using an alternative source would be extremely expensive. The designation protects an area's groundwater resource by requiring EPA to review all proposed projects within the designated area that would receive federal financial assistance. All proposed projects receiving federal funds are subject to review to ensure the projects do not endanger the groundwater source. EPA defines a sole or principal source aquifer as one that supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer. These areas may have no alternative drinking water source(s) that could physically, legally, and economically supply all those who depend upon the aquifer for drinking water. For convenience, all designated sole or principal source aquifers are referred to as "sole source aquifers."

Sole Source Aquifers	
Citation	40 CFR 149
Regulation	http://www.gpo.gov/fdsys/pkg/CFR-2004-title40-vol21/pdf/CFR-2004-title40-vol21-part149.pdf
Additional Information	http://water.epa.gov/infrastructure/drinkingwater/sourcewater/protection/solesourceaquifer.cfm

3.1.6 Executive Order 11988: Floodplain Management

See Section 2.1.10 under Biological Resources.

3.1.7 Executive Order 11990: Protection of Wetlands

See Section 2.1.11 under Biological Resources.

3.1.8 FEMA Regulations

The Federal Emergency Management Agency (FEMA) regulations are contained in 44 CFR, Emergency Management and Assistance. These regulations cover insurance and hazard mitigation, fire prevention and control, disaster assistance, and preparedness. The regulations also describe the 8-step process used to evaluate potential impacts and alternatives to projects proposed in floodplains and wetlands.

FEMA Regulations	
Citation	44 CFR
Regulation	http://www.gpo.gov/fdsys/pkg/CFR-2002-title44-vol1/pdf/CFR-2002-title44-vol1.pdf
Additional Information	N/A

3.2 State

3.2.1 Oregon Department of Environmental Quality (ODEQ) Water Quality Certification

Section 401 of the CWA authorizes ODEQ to ensure activities meet water quality standards established by the state under the CWA.

ODEQ Water Quality Certification	
Citation	N/A
Regulation	N/A
Additional Information	http://www.deq.state.or.us/wq/sec401cert/removalfill.htm

3.2.2 ODEQ NPDES Stormwater Discharge Permit 1200-C

The NPDES 1200-C general permit regulates stormwater runoff from construction activities that disturb 1 or more acres of land.

ODEQ NPDES Stormwater Discharge Permit 1200-C	
Citation	N/A
Regulation	N/A
Additional Information	http://www.deq.state.or.us/wq/stormwater/construction.htm http://www.deq.state.or.us/wq/stormwater/constappl.htm

3.2.3 Oregon Water Pollution Control Act

ORS 468B.048 establishes rules for standards of quality and purity of waters of the state in accordance with ORS 468B.015. This section of the statute presents the factors to be considered in establishing standards as well as the meeting of standards.

Oregon Water Pollution Control Act	
Citation	ORS 468B
Regulation	https://www.oregonlegislature.gov/bills_laws/lawsstatutes/2013ors468B.html
Additional Information	N/A

3.2.4 Oregon Removal-Fill Law

See Section 2.2.1 under Biological Resources.

3.2.5 Oregon Statewide Planning Goals and Guidelines

See Section 2.2.4 under Biological Resources.

3.3 Local

3.3.1 Tillamook County Comprehensive Plan

See Section 2.3.2 under Biological Resources.

3.3.2 City of Tillamook Comprehensive Plan

See Section 2.3.4 under Biological Resources.

SECTION 4 Geology and Soils

Geological and soil resources within the project area are regulated by federal and local laws and policies, as described below.

4.1 Federal

Clean Water Act

See Section 2.1.7 under Biological Resources.

Farmland Protection Policy Act

The Farmland Protection Policy Act (FPPA) is intended to minimize the impact federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses. Projects are subject to FPPA requirements if they may irreversibly convert farmland (directly or indirectly) to nonagricultural use and are completed by a federal agency or with assistance from a federal agency.

FPPA requires federal projects be compatible with state and local programs and policies to protect farmland. For the purpose of FPPA, farmland includes prime farmland, unique farmland, and land of statewide or local importance. Farmland subject to FPPA requirements does not have to be currently used for cropland. It can be forest land, pastureland, cropland, or other land, but not water or urban built-up land.

Farmland Protection Policy Act	
Citation	7 FR 658.2(a)
Regulation	http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17594.wba
Additional Information	http://www.nrcs.usda.gov/wps/portal/nrcs/detail/?cid=nrcs143_008275

Clean Air Act

See Section 6.1.1 under Air Quality.

4.2 State

There are no state regulations that address geology and soils.

4.3 Local

Tillamook Bay National Estuary Project Comprehensive Conservation Management Plan

See Section 2.3.1 under Biological Resources.

Tillamook County Comprehensive Plan

See Section 2.3.2 under Biological Resources.

City of Tillamook Comprehensive Plan

See Section 2.3.4 under Biological Resources.

SECTION 5 Coastal Resources

Coastal resources within the project area are regulated by federal, state, and local laws and policies, as described below.

5.1 Federal

Coastal Zone Management Act (P.L. 92-583)

The Coastal Zone Management Act of 1972 (CZMA) as implemented by 15 CFR Part 930 requires federal agencies to determine whether proposed activities that affect any land or water use or natural resource within the coastal zone shall be carried out in a manner that is consistent to the maximum extent practicable with the enforceable policies of approved state management programs.

Coastal Zone Management Act	
Citation	P.L. 92-583
Regulation	http://coast.noaa.gov/czm/act/
Additional Information	http://coast.noaa.gov/czm/about/

5.2 State

Coastal Zone Management Act Consistency Certification

Projects in the Oregon coastal zone, including most inland rivers and streams in that zone, must be consistent with the Oregon Coastal Management Program (OCMP) and the approved Coastal Zone Management Plan. The lead agency responsible for applying the standards of the OCMP is the Oregon Department of Land Conservation and Development (DLCD). DLCD reviews projects that affect coastal resources and makes a consistency determination, including any associated requirements. The federal consistency provision is an important feature of the CZMA, which requires federal activities to be consistent with enforceable state policies and programs.

Coastal Zone Management Act Consistency Certification	
Citation	N/A
Regulation	http://arcweb.sos.state.or.us/pages/rules/oars_600/oar_660/660_035.html
Additional Information	http://licenseinfo.oregon.gov/index.cfm?fuseaction=license_seng&link_item_id=26433

Oregon Statewide Planning Goals

See Section 2.2.4 under Biological Resources.

5.3 Local

Tillamook County Comprehensive Plan and City of Tillamook Comprehensive Plan

See Sections 2.3.2 and 2.3.4 under Biological Resources, specifically Goals 16 and 17.

SECTION 6 Air Quality

Air quality within the project area is regulated by federal and state laws and policies, as described below.

6.1 Federal

6.1.1 Clean Air Act

The federal statute that addresses criteria pollutants is the Clean Air Act (CAA). The CAA was first enacted in 1955 and has been amended numerous times in subsequent years (1963, 1965, 1967, 1970, 1977, 1990, and 1997). EPA implements the CAA through development and adoption of rules codified under 40 CFR, Subchapter C – Air Programs. EPA has generally applied a two-pronged approach to controlling air pollution: (1) setting National Ambient Air Quality Standards (NAAQS) that define maximum pollution levels in air that are still protective of human health and welfare and (2) developing emission standards for sources of air pollutants to reduce pollutant emissions to the atmosphere.

The CAA includes provisions for reducing soil erosion to preserve air quality. Exposed soil surfaces are vulnerable to wind erosion, which carries small soil particulates into the atmosphere. Suspended particulate matter is one of the six criteria air pollutants regulated under the CAA.

Clean Air Act	
Citation	P.L. 88–206
Regulation	http://www.gpo.gov/fdsys/pkg/STATUTE-77/pdf/STATUTE-77-Pg392.pdf
Additional Information	http://www.epa.gov/air/caa/

6.1.2 National Ambient Air Quality Standards

Under the authority granted by the CAA, EPA has established NAAQS for the following criteria air pollutants: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3)[1], particulate matter 10 micrometers (μm) or less in diameter (PM_{10}), particulate matter 2.5 μm or less in diameter ($PM_{2.5}$)[2], and sulfur dioxide (SO_2). Primary NAAQS were established to protect human health while secondary NAAQS were created to protect public welfare and take into consideration such factors as damage to crops, architecture and ecosystems, and visibility in scenic areas.

Table C-1 presents the NAAQS currently in effect for criteria air pollutants.

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1 *Ozone (smog) is a secondary pollutant, meaning it is formed in the atmosphere through a reaction of precursor compounds in the presence of sunlight. The important precursors for O_3 formation are oxides of nitrogen (NOx) and volatile organic compounds (VOC). Air quality impact analyses for O_3 typically assess the increase in emissions of NOx and VOC.*

2 *$PM_{2.5}$ is made up of directly emitted particulate matter as well as secondary particulate matter formed through reactions of precursor compounds. The important gaseous precursors for $PM_{2.5}$ formation are NOx, VOC, sulfur oxides (SOx), and ammonia (NH_3).*

Table C-1. National Ambient Air Quality Standards (NAAQS)

Pollutant	Averaging Time	Primary NAAQS	Secondary NAAQS	Violation Criteria
CO	1 Hour	35 ppm ($40\ mg/m^3$)	--	Not to be exceeded more than once per year
	8 Hour	9 ppm ($10\ mg/m^3$)	--	
Pb	Rolling 3-Month Average	$0.15\ \mu g/m^3$		Not to be exceeded
NO_2	1 Hour	100 ppb ($188\ \mu g/m^3$)	--	98th percentile, averaged over 3 years
	Annual	0.053 ppm ($100\ \mu g/m^3$)	Same as Primary Standard	Annual mean
O_3	8 Hour	0.075 ppm ($147\ \mu g/m^3$)	Same as Primary Standard	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
PM_{10}	24-Hour	$150\ \mu g/m^3$	Same as Primary Standard	Not to be exceeded more than once per year on average over 3 years
$PM_{2.5}$	24 Hour	$35\ \mu g/m^3$	Same as Primary Standard	98th percentile, averaged over 3 years
	Annual	$12.0\ \mu g/m^3$	$15\ \mu g/m^3$	Annual mean, averaged over 3 years
SO_2	1 Hour	75 ppb ($196\ \mu g/m^3$)	--	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	3 Hour	--	0.5 ppm ($1{,}300\ \mu g/m^3$)	Not to be exceeded more than once per year
	24 Hour	0.14 ppm ($366\ \mu g/m^3$)[1]	--	Not to be exceeded more than once per year
	Annual	0.030 ppm ($79\ \mu g/m^3$)[1]	--	Annual mean

Source: 40 CFR 50

Notes:

1 - On June 22, 2010, the 24-hour and annual primary SO_2 NAAQS were revoked (75 FR 35520). The 1971 SO_2 NAAQS (0.14 parts per million [ppm] and 0.030 ppm for 24-hour and annual averaging periods) remain in effect until 1 year after an area is designated for the 2010 1-hour primary standard. The State of Oregon recommended that all of Oregon be designated unclassifiable for the 1-hour SO_2 NAAQS (Kitzhaber 2011). Although EPA designated as nonattainment most areas in locations where existing monitoring data from 2009 to 2011 indicated violations of the 1-hour SO_2 NAAQS, they deferred action on all other areas. As a result, EPA has not yet finalized area designations for Oregon (78 FR 47191).

Key:

-- = no standard

$\mu g/m^3$ = micrograms per cubic meter

mg/m^3 = milligrams per cubic meter

ppb = parts per billion

ppm = parts per million

The CAA also specifies future dates for achieving compliance with the NAAQS and mandates states submit and implement a state implementation plan for local areas not meeting these standards (nonattainment areas). These plans must include pollution control measures and demonstrate through modeling that the standards would be met by the specified attainment date. Once a nonattainment area has achieved the NAAQS for a given pollutant, it can be redesignated as an attainment/maintenance area, which is subject to maintenance plans itemizing how the area would continue to meet the NAAQS.

National Ambient Air Quality Standards	
Citation	P.L. 88–206
Regulation	http://www.epa.gov/air/criteria.html
Additional Information	ttp://www.gpo.gov/fdsys/pkg/CFR-2014-title40-vol2/pdf/CFR-2014-title40-vol2-part51.pdf

6.1.3 General Conformity

On November 30, 1993, EPA promulgated a set of regulations, known as the general conformity rule, that included procedures and criteria for determining whether a proposed federal action would conform to the applicable state implementation plans. The purpose of the general conformity rule is to ensure federal activities do not cause or contribute to new violations of the NAAQS, actions do not cause additional or worsen existing violations of or contribute to new violations of the NAAQS, and attainment of the NAAQS is not delayed.

Before any approval is given for a federal action, an applicability analysis must be conducted to see whether a conformity determination is required. According to the applicability analysis, the general conformity regulations would apply for all federal actions except those that are:

- Covered by transportation conformity
- Have emissions clearly at or below *de minimis* levels
- Classified as an exempt action in the rule
- Covered by a presumed-to-conform approved list

EPA created *de minimis* emission levels to limit the need to conduct conformity determinations for federal projects with minimal potential emission increases. EPA created *de minimis* emission levels for each criteria pollutant, and the *de minimis* levels for any project are based on the attainment status of the project area. When the total direct and indirect emissions from a proposed project are below the *de minimis* levels, the project would not be subject to a conformity determination. Because the general conformity *de minimis* thresholds are only applicable to federal actions in areas designated nonattainment or maintenance, the general conformity regulation does not apply to the Proposed Action because Tillamook County is designated attainment for all pollutants.

General Conformity	
Citation	40 CFR 93, Subpart B
Regulation	http://www.gpo.gov/fdsys/pkg/CFR-2014-title40-vol20/pdf/CFR-2014-title40-vol20-part93-subpartB.pdf
Additional Information	http://www.epa.gov/air/genconform/

6.2 State

6.2.1 State Ambient Air Quality Standards

In addition to the NAAQS, the State of Oregon also has established ambient air quality standards. The ambient standards set forth in OAR 340-202-0050 through 340-202-0130 were established to protect public health and public welfare. **Table C-2** summarizes the Oregon standards.

Table C-2. State Ambient Air Quality Standards

Pollutant	Averaging Time	State AAQS	Violation Criteria
CO	1 Hour	35 ppm	Not to be exceeded more than once per year
	8 Hour	9 ppm	
Pb	Calendar quarter	0.15 µg/m^3	Not to be exceeded
NO_2	1 Hour	0.100 ppm	98th percentile, averaged over 3 years
	Annual	0.053 ppm	Annual mean
O_3	8 Hour	0.075 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
PM_{10}	24 Hour	150 µg/m^3	Not to be exceeded more than once per year
$PM_{2.5}$	24 Hour	35 µg/m^3	98th percentile, averaged over 3 years
	Annual	15 µg/m^3	Annual mean, averaged over 3 years
SO_2	1 Hour	0.075 ppm	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	3 Hour	0.50 ppm	Not to be exceeded more than once per year
	24 Hour	0.10 ppm	Not to be exceeded more than once per year
	Annual	0.02 ppm	Annual mean
Particle Fallout	Industrial Area	10 g/m^2	Not to be exceeded
	Residential and commercial areas	5.0 g/m^2	Not to be exceeded
	Residential and commercial areas	3.5 g/m^2	Not to be exceeded

Source: OAR 340-202-0050 et seq.
Notes:
1 - Also applicable in industrial areas if visual observations show a presence of wood waste or soot and the volatile fraction of the sample exceeds 70 percent.
2 - Only applicable in residential and commercial areas if visual observations show a presence of wood waste or soot and the volatile fraction of the sample exceeds 70 percent.
Key:

AAQS = ambient air quality standard
g/m^2 = grams per square meter
$\mu g/m^3$ = micrograms per cubic meter
ppm = parts per million

State Ambient Air Quality Standards	
Citation	OAR, Chapter 340, Division 202
Regulation	http://arcweb.sos.state.or.us/pages/rules/oars_300/oar_340/340_202.html
Additional Information	http://www.deq.state.or.us/aq/planning/

6.2.2 Oregon Air Pollution Control

ORS 468A et seq. regulates air pollution control in Oregon. The air pollution control regulations are intended to restore and maintain the quality of air resources in the state, provide for a coordinated statewide program of air quality control, and facilitate cooperation among local governments in establishing and supporting air quality control programs.

Oregon Air Pollution Control	
Citation	ORS 468A et seq.
Regulation	https://www.oregonlegislature.gov/bills_laws/ors/ors468A.html
Additional Information	http://www.oregon.gov/deq/aq/pages/index.aspx

6.3 Local

There are no local regulations related to air quality.

SECTION 7 Climate Change

Climate change is regulated by federal and state laws and policies, as described below.

7.1 Federal

7.1.1 Executive Order 13653 – Preparing the United States for the Impacts of Climate Change

EO 13653, signed by President Obama in November 2013, directs federal agencies to pursue new strategies to improve the nation's preparedness and resilience to climate change. The EO formed the State, Local, and Tribal Leaders Task Force on Climate Preparedness and Resilience (Task Force) to recommend how the federal government could assist communities dealing with climate change by removing barriers to resilient investments, modernizing federal grant and loan programs, and developing the information and tools needed to assist with preparation. In November 2014, the Task Force published its Recommendations to the President that included the following key points:

- Building resilient communities
- Improving resilience in the nation's infrastructure
- Ensuring resilience of natural resources
- Preserving human health and supporting resilient populations
- Supporting climate-smart hazard mitigation and disaster preparedness and recovery
- Understanding and acting on the economics of resilience
- Building capacity for resilience

The Task Force also recommended the federal government establish a process for tracking and reporting on progress made in implementing the recommendations.

Executive Order 13653 – Preparing the United States for the Impacts of Climate Change	
Citation	78 FR 66819 - 66824
Regulation	http://www.whitehouse.gov/the-press-office/2013/11/01/executive-order-preparing-united-states-impacts-climate-change
Additional Information	N/A

7.2 State

7.2.1 Oregon House Bill 3543 – Global Warming Actions

Oregon House Bill 3543 establishes the following greenhouse gas (GHG) emission reduction goals for Oregon:

- By 2010, arrest the growth of Oregon's GHG emissions and begin to reduce GHG emissions.
- By 2020, achieve GHG levels that are 10 percent below 1990 levels.
- By 2050, achieve GHG levels that are at least 75 percent below 1990 levels.

The bill also created the Oregon Global Warming Commission, which includes members representing the social, environmental, cultural, and economic diversity of the state. The Oregon Global Warming Commission is required to recommend ways to coordinate state and local efforts to reduce GHG emissions in Oregon and prepare for the effects of climate change.

Oregon House Bill 3543	
Citation	N/A
Regulation	https://olis.leg.state.or.us/liz/2007R1/Downloads/MeasureDocument/HB3543
Additional Information	http://www.oregon.gov/ENERGY/GBLWRM/Pages/HB3543.aspx

7.3 Local

There are no local regulations related to climate change.

SECTION 8 Cultural Resources

Cultural resources within the project area are regulated by federal and state laws and policies, as described below.

8.1 Federal

8.1.1 National Historic Preservation Act, Section 106

The National Historic Preservation Act (NHPA), Section 106, requires federal agencies to determine whether a project has the potential to affect historic resources and identify potentially affected historic resources. If a project has the potential to affect historic resources, there are additional requirements to consult with the state historic preservation officer and tribes and seek input from the public. The process for compliance with Section 106 is detailed in 36 CFR Part 800.

National Historic Preservation Act, Section 106	
Citation	54 U.S.C. 300101, et seq.
Regulation	http://www.achp.gov/docs/nhpa%202008-final.pdf; http://www.achp.gov/news-nhpa-move.html
Additional Information	http://www.achp.gov/106summary.html

8.1.2 Executive Order 13084 – Consultation and Coordination with Indian Tribal Governments

EO 13084 – Consultation and Coordination with Indian Tribal Governments, which was superseded on November 6, 2000 by the identically titled EO 13175, sets forth guidelines for all federal agencies to (1) establish regular and meaningful consultation and collaboration with Indian tribal officials in the development of federal policies that have tribal implications; (2) strengthen the United States government-to-government relationships with Indian tribes; and (3) reduce the imposition of unfunded mandates upon Indian tribes.

Executive Order 13084 – Consultation and Coordination with Indian Tribal Governments	
Citation	63 FR 27655
Regulation	http://www.nps.gov/nagpra/AGENCIES/EO_13084.HTM
Additional Information	N/A

8.2 State

8.2.1 Indian Graves and Protected Objects

The Indian Graves and Protected Objects law outlines the protocols to be followed in the event archaeological objects or sites are encountered.

Indian Graves and Protected Objects	
Citation	ORS 97.740-760
Regulation	http://www.oregonlaws.org/ors/97.740
Additional Information	N/A

8.2.2 Archaeological Objects and Sites

The Archaeological Objects and Sites regulation provides definition of archaeological sites 75 years of age or older, significance, and cultural patrimony and prohibits sale and exchange of cultural items or damage to archaeological sites on public and private lands. Items of cultural patrimony or associated with human remains are protected everywhere, unless the activity is authorized by an archaeological excavation permit.

Archeological Objects and Sites	
Citation	ORS 358.905-961; ORS 390.235
Regulation	https://www.oregonlegislature.gov/bills_laws/lawsstatutes/2013ors358.html
Additional Information	N/A

8.2.3 Oregon State Historic Preservation Office (SHPO) "Archaeological Reporting Guidelines"

The Oregon SHPO "Archaeological Reporting Guidelines" outline the survey standards and expectations and provide direction for the preparation and submission of archaeological site record forms along with the accompanying survey reports.

Oregon SHPO "Archaeological Reporting Guidelines"	
Citation	N/A
Regulation	http://www.oregon.gov/oprd/HCD/ARCH/docs/state_of_oregon_archaeological_survey_and_reporting_standards.pdf
Additional Information	N/A

8.2.4 Oregon SHPO "Guidelines for Conducting Field Archaeology in Oregon"

The Oregon SHPO "Guidelines for Conducting Field Archaeology in Oregon" describe widely accepted archaeological practices used in the Pacific Northwest and encourage the selection of efficient and cost-effective methods and techniques.

Oregon SHPO "Guidelines for Conducting Field Archaeology in Oregon"	
Citation	N/A
Regulation	http://www.oregon.gov/oprd/HCD/ARCH/docs/final_field_guidelines%202013.pdf
Additional Information	N/A

8.3 Local

There are no local regulations related to cultural resources.

SECTION 9 Socioeconomics

Regional economics, environmental justice, public health and safety, and recreation within the project area are guided by state and local laws and policies, as described below.

9.1 Federal

9.1.1 Executive Order 12898 – Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

EO 12898, known as the Federal Environmental Justice Policy, requires that federal agencies make achieving environmental justice part of their missions by identifying and addressing disproportionately high and adverse human health or environmental effects on minority or low-income populations that result from their programs, policies, or activities. The EO also tasks federal agencies with ensuring that public notifications regarding environmental issues are concise, understandable, and readily accessible.

As stated in EPA guidance, disproportionately high and adverse effects encompass both human health and environmental effects. Informed judgment needs to be exercised as to what constitutes "disproportionate" as well as "high and adverse."

Executive Order 12898 – Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	
Citation	59 FR 7629
Regulation	http://www.archives.gov/federal-register/executive-orders/pdf/12898.pdf
Additional Information	http://www2.epa.gov/laws-regulations/summary-executive-order-12898-federal-actions-address-environmental-justice

9.1.2 Title VI of the Civil Rights Act

Title VI of the Civil Rights Act prohibits discrimination on the basis of race, color, national origin, age, sex, or disability in programs and activities receiving federal financial assistance.

Title VI of the Civil Rights Act	
Citation	42 U.S.C. 2000d–2000d-7
Regulation	http://www.justice.gov/crt/about/cor/coord/titlevistat.php
Additional Information	http://www.justice.gov/crt/about/cor/coord/titlevi.php

9.2 State

9.2.1 Oregon Beach Bill

The 1967 Beach Bill established the Oregon Coastline as a state recreation area administered by the Oregon Parks and Recreation Department. The bill charges the department with the protection and presentation of the recreation, scenic, and natural resource values found in Oregon's ocean shore. Administrative rules developed by the department include construction and alteration standards; access requirements, including vehicle access; and recreation area use rules.

Oregon Beach Bill	
Citation	Oregon House Bill 1601
Regulation	http://www.govoregon.org/beachbilltext.html
Additional Information	http://www.oregon.gov/oprd/RULES/pages/oceanshores.aspx

9.2.2 Oregon Statewide Planning Goals and Guidelines

Oregon has developed Statewide Planning Goals and Guidelines for use in development of comprehensive plans by counties, cities, and other local jurisdictions. Goal 9 is for Economic Development: To provide adequate opportunities throughout the state for a variety of economic activities vital to the health, welfare, and prosperity of Oregon's citizens. Tillamook County has developed a comprehensive plan consistent with the state goals.

In addition, Oregon state planning guidelines specify that new development must consider flooding, landslides, and other hazards relevant to public safety. Projects involving modification of established drainage patterns should be evaluated in terms of the effect these changes would have on drainage and slope stability.

9.3 Local

9.3.1 City of Tillamook Comprehensive Plan

See Section 2.3.4 under Biological Resources.

9.3.2 Tillamook County Public Works Department

The Tillamook County Public Works Department manages emergency transportation routes, identifies road hazards, implements road closures, and maintains mapping capabilities and equipment. Staff and resources are assigned to support emergency evacuation and essential transportation routes.

9.3.3 Tillamook County Division of Emergency Management Operations Plan

The Tillamook County Division of Emergency Management coordinates the emergency relocation and evacuation of county populations in the event of an emergency. Evacuation instructions and information for the public are disseminated using media partners, door-to-door contacts, sirens, and public address systems.

The Tillamook County Division of Emergency Management’s Emergency Operations Plan describes the coordinated response and recovery activities to be conducted during any type or size of emergency situation.

SECTION 10 Hazardous Materials

Hazardous materials within the project area are regulated by federal, state, and local laws and policies, as described below.

10.1 Federal

10.1.1 Resource Conservation and Recovery Act

EPA is the lead federal agency responsible for enforcing federal regulations regarding hazardous materials. The Resource Conservation and Recovery Act (RCRA) gives EPA the authority to control hazardous waste from the "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous wastes. RCRA also sets forth a framework for the management of non-hazardous solid wastes.

Resource Conservation and Recovery Act	
Citation	42 U.S.C. 6901 et seq.
Regulation	http://www.epw.senate.gov/rcra.pdf
Additional Information	http://www2.epa.gov/laws-regulations/summary-resource-conservation-and-recovery-act

10.1.2 Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) provides a federal "Superfund" to clean up uncontrolled or abandoned hazardous waste sites as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment.

Comprehensive Environmental Response, Compensation, and Liability Act	
Citation	42 U.S.C. 9601 et seq.
Regulation	http://www.epw.senate.gov/cercla.pdf
Additional Information	http://www.epa.gov/superfund/policy/cercla.htm

10.1.3 Superfund Amendments and Reauthorization Act

The Superfund Amendments and Reauthorization Act (SARA) amended CERCLA and made several important changes and additions to the program.

Superfund Amendments and Reauthorization Act	
Citation	42 U.S.C. 103
Regulation	http://www.epw.senate.gov/sara.pdf
Additional Information	http://www.epa.gov/superfund/policy/sara.htm

10.1.4 Hazardous Material Transportation Act

The Hazardous Material Transportation Act (HMTA) addresses the transportation of hazardous materials.

Hazardous Material Transportation Act	
Citation	49 U.S.C. 5101-5127
Regulation	http://www.gpo.gov/fdsys/pkg/USCODE-2011-title49/html/USCODE-2011-title49-subtitleIII-chap51.htm
Additional Information	http://www.epa.gov/oem/content/lawsregs/hmtaover.htm

10.2 State

10.2.1 ODEQ Land Quality Program

In Oregon, ODEQ is tasked with enforcing environmental cleanup laws for the protection of the state's environmental resources. ODEQ's Land Quality program is responsible for waste reduction and management, spill preparedness and response, environmental assessment and cleanup, and underground storage tank compliance and cleanup. ODEQ maintains a state-wide database that provides information on sites with the potential for hazardous materials.

ODEQ Land Quality Program	
Citation	N/A
Regulation	N/A
Additional Information	http://www.oregon.gov/deq/LQ/pages/index.aspx

10.3 Local

There are no local regulations related to hazardous materials.

Appendix D
Floodplain and Wetland
8-step Decisionmaking Process

Appendix D Floodplain and Wetland 8-Step Decision Making Process

Tillamook Southern Flow Corridor Project
Executive Order 11988 – Floodplain Management
Executive Order 11990 – Protection of Wetlands
Eight-Step Decision Making Process

Executive Order (EO) 11988 (Floodplain Management) requires federal agencies "to avoid to the extent possible the long and short term adverse impacts associated with the occupancy and modification of the floodplain and to avoid direct or indirect support of floodplain development whenever there is a practical alternative."

EO 11990 (Protection of Wetlands) requires federal agencies "to avoid construction or management practices that would adversely affect wetlands unless that agency finds that (1) there is no practicable alternative, and (2) the proposed action includes measures to minimize harm to the wetlands."

The Federal Emergency Management Agency (FEMA) implements these EOs through 44 Code of Federal Regulations (CFR) § 9 (Floodplain Management and Protection of Wetlands). The eight-step decision-making process in 44 CFR § 9.6 has been applied to the proposed Tillamook Southern Flow Corridor (SFC) project, as described below. The SFC project would include floodplain and wetland restoration actions to reduce flood damage in portions of Tillamook, Oregon near the Highway 101 business corridor, and re-establish a properly functioning and self-sustaining estuarine tidal marsh ecosystem that would provide critical rearing habitat for salmonids and other native fish species and wildlife species in the Tillamook Bay estuary. The project area is located in the floodplain of the Trask, Wilson, and Tillamook rivers. The steps in the eight-step decision-making process are as follows.

Step 1. Determine if the Proposed Action is located in the base floodplain and/or wetland

A majority of the work on the SFC project would be conducted within Zone A of the 100-year floodplain ("base floodplain") according to the Flood Insurance Rate Maps (FIRMs) as listed in **Table D-1**. The floodplain, in relation to the proposed project, is depicted on **Figure 4.5-1** of the environmental impact statement (EIS). The proposed project would not result in the construction of any structures within the 100-year floodplain. The proposed project would involve removal of 6.9 miles of levees and modification of 2.8 miles of levees. In addition, new setback levees would be built in a new configuration to protect agricultural lands in the lower delta.

Table D-1: Flood Insurance Rate Maps for the Project Area

Panel Number	Date
4101960155B	September 30, 1983
4101960160C	August 30, 2002
4101960165A	August 1, 1978
4101960170C	August 30, 2002
4102020001E	April 16, 2004
4102020002E	April 16, 2004
4102020003E	April 16, 2004
4102020004E	April 16, 2004

According to the National Wetlands Inventory maps, most of the project area is wetlands. Section 4.5.2 of the EIS contains maps and descriptions of wetlands within the project area.

Sadri Property – The proposed project includes remediation of hazardous materials on the Sadri property. The removal of contaminated material at the Sadri property would result in removal of approximately 20,000 cubic yards of potentially contaminated soil. Based on contaminant levels, most of this material would be suitable for re-use as fill in upland (non-wetland) areas on site with additional controls, such as an impermeable liner or cap, to further limit erosion and migration of contaminants into sensitive ecological environments and limit human exposure to the contaminated material. This work is proposed to occur within the 100-year floodplain in the southeastern portion of the SFC project area, south of Hoquarten Slough (the Sadri property is shown on Figure 3-5 of the EIS). The hazardous materials on the Sadri property are currently located in wetlands; therefore, excavation for remediation also would occur in wetlands.

Step 2. Provide early public notice (Preliminary Notice)

A public notice concerning the proposed flood reduction and habitat restoration project was published as part of the Notice of Intent to Prepare an EIS in the Federal Register on May 6, 2014. All notification materials announcing the National Environmental Policy Act scoping meeting included the notice that the project is located in a floodplain and may affect wetlands. Notification materials included postcards and emails to members of the project contact list, posters displayed around Tillamook and on the local television station, and display ads in three local newspapers: The Oregonian, The Tillamook Headlight Herald, and the Tillamook County Shopper.

Step 3. Identify and evaluate alternatives to locating in the base floodplain and/or wetlands

The No Action Alternative is described in Section 3 of the EIS. The No Action Alternative would not meet the purpose and need for the project and is not a practicable alternative.

The Hall Slough Alternative is also described in Section 3 of the EIS. The majority of the Hall Slough Alternative would be located within Zone A of the 100-year floodplain, and it would affect approximately 42 acres of wetlands.

An alternative that would relocate the project out of the floodplain was considered but rejected because it would not adequately reduce flood damage and improve habitat. To reduce flood damage in the lower Wilson and Trask rivers floodplain and to re-establish a properly functioning and self-sustaining estuarine tidal marsh ecosystem in the Tillamook Bay estuary, alterations would need to be made within the Wilson and Trask rivers floodplain. Relocating the proposed project area to avoid the floodplain and wetland effects would result in minimal flood reductions in the project area. An alternative that would relocate the project outside of the floodplain and not impact wetlands would not meet the project purpose and need and is not a practicable alternative.

Based on the alternatives analysis in the EIS, it was concluded the most practicable alternative to reduce potential flood risks in the proposed project area and restore habitat for the threatened Coastal coho salmon primarily would involve activities within the floodplain and wetlands.

Sadri Property – Tillamook County evaluated three alternatives where contaminated material would be disposed of outside of the 100-year floodplain:

- The No Action Alternative would require the ground surface on the Sadri property remain in its current condition, leaving a significant impediment to floodwaters in Hoquarten Slough. This alternative would result in no work being conducted within the floodplain. The result would be a reduction in the flood control benefits, leaving upstream properties vulnerable to flood damage. The No Action Alternative would also provide no protection of the floodplain by leaving contaminated fill materials in the floodplain. The No Action Alternative would not meet the project purpose and need, and it would leave an environmental hazard in a setting where it could pose a risk to people and ecological receptors.

- One alternative (Alternative A, as described in the February 13, 2015 whitepaper by Anderson Geological, discussing alternatives for disposal of contaminated fill) would involve the reuse of Type 2[1] fill at an offsite location and the disposal of Type 3[2] fill at a Subtitle D landfill. This alternative would result in all of the excavated contaminated fill being removed from the floodplain and disposed of in upland areas. The Port of Tillamook Bay (POTB) ordinarily would accept the Type 2 materials at one of their upland sites; however, this property is quickly approaching its maximum capacity and cannot accept the volume of material that would be generated. POTB also operates a solid waste landfill; however, that facility has reached its permitted capacity and is no longer accepting waste. Unless a project (such as a transportation project requiring roadbed fill) is identified, this alternative is not feasible. Alternative A is also cost prohibitive.

- A second alternative (Alternative C as described in the February 13, 2015 whitepaper by Anderson Geological) would involve the disposal of all of the Type 2 and Type 3 material at a Subtitle D landfill. It is estimated 25,000 tons of material would be

[1] *Type 2 fill is fill material in which organic contaminants have been detected above aquatic ecological screening levels but below Clean Fill Criteria. Metals are present at or below natural background concentrations.*
[2] *Type 3 fill is fill material in which organic contaminants have been detected above terrestrial ecological screening levels and Clean Fill Criteria. Metals are present above natural background concentrations.*

landfilled under this option at a cost of $100/ton. This alternative would result in no contaminated material being relocated within the floodplain by moving all of the excavated contaminated fill from the floodplain into the landfill. Alternative C is cost prohibitive.

- Alternative B described in the paper is the proposed action of consolidating the Type 2 and most of the Type 3 materials in a non-wetland portion of the Sadri parcel and covering it with an impervious cap to limit leaching of contaminants. The cap would be armored to prevent erosion of the material into the adjacent floodplain. The material would still be within the floodplain, but it would be configured so it would not block flood flows as it does currently. The impervious cap would consist of a parking lot that would support recreational access to Hoquarten Slough and prevent exposure of people and ecological receptors to the contaminated material. Materials deemed unsuitable for use as engineered fill due to high organic content would be separated from the mineral soils, covered with an impermeable flexible membrane, covered with topsoil, and planted with vegetation.
- Under all alternatives, approximately 600 cubic yards of heavily contaminated material would be removed to a Subtitle D landfill.
- Under all alternatives, clean material excavated from the Sadri property would be reused on site and within floodplains and wetlands to further the project objectives, which include the construction of new setback levees and filling of drainage ditches to restore floodplain and tidal wetland functions.

Step 4. Identify impacts of Proposed Action associated with occupancy or modification of the floodplain or wetland

Impact on natural function of the floodplain

The Proposed Action would not adversely affect the functions and values of the 100-year floodplain in the long term. The Proposed Action would not place any structures within the floodplain that would impede or redirect flood flows nor would it result in any excavation below natural floodplain elevations. Approximately 6.9 miles of levees would be removed, and the material would be used to build about 1.4 miles of new setback levees, modify (raise and strengthen) approximately 2.8 miles of existing levees, fill approximately 3.3 miles of existing drainage ditches, and use any excess material to fill low spots created through past subsidence to help prevent fish stranding and raise the floodplain elevation to a level that would be more likely to support a tidal marsh. Fill would be placed within the floodplain and wetlands to construct new setback levees that would keep high tides out of the upstream and adjacent agricultural lands. FEMA has reviewed hydraulic modeling conducted to support the design process such that the proposed levees would not impede flood flows and there would be no increase in upstream flood elevations. Although the Proposed Action would reduce risk to homes in and near the project area, the Proposed Action would not facilitate any development within the floodplain.

The functions of the floodplain to provide flood storage and conveyance, filter nutrients and impurities from runoff, reduce flood velocities, reduce flood peaks, moderate water temperatures, reduce sedimentation, promote infiltration and aquifer recharge, and reduce frequency and duration of low surface flows would remain intact after the implementation of the project. There would be minor short-term impacts to water quality during construction of the project, with implementation of best management practices (BMPs) and measures to control erosion and sedimentation that can increase turbidity.

Floodplains also provide services in the form of providing fish and wildlife habitat, breeding, and feeding grounds. These floodplain values would not be significantly adversely impacted by construction, and the overall integrity of the ecosystem would be improved over the long term. Although construction of the project may temporarily impact Oregon Coast coho salmon and the Marbeled murrelet, the Proposed Action likely would result in long-term net improvements to the habitat of these threatened species. The Proposed Action would have negligible impacts on native species and their habitats, and population levels of native species would not be affected over the long term. There is the potential for adverse impacts to migratory bird species that may be present at the time of vegetation removal activities during construction. The Proposed Action would not adversely affect the societal and recreational benefits provided by the floodplain in the project area. Open space and recreational uses of the project area would not be adversely affected by the Proposed Action.

The Proposed Action would reduce flood damages in and near the project area by lowering flood elevations and improving hydraulic connectivity within the study area. Potential negative impacts of a major flood on the natural floodplain functions would be reduced through implementation of the Proposed Action.

Sadri Property – The hazardous materials remediation activities on the Sadri property would involve the consolidation of Types 2 and 3 materials that currently exist on the Sadri property. The entire Sadri property and the adjacent county and city properties that would receive the fill materials are below the 100-year flood elevation. The area receiving the fill would be built up above the 100-year flood level and covered with an impervious cap to limit leaching of contaminants through the material and armored to prevent erosion of the material into the adjacent floodplain. Future plans for the built-up area include use as a parking and day-use area to support a canoe and kayak launch at Hoquarten Slough. The hazardous materials remediation activities on the Sadri property would relocate contaminated materials to an area that is less vulnerable to erosion from floodwaters and would cap and armor the material to prevent erosion and leaching of contaminants into the floodplain. The work would promote the natural and beneficial functions of the floodplain. This portion of the floodplain was filled many years ago, and consolidation and capping of the hazardous materials would not affect the overall existing floodplain capacity. In conjunction with the rest of the SFC project, the overall floodplain capacity is expected to increase with the removal of 6.9 miles of existing levees. Consolidating and capping the hazardous materials would reduce mobilization of hazardous materials in the environment and would be beneficial for the natural and beneficial functions of the floodplain.

Impact of floodwater on the existing and proposed facilities

The Proposed Action does not include any structures or facilities within the floodplain; therefore, no facilities would be affected by floodwater in the floodplain. The Proposed Action would hydraulically reconnect the Wilson and Trask rivers to the floodplain and Tillamook Bay through levee removal and levee setback. Flood elevations are expected to be reduced. Cut vegetation and mulch would be placed as needed throughout the construction area to reduce erosion and sedimentation impacts during construction. Mulch would be used to prevent soil erosion. Potential floodwaters would not affect the project.

Sadri Property – The hazardous materials remediation activities would provide improved protection of the floodplain over current conditions by isolating and covering the material and protecting the material from erosion from floodwaters. The fill would be removed from one area of the floodplain and placed on another area of the floodplain where it would not block flood flows as it does currently. Although a portion of this area would be used as a parking and day-use area to support canoe and kayak launching into Hoquarten Slough, the increase in impervious area from the parking lot would be offset by the removal of building foundations and concrete on the Sadri property and in other parts of the SFC project area.

Wave Analysis – There is a low potential for a moderate, short-term, localized effect from wind-generated waves under high water conditions on areas south of the project area. If winds from the north-northwest occur simultaneously with a high water event, waves could be generated that could pass over the project area once the levees were removed and reach areas to the south that were previously sheltered by those levees (see **Figure 4.5-7**). A wave analysis (see Attachment A) found that because the levees around the project area would be lowered to an elevation equivalent to the mean higher high water (MHHW) (8 feet NAVD 88), any tide level lower than MHHW would not allow waves to pass over the project area or reach areas to the south. At water levels higher than the MHHW, the modeling shows that there is a potential for larger waves to pass over the study area and potentially affect levees south of the project area.

However, the potential risk is low because winds from the north-northwest typically only occur in the late spring and summer months when very high tides that exceed the MHHW are rare. While there is a reasonable chance that the effect would occur in any given year, it would require a strong wind out of the north-northwest to occur simultaneous with a very high tide. In addition, the high tides that would allow waves to pass over the study area would only last for a period of a few hours, which would further limit the potential impact. Floods could also generate water depths that would allow larger waves to pass over the project area. However, floods typically occur in the winter when winds from the north-northwest direction are rare. In addition, waves would only affect the portion of the levee that is above the floodwaters, which at very high water depths is a very small portion of the affected levee.

Impact on wetlands

Implementation of the proposed project would allow for the conversion of existing freshwater wetlands that are highly modified (by pasture uses and hay production) in the project area to convert to tidal wetlands that historically would have occurred in this part of the floodplain. Approximately 522 acres of tidal wetlands would be restored from lands that are either not currently wetland or are low quality freshwater wetlands. This will allow wetlands to function above their current levels.

Pre-construction wetland delineations have been completed and will be incorporated into the project's final design. Although the new setback levees would fill approximately 10 acres of wetlands, the removal of other levees and dredge fill would allow for the restoration of approximately 50 acres of wetlands in areas that are not currently wetlands. Channel modifications within wetland areas will be limited as much as practicable to minimize disturbance to existing wetlands.

Step 5. Design or modify the Proposed Action to minimize threats to life and property and preserve its natural and beneficial floodplain values

The objective of the Proposed Action is to reduce flood damage and improve wildlife habitat in the study area. No structures are or would be located in the floodplain as a result of the proposed project. The Proposed Action would be beneficial to the natural and beneficial values of the floodplain.

Many of the effects discussed above are considered minor or beneficial to the floodplain. The purpose of the Proposed Action, to reduce flood damage and improve wildlife habitat, contributes to the conservation of the floodplain and its natural and beneficial values. Short-term construction-related water quality impacts would be mitigated by the implementation of BMPs.

Although construction of the proposed project would result in disturbances within the floodplain, following construction, the project would have a beneficial effect on the floodplain and wetlands. Impacts to federally listed species would be avoided, minimized, or offset by implementation of conservation measures and other measures as identified through consultation with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. Over the long term, the project is intended to improve habitat conditions for listed species. Impacts on migratory bird species would be minimized by seasonal restrictions that require the majority of vegetation removal activities to be conducted outside of the nesting season. For any work in the floodplain, Tillamook County and POTB would be required to coordinate with the local floodplain administrator and obtain any required permits prior to initiating work. All coordination pertaining to these activities and applicant compliance with any conditions would be documented and copies forwarded to the state and FEMA for inclusion in the permanent project files. A mitigation measure has been added to Section 6 to require the Port to prepare a plan to monitor for impacts and to identify a process for developing any necessary plan of action.

Step 6. Determine if Proposed Action is practicable and reevaluate alternatives

The Proposed Action would reduce flood damage in and near the study area by hydraulically reconnecting the rivers to the bay through levee removal and levee setback. The Proposed Action would also remediate contaminated soils at the Sadri property. The Proposed Action would not increase exposure of any segment of the population to flood hazards because it does not include a housing component and would not facilitate development in the floodplain. The Proposed Action would not increase current flood hazards and would include floodplain and wetland restoration actions to reduce flood damage. The project would provide major beneficial effects on floodplain and wetland values over the long term. For these reasons, it is practicable to implement the Proposed Action within the floodplain and wetlands, and the Proposed Action satisfies the identified purpose and need. Alternatives consisting of locating the project outside of the floodplain or taking no action are not practicable because these alternatives would not reduce flood damage or improve wildlife habitat in the Tillamook Bay estuary. FEMA maintains that the Proposed Action alternative is the only practicable alternative to meet the purpose and need of the project.

Following public review of the Draft EIS, FEMA received comments from the public. Several commenters expressed concerns about potential effects on adjacent lands. Responses to these comments are found in Appendix L of the Final EIS. Additional analysis of potential effects in response to comments did not find a potential for any additional significant adverse impacts or the need for any additional mitigation measures to protect floodplains or wetlands.

Step 7. Provide findings and public explanation (Final Notification)

Step 7 requires the public be provided with an explanation of any final decision that the floodplain is the only practicable alternative. In accordance with 44 CFR § 9.12, POTB must prepare and provide a final public notice 15 days prior to the start of any flood reduction and habitat restoration activities in the floodplain. Documentation of the final public notice is to be forwarded to FEMA for inclusion in the permanent project files.

Step 8. Implement the action

Step 8 is the review of the implementation and post-implementation phases of the Proposed Action to ensure the requirements stated in 44 CFR § 9.11 are fully implemented. The proposed flood reduction and habitat restoration project would be conducted in accordance with applicable floodplain development requirements.

Conditions identified in Step 5 would be implemented, including BMPs and mitigation measures identified in the EIS and any permit conditions that may be imposed by the regulatory agencies.

Attachment A:

Wave Analysis

Memorandum

To: *Kate Stenberg, Ph.D.*

From: *Michael Giovannozzi, P.E.*

Date: *October 16, 2015*

Subject: *Southern Flow Corridor Project*
Tillamook County, OR
Wave Analysis

Background

The Southern Flow Corridor (SFC) project includes floodplain and wetland restoration actions near the confluence of the Wilson and Trask Rivers in the lower Tillamook Valley. Implementation of this project would reduce flooding in the lower Trask, Tillamook, and Wilson river floodplains, including the U.S. Highway 101 (Highway 101) business corridor in Tillamook, Oregon, and restore tidal marsh habitats along Tillamook Bay. The proposed plan includes modifications to the existing levees (lowering to +8 ft NAVD88). In response to a public comment on the DEIS, this analysis explores the potential for wave action to affect the Peterson Farm levee and other levees located to the south of the project area due to lowering of the project area levees.

The following items were reviewed as part of this activity:

- Draft EIS for SFC
- SFC Preliminary Design - 65% Draft (Northwest Hydraulic Consultants)
- Various DEMs associated with hydraulic modeling of the project area (Northwest Hydraulic Consultants)
- "Climate change impacts on wave and surge processes in a Pacific Northwest (USA) estuary", Cheng, T.K., Hill, D.F., Beamer, J. and Garcia-Medina, G. (2015), *J. Geophsy. Res. Oceans*, 120, 182-200.
- "The Contributions to Storm Tides in Pacific Northwest Estuaries: Tillamook Bay, Oregon and the December 2007 Storm", Cheng, T.K., Hill, D.F. and Read, W., (2015), *J. Coastal Res*, 31, 723-734.
- USACE DEM of the project area
- NOAA DEM of Tillamook Bay
- FEMA FIS and FIRM for Tillamook
- NOAA Tides at Station 9437540 (Garibaldi, OR)
- NOAA NCDC Winds at Garibaldi Tillamook Station (Station 997706)

Analysis

A cursory-level wave analysis was conducted to assess potential wave conditions at levees south of the project area for both with- and with-out project conditions for various water levels. FEMA's overland wave propagation model, WHAFIS (FEMA 1988 and Divosky 2007), was utilized for this effort.

Water Levels

NOAA tides were reviewed for Tillamook Bay. Table 1 provides a summary of the water levels due to meteorological tides. Monthly maximum water levels were extracted from this dataset and utilized for an extremal water level analysis. Water levels show a seasonal dependence with higher water levels generally occurring in the winter months (November through January) and the lowest water levels occurring in late summer (August and September) as illustrated in Figure 1. Table 2 provides a summary of the extremal water level analysis. Several distributions were tested for best fit; in the end a Weibull (k=2) distribution was selected. Figure 2 shows the water level data fit to a Weibull (k=2) curve. It should be noted that the general rule of thumb for an extremal analysis is that return periods can be reliably estimated out to 3 times the length of the data set. Since the Tillamook Tide Gauge record consists of 10 years of water level data, we can only reliable estimate the 30 year return period.

Table 1. Tides for Tillamook Bay, OR - Garibali Station (NOAA)

Garibaldi, OR - Station ID: 9437540				
Station Location 45 33.2 N, 123 55.1W				
Water Level		**Datum**		
		Station Datum	**MLLW**	**NAVD88**
Mean Higher-High Water	MHHW	12.30	8.31	7.96
Mean High Water	MHW	11.59	7.60	7.25
Mean Tide Level	MTL	8.47	4.48	4.13
Mean Sea Level	MSL	8.48	4.49	4.14
Mean Diurnal Tide Level	DTL	8.14	4.15	3.80
Mean Low Water	MLW	5.35	1.36	1.01
Mean Lower-Low Water	MLLW	3.99	0.00	-0.35
Station Datum	SD	0.00	-3.99	-4.34
North American Vertical Datum of 1988	NAVD88	4.34	0.35	0.00
National Geodetic Vertical Datum of 1928	NGVD29	7.80	3.81	3.45

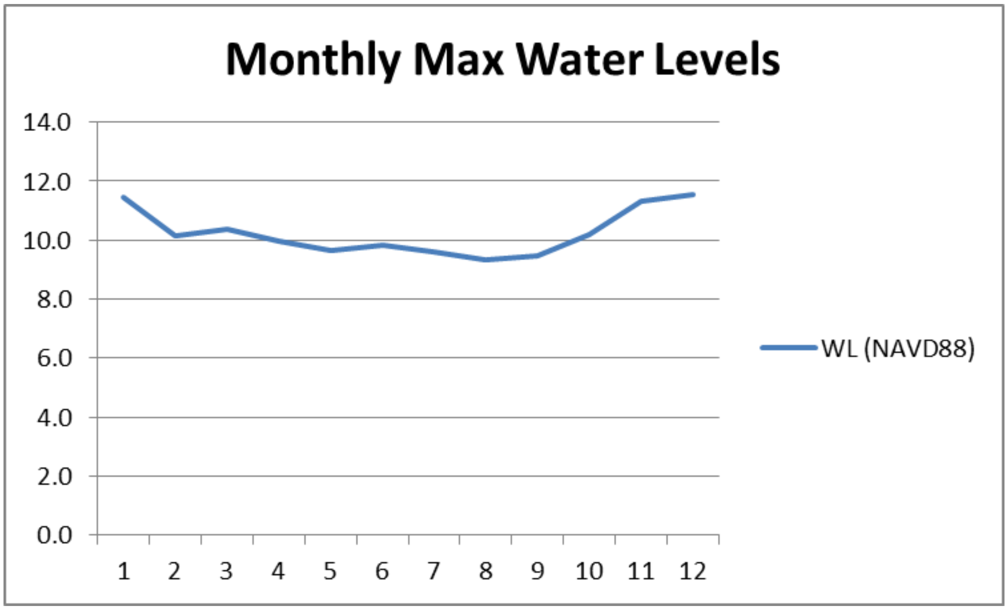

Figure 1. Monthly Maximum water levels (2005 to 2015)

Table 2. Extremal Water Level Analysis for Tillamook Tide Station

Return Period	Annual Occurrence	Water Level (ft, NAVD88)
1	1	10.5
5	0.2	11.1
10	0.1	11.3
25	0.04	11.6
50	0.02	11.8
100	0.01	12.0

= extrapolation beyond 30 yrs is unreliable

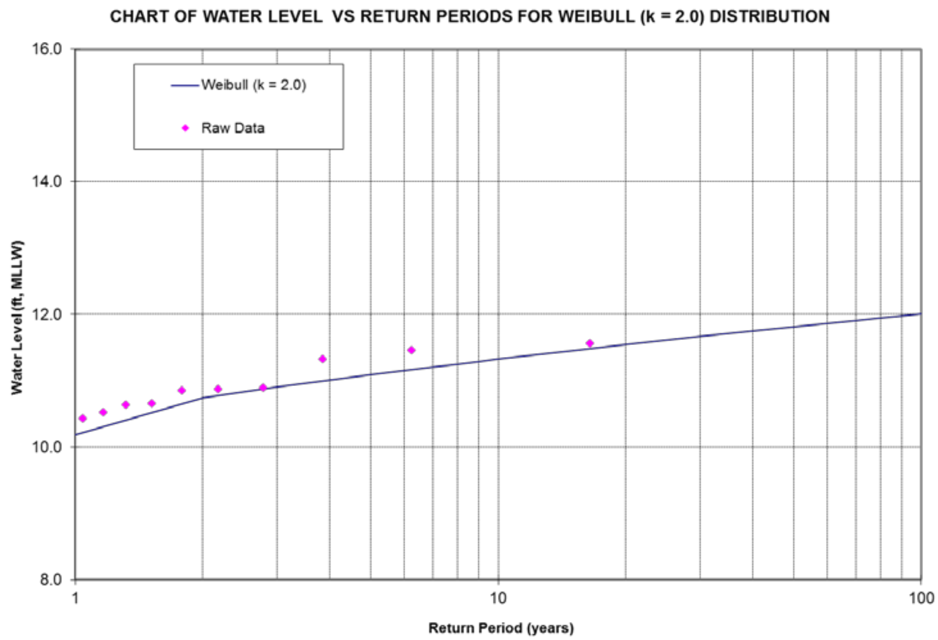

Figure 2. Water Level Extremal Analysis using a Weibull (k=2.0) Distribution

Winds

Winds are seasonal with the greatest wind speeds occurring between November to March (Cheng 2015); however a review of the wind roses for Garibaldi (Figure 3) indicates that most winds during the winter approach form the east through southeast, which would not generate waves at the project site. This is also in agreement with communications from the project team. Nevertheless, Cheng (2015) reports that gusts ranging from 50-74 knots occur in the region. Duration for the gusts is typically on the order of 1-2 hours or less. Therefore a more detailed wind analysis was a conducted.

Hourly wind speed and direction data was available for Garibaldi from June 2006 through June 2015 (NOAA NCDC). The data was filtered to remove winds outside of the cone of influence affecting the project site (i.e. only winds originating from 320 to 10 degrees were retained). Monthly maximum winds were extracted from the filtered dataset and utilized for an extremal wind speed analysis. Table 3 provides a summary of the extremal wind speed analysis. Several distributions were tested for best fit; in the end a Weibull (k=2) distribution was selected. Figure 4 shows the wind speed data fit to a Weibull (k=2) curve. Again, it is noted that the general rule of thumb for an extremal analysis is that return periods can be reliably estimated out to 3 times the length of the data set. Since the Tillamook Wind Speed Gauge record consists of 10 years of data, we can only reliable estimate the 30 year return period.

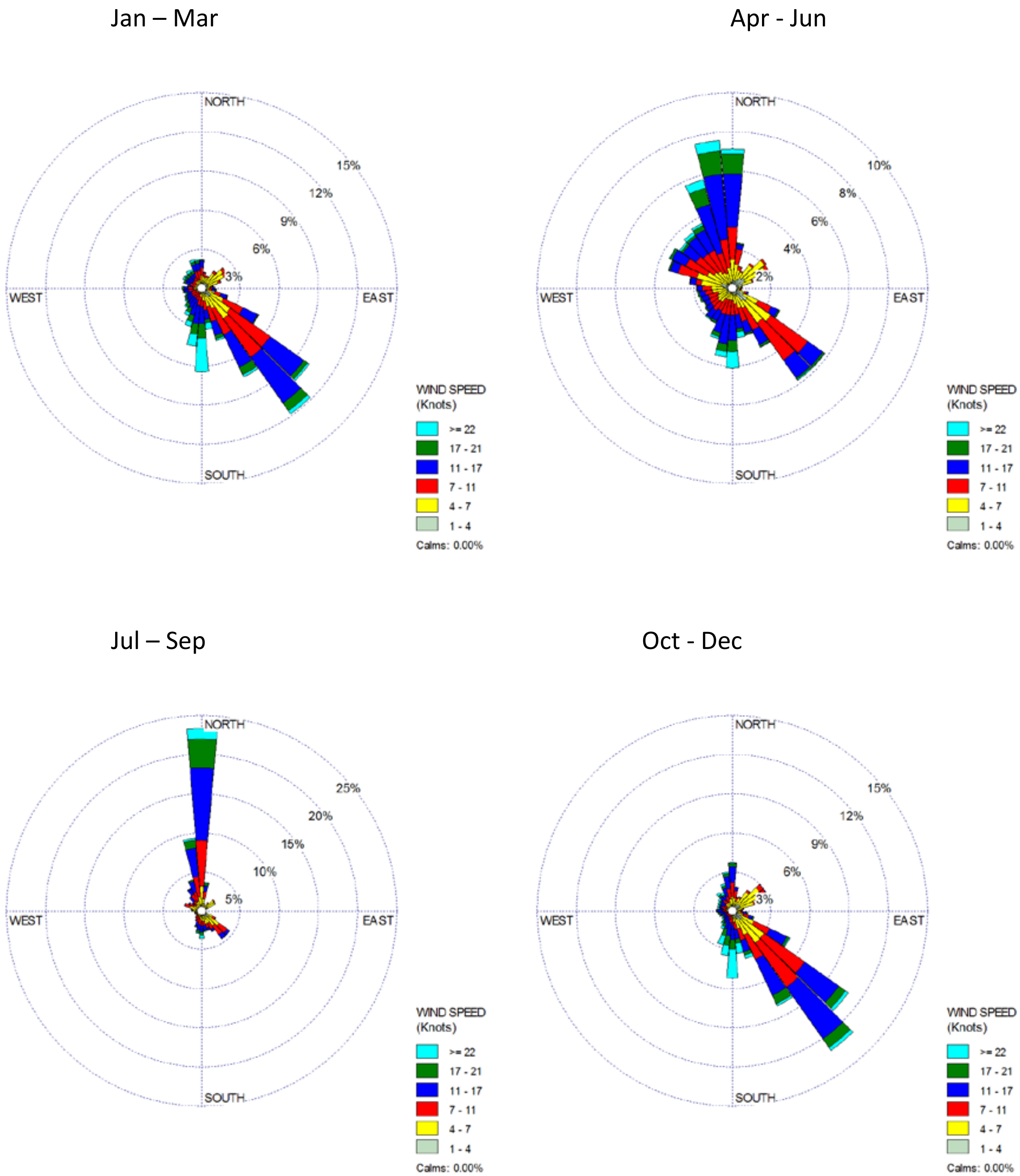

Figure 3. Seasonal Wind Roses for Garibaldi

Table 3. Extremal Wind Speed Analysis for Tillamook Tide Station for winds from the NNW (320 to 10 degrees north)

Return Period	Annual Occurrence	Wind Speed (mph)
1	1	37.7
5	0.2	44.9
10	0.1	47.6
25	0.04	50.7
50	0.02	53.0
100	0.01	55.2

(shaded) = extrapolation beyond 30 yrs is unreliable

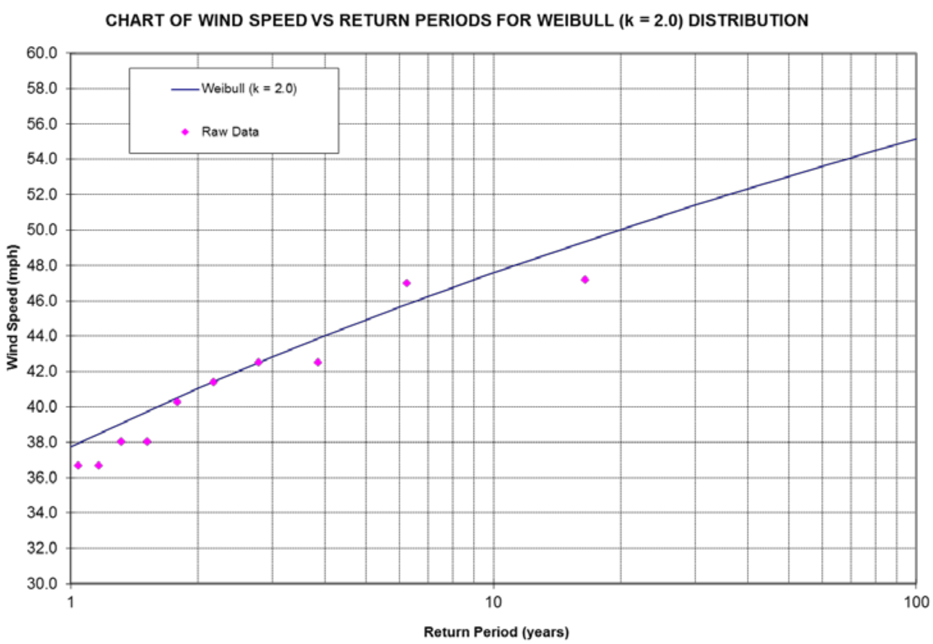

Figure 4. Wind Speed Extremal Analysis using a Weibull (k=2.0) Distribution

Joint Probability of Water Levels and Winds

A joint probability analysis for the water levels and wind speeds was completed. The two variables are assumed to be completely independent; therefore, the joint probability is simply the product of the individual probabilities of occurrence. Table 4 summarizes the joint probability of occurrence (and associated return period intervals) for the combined extreme water levels and winds.

Table 4. Joint Probability of Extreme Winds and Water Levels

Joint Prob of Annual Occur.	Joint Return Period	Wind Speed (mph)*	Water Level (ft, NAVD88)
1	1	37.7	10.5
0.04	25	44.9	11.1
0.01	100	47.6	11.3
0.0016	625	50.7	11.6
0.0004	2500	53.0	11.8
0.0001	10000	55.2	12.0

* winds from the NNW (320 through 10 deg)

Selected Storm Scenarios

Four combined water level and wind speed scenarios were selected for the wave analysis. The first three scenarios were obtained from the joint probability analysis and consist of the 1-year, 25-year, and 100-year return period storms (from Table 4). The fourth scenario is a hypothetical storm with a water level equal to +8.0 ft NAVD88 (to match MHHW condition) and a wind speed of 30 mph[1]. The water level scenarios are summarized in Table 5.

Table 5. Storm scenarios (water level and winds) considers for wave analysis

Scenario		Water Level (ft, NAVD88)	Wind Speed (mph)*	
			Offshore (Tillamook Bay)	Inshore (mud flats and overland)
1	1-year Return Period	11.3	47.6	35.7
2	25-year Return Period	11.1	44.9	33.7
3	100-year Return Period	10.5	37.7	28.3
4	MHHW with 30mph Wind	8	30.0	22.5

* Wind applied coincidently with fetch direction

[1] Given the small fetch across Tillamook Bay in the direction of the project site (~5 miles), it is likely that fully-developed waves can be generated from typical gusts in just a short period of time (on the order of an hour). It is therefore prudent to select a conservative wind speed for the wave analysis. FEMA's Pacific Coast Guidelines (FEMA 2005) recommends applying the following minimum wind speeds for wind wave growth analysis in restricted fetch areas: 30 mph for open water conditions (i.e. across the bay), 22.5 mph for inshore submerged lands and vegetated areas (i.e. across the southern Tillamook Bay mudflats and SFC project site).

Topography/Bathymetry

Bathymetry of Tillamook Bay was obtained from the NOAA Coastal Inundation Digital Elevation Model (DEM) from NOAA website. Detailed topography was provided by the USACE-Portland District as a triangular network that was converted into a contour shapefile. This data was imported into GIS and used to develop cross-shore transects for the wind-wave growth analysis. Figure 5 shows a sample cross-section, where red indicates bathymetry from the NOAA DEM and green indicates topography from the USACE topographic survey. The blue dashed line is the 100-year water level for reference.

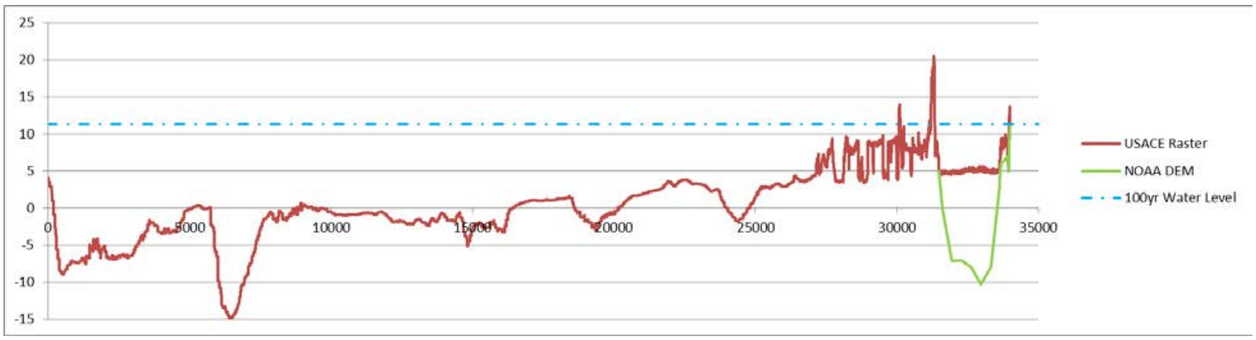

Figure 5. Transect 1: Red line denotes USACE topo/bathy survey, Green Line Denotes NOAA DEM data and Blue dashed line is the 100-year water level.

Wave Analysis

FEMA's WHAFIS model was used to assess wave growth and transformation across Tillamook Bay and the SFC project site. The WHAFIS model was run through the CHAMP graphical user interface (FEMA 2007). Three transects were selected for the analysis (Figure 6) and then the results were combined using a weight-averaged scheme as summarized in USACE (1992). The averaging scheme is recommended for restricted fetch areas such as Tillamook Bay. The wave analysis was performed for each of the four scenarios summarized in Table 5 and for both the with- and with-out project conditions. The original cross-shore transects were modified such that the levees and areas internal to the levees were adjusted to be +8 ft NAVD88. Figure 7 illustrates the difference between with- and without project conditions, where the green line denotes the without project condition and the red line denotes the with-project condition. The with-project condition represents an idealized case where the levees have been reduced to +8ft and the interior area to the levees has been filled to +8ft. The blue dashed line represents the 100-year water level for reference.

Transect	Fetch (miles)	Direction (deg from N)
1	5.14	338
2	4.97	348
3	2.39	358

Figure 6. Fetch Locations and Lengths used for Wave Growth Analysis.

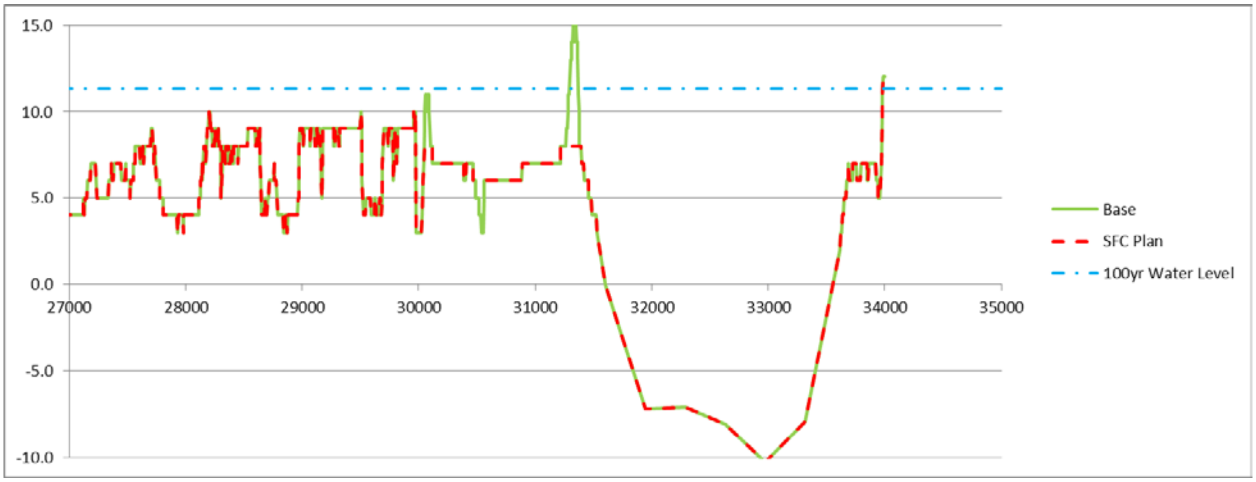

Figure 7. Transect 1: Green Line denotes base condition, Red Dashed Line denotes with project condition (SFC Plan) and Blue line denotes 100-year water level.

Table 6 summarizes the results for the 3 transects over the 4 different water levels for both the Base condition (without project) and SFC (with project). The table summary clearly illustrates that lowering of levees around the project area (with project condition) results in larger waves (both wave height and wave period) approaching areas to the south.

The wave analysis results were then combined using a weighted average of the 3 fetches (Table 7). For the 100-year event (Scenario 3), the wave analysis indicates that lowering the levees (with project) can result in a 42% and 123% increase in wave height and waver period, respectively. For Scenario 4, water levels match that of the proposed levees, so waves generated within Tillamook Bay will break at the SFC project site and will not extend further south. When the water levels begin to rise above the levees (Scenarios 1 and 2), wave energy from Tillamook Bay will still propagate waves (albeit at a lower wave height) across the project site and then affect levees to the south. An important consideration is that even though the levees can be effective at reducing incoming wave height, the wave period typically remains unchanged. The larger wave periods can lead to increased wave run-up and wave breaking along the levees. Therefore, it is important to consider the combination of wave height and period as a single parameter such as the depth-integrated wave momentum flux.

Table 7 also shows the computed wave energy flux at the levee to the south of the project area for the various water levels. The wave momentum flux is a convenient way to combine wave height and waver period and provides insight into the amount wave energy that will interact with levees to the south of the project area. Higher values indicate higher energy and thus potential for increased erosion and wave run-up. Actual calculation of the erosion and wave run-up are case specific and require a more detailed analysis dependent upon levee construction method, materials, and geometry. The point being made here is that the SFC project could potentially affect the levees to the south by allowing larger waves to cross the SFC project site and interact with the levees. Table 7 indicates that the SFC project can increase the wave momentum flux by over 180% for the scenarios 1, 2 and 3.

Table 6. Summary of Wave Analysis for the Three Transects for the Four Storm Scenarios

Scenario			Wave Condition at Project Site			Wave Conditions at Peterson Farm (with and without Project)					
			Transect 1	Transect 2	Transect 3	Transect 1		Transect 2		Transect 3	
						5.14 mile fetch		4.97 mile fetch		2.39 mile fetch	
						Base	SFC	Base	SFC	Base	SFC
1	1-year Event, 37.7mph, WL = 10.5 ft	Hs (ft)	0.45	0.38	0.3	1.18	1.44	1.04	1.43	0.96	1.42
		Tp (sec)	3	2.94	2.53	1.44	3.13	0.98	3.09	1.27	2.74
2	25-year Event, 44.9mph, WL =11.1 ft	Hs (ft)	0.88	0.88	0.85	1.45	1.88	1.28	1.85	1.18	1.83
		Tp (sec)	3.21	3.16	2.75	1.55	3.37	1.43	3.32	1.36	2.96
3	100-year Event, 47.6mph, WL = 11.3 ft	Hs (ft)	1.04	0.98	0.98	1.55	2.04	1.37	2.01	1.26	1.99
		Tp (sec)	3.28	3.24	2.84	1.59	3.44	1.46	3.4	1.39	3.05
4	MHHW, WL = 8.0ft, 30.0mph	Hs (ft)	0.15	0.12	0.1	0.71	0.71	0.77	0.77	0.72	0.72
		Tp (sec)	0.46	0.4	0.36	1.29	1.29	1.2	1.2	1.15	1.15

Table 7. Weight-Averaged Results for the Four Scenarios at the Project Site and at Peterson Farm (for both base and SFC Conditions). Results are also combined as a Depth-Integrated Wave Momentum Flux.

Scenario			Weighted Average Wave Conditions				Depth-Integrated Wave Momentum Flux (with and without Project)				
			At Project Site	at Peterson Farm (with and without Project)							
				Base	SFC	% Increase	Base		SFC		% Increase
1	1-year Event, 37.7mph, WL = 10.5	Hs (ft)	0.39	1.08	1.43	32	95.5	lb/ft	272.5	lb/ft	185
		Tp (sec)	2.89	1.22	3.04	148					
2	25-year Event, 44.9mph, WL =11.1	Hs (ft)	0.87	1.33	1.86	40	153.9	lb/ft	435.5	lb/ft	183
		Tp (sec)	3.10	1.47	3.27	123					
3	100-year Event, 47.6mph, WL = 11.3	Hs (ft)	1.00	1.42	2.02	42	174.3	lb/ft	505.1	lb/ft	190
		Tp (sec)	3.18	1.50	3.35	123					
4	MHHW, WL = 8.0ft	Hs (ft)	0.13	0.74	0.74	0	51.4	lb/ft	51.4	lb/ft	-
		Tp (sec)	0.42	1.23	1.23	0					

One thing to note is that high water levels typically occur for a very limited duration (on the order of several hours) and even though the winds may cause fully-developed waves to form, the waves will have limited high water duration in which to interact with the levees south of the project area.

Probability of Occurrence over Time

The risk of property damage or destruction during a storm event is always present, but the level of risk may be managed in order to determine what extreme events the affected levees should be able to withstand over the lifespan of the SFC project (or other period of performance).

The return period is useful for risk analysis (such as natural, inherent, or hydrologic risk of failure). When dealing with structure design expectations, the return period is useful in calculating the riskiness of the structure. To assist in deciding what level of risk is acceptable for the project, the following risk assessment calculation may be used:

$$R = 1 - (1 - 1/T_r)^n,$$

where R is the probability that an event with a return period of T_r years will occur at least once during a time period (project life) of n years.

Using this methodology, there is a 1% chance of a 100-year event occurring during any given year, 9.6% chance over a consecutive 10-year period, and 39.5% chance over the 50 year design life of the SFC project. Likewise, there is a 4% chance of the 25-year event occurring during any given year, 33.5% chance over a consecutive 10-year period, and 87% chance over the 50 year design life of the SFC project. There is a 100% chance the 1-year event will occur in any given year. Table 8 summarizes the probability of occurrence for the 1-year, 25-year and 100-year events for various periods of performance.

Table 8. Probability of Occurrence for a Given Storm over for Various Time Frames (in years)

Scenario	Return period (years)	Probability of Occurrence (%) for a Given Time Frame (in years)				
		50	40	25	10	1
1	1	100.0%	100.0%	100.0%	100.0%	100.0%
2	25	87.0%	80.5%	64.0%	33.5%	4.0%
3	100	39.5%	33.1%	22.2%	9.6%	1.0%

Summary

An extremal analysis was performed using wind and water level records over a 10 year period, allowing a reliable estimate of 30 year return periods. A joint probability distribution then provided 1-, 25-, and 100- year return periods for combined winds and water levels. A wave analysis was conducted for the 3 storm events and a hypothetical event. The wave analysis indicates that the proposed SFC project can allow larger waves with increased wave energy to approach levees south of the project area. The risk analysis indicates the larger events (25 and 100-year events) are expected to occur infrequently but with increasing probability as the period of performance increases. However, the combined high wind and high water level events are expected to occur for limited durations (on the order of hours), which will limit the wave impact on the levees for a given storm event.

Further analysis is recommended to assess typical combined durations of high winds and water levels and their effect on the levees to the south of the project area. In addition, a two-dimensional wave model with detailed project conditions (i.e. realistic topography of the SFC site, rather than the idealized +8 elevation across the entire project site) should be applied to better assess the potential for impacts on levees south of the project area. Lastly, detailed information on the geometry and composition of the existing levees can be utilized to perform an erosion/damage assessment of them.

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Appendix E
Hydraulic Modeling Peer Review Report

Hydrologic and Hydraulic Modeling Review

Southern Flow Corridor Project

DR-1733-OR

Tillamook County, Oregon

September 2015

This document was prepared by

CCPRS

Fast Response. Smart Recovery.

Contract No.: HSFEHQ-12-D-0881
Task Order: HSFE80-14-J-0004

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Acronyms and Abbreviations

DEIS	Draft Environmental Impact Statement
EIS	Environmental Impact Statement
FEMA	Federal Emergency Management Agency
NOAA	National Oceanic and Atmospheric Administration
PA	Public Assistance
POTB	Port of Tillamook Bay
SFC	Southern Flow Corridor
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

SECTION 1 Introduction

1.1 Overview

The Federal Emergency Management Agency (FEMA), the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Fish and Wildlife Service (USFWS), in partnership with the U.S. Army Corps of Engineers (USACE), and state and local partners, are proposing to fund a project to reduce flood damage and restore habitat in the Tillamook Bay estuary. FEMA will prepare an environmental impact statement (EIS) as required by the National Environmental Policy Act (NEPA) to document the benefits and impacts of possible alternative solutions to these issues. FEMA is the federal lead agency. NOAA, USFWS, and USACE are cooperating agencies.

1.2 Purpose of this Report

This report summarizes a review of hydrologic and hydraulic modeling performed to date for the Southern Flow Corridor (SFC) project. The EIS relies on certain technical evaluations, especially using computational simulation modeling of flood events, to compare impacts of alternatives being considered. As the lead agency, FEMA identified the need to perform an independent review of the history of model development, applications, assumptions and uncertainties, and ultimately, the overall suitability of the modeling work to date to prepare the EIS.

1.3 Background

Five rivers enter the Tillamook Bay estuary, which includes the mouths of the Miami, Kilchis, Wilson, Trask, and Tillamook Rivers. Flooding occurs frequently in the lower reaches of the Wilson, Trask, and Tillamook Rivers, typically between October and April. High tides combine with storm surges, heavy rainfall, and snowmelt, causing coastal and inland flooding. Fourteen major river and coastal floods have been recorded in the Tillamook Basin since 1916. Flood losses in Tillamook County exceeded $60 million from 1996 through 2000 and included damages to homes, farmland, businesses, and infrastructure. Additional flood losses have been incurred by the Tillamook community since 2000.

In response to these frequent flood events, Port of Tillamook Bay (POTB), Tillamook County, the City of Tillamook, several state and federal agencies, non-profit organizations, and local business interests have been working together to identify solutions to Tillamook Valley's ongoing flood problem. Numerous investigations, studies, and collaborative evaluations of potential flood reduction actions that have taken place since 1994 led to the designation of flooding in central Tillamook County as an Oregon Solutions project by the governor of Oregon. The Tillamook Bay SFC project is an outcome of that Oregon Solutions effort.

FEMA's engagement in the ongoing flood problem and the SFC project stems from a December 2007 flood event (DR-1733) that resulted in damage across the Tillamook Valley, including severe damage to a historic railroad owned by POTB. FEMA received an application to its Public Assistance (PA) grant program from the POTB for the SFC project as an alternate project to the repairs of its rail line. FEMA's proposed action is to provide funding for the project as authorized under Section 406 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 93–288, as amended.

1.4 Project Study Area

The project study area is located in northwestern Oregon and includes portions of the City of Tillamook, Tillamook Bay, the Tillamook River, Trask River, Wilson River, as well as Blind Slough, Hall Slough, Dougherty Slough, Hoquarten Slough, and Nolan Slough, as shown in **Figure 1.1**. The U.S. Highway 101 business corridor is located in the eastern portion of the project study area. The project study area includes lands that may be affected directly or indirectly by each alternative.

Tillamook Bay is a shallow estuary with a complex system of tidal channels and broad inter-tidal mudflats. The estuary receives riverine input from five rivers, all with headwaters in the Coast Range. A number of narrow channels provide confined pathways for riverine flows entering the estuary from upland sources. Tidal flows enter and leave the estuary from the ocean through a narrow opening at the north end of the Bay. The extent of riverine versus tidally controlled hydraulics in the lower river channels and sloughs varies with the flow and tides. During times of significant upland precipitation and runoff, the hydraulic conditions within the backbay area of the estuary become dominated by riverine flow. The situation becomes a battle of two flow regimes: riverine versus estuarine. Overbank flows during riverine floods also tend to be more controlled by the extensive network of levees they must flow over to reach the Bay.

1.5 Summary of Purpose and Need

As presented during scoping, the purpose of the SFC project in Tillamook Bay is to reduce life safety risks from floods and flood damages to property and other economic losses from floods while also contributing to the recovery of federally listed Oregon Coast coho and restoring habitat for other native fish and wildlife species.

The objectives for this action are to reduce flood damage in portions of Tillamook, Oregon, near the U.S. Highway 101 business corridor and to re-establish a properly functioning and self-sustaining estuarine tidal marsh ecosystem that would provide critical rearing habitat for salmonids and other native fish species and wildlife species in the Tillamook Bay estuary.

The need for the project results from the area’s history of severe repetitive flooding with widespread damage to property, road closures, and other economic losses. In addition, several fish and wildlife species that historically depended on the wetland, tidal marsh, and aquatic habitats of the estuary are threatened or endangered.

Future unmitigated flooding in the Tillamook Valley would contribute to potential future life safety risks and physical and economic damages to property and businesses in the floodplains. Blockages to fish passage, losses of aquatic and wetland habitats, and altered sediment erosion and deposition regimes would continue to degrade important fish and wildlife habitats in the estuary, cause additional species to become threatened or endangered, and hamper recovery plans for currently protected species that use the project area.

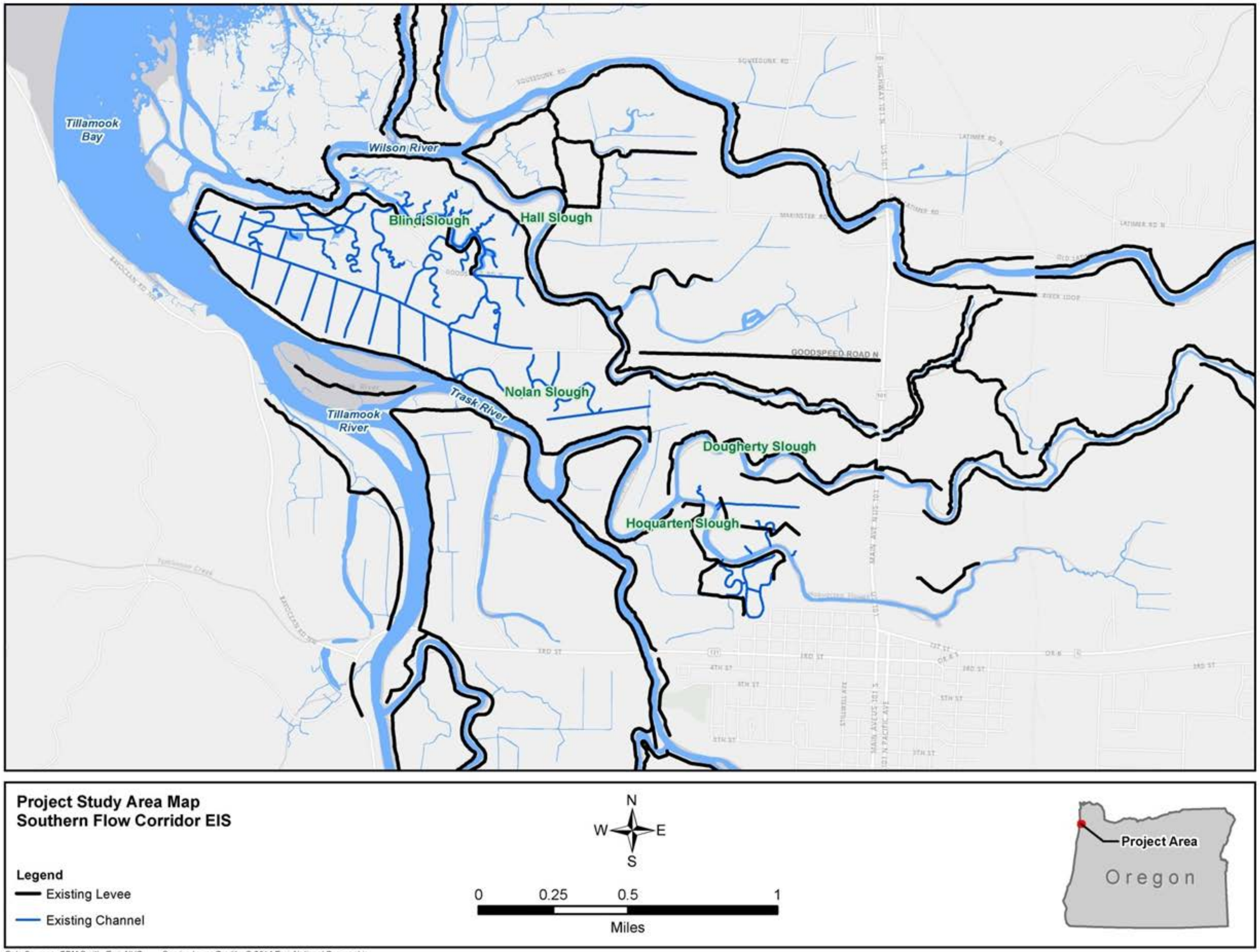


Figure 1.1. Project Study Area

1.6 Project Participants

The project participants include FEMA and other federal, state, and local partners. NOAA and USACE are cooperating agencies. NOAA and USFWS are considering funding portions of the project. Additionally, they will provide specific expertise on biological resources and threatened and endangered species. The Oregon Office of Emergency Management (OEM) is the grantee for FEMA grant funding. The POTB is the subgrantee for FEMA grant funding, and Tillamook County is the grantee for NOAA and USFWS funding. Other project partners include Oregon Solutions, the Oregon Watershed Enhancement Board (OWEB), the Tillamook Estuary Partnership, the Tillamook Bay Habitat and Estuary Improvement District (TBHEID), and individual donors. In addition, CCPRS is FEMA's consultant team for preparation of the EIS, and Tillamook County has engaged Northwest Hydraulic Consultants to assist with project development.

SECTION 2 Methodology

2.1 Modeling and EIS Objectives

Simulation modeling allows technical teams and policy-makers insight into how a system behaves under conditions that would be difficult to replicate, risky, or expensive to prove experimentally or at scale. A significant number of decisions are needed to construct a useful model, apply it, and interpret results in an appropriate and suitable manner for the objectives of the study.

Based on the project purpose and need statement, defined alternatives, public and agency comments, and discussions with lead agency and project partner staff, this review applies the following objectives to characterize the ability for the existing hydraulic and hydrologic modeling to support findings in the NEPA process:

- Establish a basis for comparing risk to life and property among all alternatives during flood events due to a range of estimated flood depths, durations, and velocities.
- Establish a basis for comparing natural hydrologic and sediment transport processes among all alternatives.
- Characterize the spatial variability of innudation frequencies within the project area to compare relative impacts of all alternatives on agricultural lands and proposed habitat areas.
- Characterize the performance of levees and the local movement of flood waters within the project area to compare alternative impacts on channels, overland flow, tide gates, sloughs and wetlands.

This section provides a brief description of the approach used for the review to assess the extent to which the project objectives can be met within the context of the NEPA process.

2.2 Literature Review

The project area has been heavily investigated over the past several decades in response to frequent flood events. Many documents and reports describe previous modeling studies and data collection efforts. These documents, along with data files such as CAD drawings, spreadsheets, and survey maps, are the primary sources for this review.

The emphasis of this review is to understand the objectives, methods, and possible limitations of previous studies. Because some of the EIS alternatives are evaluated based on prior analyses and modeling efforts, this review documents that such comparisons are based on suitably valid assumptions.

2.3 Site Visit

CCPRS performed a site visit on August 12, 2014, to evaluate the geography, land cover, structures, and waterways within the study area. This site visit is described in more detail in Section 4.

2.4 Workshop and Agency Communication

Numerous public and private organizations have participated in development and use of hydraulic modeling tools in the project area. CCPRS coordinated and discussed the project and alternatives with several parties who have been involved in both the current and previous work efforts. Coordination with the public and agencies is described in more detail in Section 5.

2.5 Risk and Uncertainty

Primary responsibility for avoiding errors and omissions rests with the model developers and authors of previous studies. This review includes observations regarding the model construction and performance, but this review is not intended as a quality control process; however, correctly interpreting model results for use in the EIS requires a characterization of uncertainties associated with the modeling process and risks caused by its limitations. This forms a basis for characterizing confidence in model results for use in the EIS.

Based on the reviewers' experience, agency discussions, public comments, and communications with contractors tasked with developing the models, a list of risk and uncertainty areas was developed and investigated. While the review does not provide numerical or statistical confidence limits around reported results, it does provide essential context and supports a finding of suitability for the EIS analysis.

The review identified several areas of uncertainty and concerns with the model structure and application. Several recommendations were identified that could increase the confidence in the reported model results. These recommendations were discussed with the model designer and are addressed in Attachment A. In addition, revisions were made to the hydraulic model used for analysis and the revised results were reported in the Draft EIS, and subsequent documents reflect those changes that were made as part of this review process. For example, the predictions of flood reduction with the Proposed Action as presented in the Draft EIS reflect the revised model results that came from this review and the discussion between the peer review hydrologists and the model designers. This appendix presents the model review and recommendations for improvement. Attachment A presents the model designers' response to the recommendations, and the EIS presents the results of the revised model.

A general description of uncertainty, specific areas of interest, prioritization based on risk, and potential mitigation strategies from the initial review cycle are described Section 6 of this report. The following key areas are described in general terms and treated in more detail in the subsequent Hydrology and Hydraulics sections (Sections 7 and 8, respectively):

- Selection and limitations of numerical models
- Monitoring data site selection and measurement error
- Field survey site selection and measurement error
- System connectivity and geometry
- Parameter selection

- Calibration and validation
- Flood event selection, error, and bias
- Temporal stationarity
- Absolute and comparative results

2.6 Hydrology

For purposes of the EIS, hydrology refers to the selection and development of flood events in the vicinity of the project area to be tested under the No Action Alternative and several action alternatives. A flood event may consist of estuarine tidal inundation, base flow, and rainfall runoff. Magnitude and timing of peak flow rates depends on ground cover, type of precipitation and intensity, and the routing of water through stream channels.

The review considers selection of the event(s), use of measurement data to support development of the simulations, and uncertainty that may affect the utility of model results.

2.7 Hydraulics

Hydraulic models simulate a simplified representation of the physical system to predict expected water surface elevations, velocities, and depths during specific flood events. Models can be used to compare alternative actions, to establish flood conditions in absolute terms, or both. The EIS evaluation, which includes a No Action Alternative, is primarily a comparative analysis. The focus of this review is to characterize the likelihood that the modeling work to date reflects a reasonable basis to compare the alternatives and their expected environmental impacts. In particular, the objectives listed in Section 2.1, which reflect the interests of partner agencies and the public, are the primary criteria for that determination.

Hydraulic analysis of the project area has been performed several times in the past two decades. Because the EIS relies, in part, on this past work, the review establishes a timeline of model changes and enhancements, including on-the-ground improvements, and considers whether changing baseline model performance materially affects comparative conclusions.

The physical system consists of complex river and local drainage interactions, including levees, tide gates, spillways, and other control structures. Simulation of the system requires simplifying assumptions, as well as a calibration process to attempt to match historic performance to a reasonable extent, using industry-standard techniques. The review investigates the existing model(s) set-up, the applicablity and accuracy of measurement data to support the hydraulic model(s) (e.g., the location and number of channel cross sections), the stability of the model(s), how well the model(s) replicate existing processes, and the effectiveness of the calibration efforts. The review also characterizes the stability of the models, and how they might be affected by levee failures or other non-discountable potential factors that might occur in the foreseeable future.

2.8 Related Studies

An important aspect of system performance in the project area is the movement of sediments, including those transported downstream from the upper watershed and those moving upstream from Tillamook Bay due to tidal and storm activity.

This review relies on findings from related studies, specifically including the USACE sediment study (Pearson 2002), as a source of information to assess how the sediment budget may affect current and future performance of the EIS alternatives. In particular, the review focuses on how these factors have been considered or incorporated in the hydraulic modeling work.

In addition, some other documents that are not directly associated with the hydraulic modeling are considered because they influence the overall assessment of the modeling work for the EIS. These documents include tide gate and other design documents as well as climate forecasts and future projection data.

The methods and assumptions of these related studies have not been independently reviewed as part of this work beyond establishing their general credibility as an information source.

2.9 Alternatives Assessment

The EIS document itself will be the primary study of the project alternatives. Within the context of the objectives listed above for the hydrologic and hydraulic model review effort, this review provides an evaluation of the effectiveness of the preferred alternative in relation to other project alternatives.

The review of the alternatives has two components:

a) Characterize how the alternatives are represented in the hydraulic model(s)

b) Assess the comparative performance of alternatives and degree of confidence in reported results, given risks and uncertainties associated with the modeling work

2.10 Findings and Conclusions

A peer review of this type is typically performed to determine whether or not a technical task has been completed following industry standard practices. In this case, the modeling tools have been developed over nearly two decades, updated and enhanced multiple times, and used for a variety of purposes. Industry standard practices have evolved during that time and the objectives of the EIS analysis are similar, but not identical, to those used to establish the methods for construction of the original model and subsequent updates.

This EIS analysis relies on comparative results developed using current and earlier versions of hydraulic modeling tools for the project area. To make a finding that this approach is appropriate and suitable for the EIS analysis, certain modeling objectives were defined for this review to set the context for the alternatives being considered. Comments from agencies and the public were also considered.

This review considers, one by one, whether the hydraulic modeling work completed can reasonably meet the stated objectives. Finally, given the objectives, identified risks and uncertainties, and the specific alternatives to be compared in the EIS, the review makes recommendations to enhance the suitability of the model results for use in the EIS analysis.

Attachment A presents the model designers' response to this review's recommendations, and the Draft EIS presented the revised model findings that resulted from implementation of the recommendations.

SECTION 3 Literature Review

3.1 Computer Simulation Models

Over the past 20 years, a number of studies have been undertaken within the Tillamook Valley to assess flood conditions and identify or refine concepts to reduce flood damages. Each study has had unique characteristics and objectives. The EIS relies heavily on the work of the past with respect to hydrologic and hydraulic modeling, as well as current enhancements and refinements, to evaluate the impacts of each of the alternatives. Because the development of modeling tools is both the primary subject of this review and intertwined with numerous previous studies, this literature review treats the development of the models themselves as a valuable history to document and better understand the evolution of the current project.

3.1.1 Original Development

Prior to the USACE General Investigation and Feasibility Study (2005), the most recent hydraulic modeling study of the Tillamook area was performed in late 1960s and early 1970s by USACE and CH2M Hill in development of the 1978 FEMA Flood Insurance Report for Tillamook County. The modeling in the late 1960s and early 1970s used 2-foot topographic data and cross-sectional data gathered in 1965. The study evaluated the rivers with the one-dimensional (1D), steady-state model HEC-2. As all the rivers of Tillamook Bay are tidally influenced, it was readily apparent that the only way to develop a good understanding of flood behavior in the Tillamook area was to develop an unsteady flow model of the rivers.

For the USACE General Investigation and Feasibility Study in 2005, preliminary modeling of alternatives took place to evaluate each alternative's effectiveness on reducing flood impacts on Tillamook County. Preliminary alternatives were minimally designed to show greatest possible benefits for evaluation. The November 1999 flood was modeled for each alternative using MIKE11. Model results were compared to base conditions for the November 1999 flood.

The MIKE11 model is a 1D, unsteady flow model developed by the Danish Hydraulic Institute. The model is able to solve general hydraulic equations for hydraulic structures as internal boundary conditions such as weirs and culverts are altered. Basic inputs to the model includes river cross-sections, structural geometries, and geographical networks. The model uses branches for rivers and floodplains that consist of nodes (points along the branch) with corresponding cross-sectional dimensions. Like all unsteady flow models, the MIKE11 model requires a boundary condition at all upstream branches and downstream branches of a model network. In the case of Tillamook, temporary peak-stage monitoring gages were used as upstream boundary condition at the upstream ends of the five rivers. The downstream boundary consisted of tidal conditions in Tillamook Bay.

USACE collected the following geometric data for use in the model:

- River cross sections
- Floodplain mapping
- River structures (cross sections of bridges, culverts, dikes, levees, and tidegates)

- Boundary condition data (hydrologic data for each point within the model that is either an end to a reach, a beginning of a reach or a source or sink of water within a reach)
- Crest stage gauge data
- High water mark surveys
- Tributary inflows

Interior drainage in the Tillamook region is provided by hundreds of tide-gated culverts throughout the lower river system. Because there are so many private culverts, USACE did not survey them all. The Tillamook County Watershed Council, in cooperation with the Tillamook Bay National Estuary Program (NEP), completed a cursory inventory of all culverts in the area. This data was used to develop the initial models. Some culvert lengths and most elevations of culverts were estimated from floodplain mapping. USACE hired a local contractor, Nehalem Marine, to survey culvert properties for 20 culverts. USACE gathered other data from Nehalem Marine's records of recent culvert replacement and installations.

WEST Consultants Inc., under contract by USACE, developed the MIKE11 1D, unsteady-flow model of the combined Tillamook, Trask, and Wilson River systems for the study. Surveyed cross-section information was provided for the Tillamook, Trask, Wilson, and Old Trask Rivers; Hall, Dougherty, and Hoquarten Sloughs; and the 'Little Cut' and 'Big Cut' branches between the Wilson and Kilchis Rivers.

A geographic information system (GIS) triangular irregular network (TIN) was used to define overbank features including floodplain geometry and dike/levee heights for the model, and to delineate flooding extents and depths. Aerial mapping for 2-foot contour accuracy of the TIN was conducted by USACE in September 1999 and May 2000. Bathymetric data for Tillamook Bay was collected by USACE in 1995 and 2000.

Wilson and Trask River hourly stage and flow data (gauges #14301500 and #14302480, respectively) were obtained from USGS. Tillamook River flows (gage #14302700) were collected by OWRD. Fifteen-minute tidal information at Garibaldi (located near the north end of Tillamook Bay), as well as 15-minute hourly stage data at Kilchis Cove and Dick Point (both in Tillamook Bay), Gienger Farm (on the Wilson River), and Carnahan Park (on the Trask River) were recorded at USACE gages.

Bridge information was supplied from USACE surveys, Oregon Department of Transportation bridge scour reports and bridge plans, and the 1999 FEMA Flood Insurance Restudy. Culverts included in the MIKE11 model typically connected the overbank areas to the rivers or sloughs. Culvert data was collected and supplied by Tillamook County. Upstream and downstream invert elevations were estimated from the TIN when survey data was not available.

USACE supplied orthophotos (color photos dated 2000, black and white photos dated 1995). A photo album by the Best Impressions Picture Company in Rockaway, Oregon and an aerial video of the November 1999 flood event also were provided. USACE and Tillamook County provided high water marks for the November 1999, May 2001, and November 2001 flood events. The stage data at Dick Point, Gienger Farm, and Carnahan Park, as well as the imagery of the November 1999 event, also were used in calibrating the hydraulic model.

The initial MIKE11 model construction included some limitations. Only the significant culverts were added to the model, and many of these significant culvert invert elevations were estimated from the TIN. Additional culverts and surveyed invert elevations would have been necessary to perform more detailed modeling in any specific location. Dike/levee (‘link channel’) elevations were also estimated from the TIN.

USACE used a two-dimensional (2D), finite element model, ADvanced CIRCulation (ADCIRC), to evaluate several preliminary alternatives for decreasing the stage of multiple rivers that discharge into the Tillamook Bay estuary. The objective of the ADCIRC modeling was to determine if an estuarine-based channel modification could reduce the water elevation in the backbay area of the estuary during high riverine flow events. The model results showed that estuary-based alternatives were not effective for reducing the flood stage at the river mouths during high riverine flow events.

3.1.2 Platform Conversion

In late 2003, after the USACE General Investigation and Feasibility Study process, a decision was made to convert the MIKE11 model to the USACE Hydrologic Engineering Centers River Analysis System (HEC-RAS) model. The HEC-RAS hydraulic model of the Tillamook area was developed using the MIKE11 model used by the USACE General Investigation and Feasibility Study. The HEC-RAS model was used as the primary technical tool in hydraulic evaluation of No Action, Initial, and Preferred Alternatives for the EIS.

3.1.3 Intermediate Enhancements

In December 2008, Northwest Hydraulic Consultants (NHC), under contract with Tillamook County, took over modeling of the project area. Enhancements to the HEC-RAS model consisted of developing new floodplain cross sections using LiDAR data acquired in 2008. The berms and levees along the various channels were also updated based on the LiDAR data as well as a more recent ground survey. Many areas within the project area are covered by dense brush or under tree canopy, and the quality of both the LiDAR and USACE photogrammetric data is lower. No channel cross sections were resurveyed.

NHC kept the basic structure and naming convention of the existing model. Only the Wilson River portion of the model was updated–the Tillamook and Trask River systems did not have new LiDAR coverage available. In addition to topographic updates, some reaches were adjusted to better match flood flow paths, and extensive work was put into creating a numerically stable model that could reliably run under a variety of flood scenarios. The model was also extended down the bay to use Garibaldi as a lower boundary condition.

3.1.4 Current Model Activities

Model calibration, field inspection, and high water marks all point to the importance of berms in controlling flood patterns in the Wilson River, especially in smaller floods. Unfortunately, berms have one of the higher levels of uncertainty within the model due to two factors:

1. The actual elevations of the berms are less certain than most other topographic features.
2. Canopy cover, brush and the small size of the berms mean both photogrammetric and LiDAR based aerial mapping can have significant errors here.

These uncertainties have been mitigated by an additional ground survey to update model inputs.

NHC evaluated a variety of previously proposed and new projects for flood reduction benefits. Each alternative was evaluated against project objectives using modeling results.

Model revisions since 2010 include the addition of design-level levee survey data and updated lateral structure parameters.

Bathymetry was resurveyed in 2014 downstream of the Netarts Highway in the Trask and Tillamook rivers and Highway 101 on the Wilson River and the in-channel geometry was updated. The updated bathymetry reflects significant aggradation over the past ten years, especially on the Wilson River, which shows a 2 to 3-foot rise in bed elevation.

3.2 Studies

The study area and associated watersheds have been studied extensively over the past twenty years. As part of the 2004 USACE General Investigation and Feasibility Study, a bibliography was prepared and is excerpted below. A description of the USACE General Investigation and Feasibility Study and a review of subsequent studies (since 2004) follow.

- *Development of an Integrated River Management Strategy, September 21, 2002. Prepared by Philip Williams & Associates, Ltd., Clearwater BioStudies, Inc., Michael P. Williams Consulting, Urban Regional Research, and Green Point Consulting. Prepared for the USFWS, U.S. Environmental Protection Agency (EPA), and USACE.*

  This project put forward an integrated river management strategy that combined flood damage reduction with salmon recovery. The strategy was developed by an interdisciplinary team using Tillamook Bay Basin as a pilot study area. Analyses of the fluvial, biological, and institutional elements composing the Tillamook Bay river system were conducted at a number of spatial scales. The results were used to identify opportunities and constraints, and to develop a planning level Integrated River Management Strategy for Tillamook.

- *Tillamook Bay Wetlands: Management Plan for the Wilson, Fuhrman, and Farris Wetland Acquisition Properties, November 2001. Compiled and written by Derek Sowers and Mark Trenholm, staff of the Tillamook County Performance Partnership, for Wetlands Management Plan Development Team.*

  The purpose of this management plan was to describe how the properties proposed for acquisition and restoration by the Tillamook County Performance Partnership would be managed to meet the goals and objectives stated in the grant agreements with OWEB and USFWS, and as agreed upon by the relevant local stakeholders. The management plan is designed to provide assurance to the grant funding agencies, all potentially affected parties, as well as the general public, that the acquisition and management of the land parcels would be implemented in a carefully planned manner and to address any existing or potential concerns. The management plan contains discussions of all of the major elements in need of consideration prior to making the substantial commitment of resources necessary to implement and maintain the project. The elements include goals and objectives, site descriptions and background information, restoration and enhancement activities, identification of responsible participants, public access plan, monitoring and evaluation, and costs and funding.

- *Wilson River Watershed Assessment, February 2001. Prepared by E&S Environmental Chemistry, Corvallis, OR.*

  The assessment was prepared to inventory and characterize the current conditions of the Wilson River watershed, and to provide recommendations that address the issues of water quality, fisheries and fish habitat, and watershed hydrology. The assessment creates a framework for identifying restoration activities to improve water quality and aquatic habitat in the watershed.

- *Comprehensive Conservation and Management Plan for Tillamook Bay, Oregon, December 1999. Prepared by the Tillamook Bay National Estuary Project, Garibaldi, OR.*

  Designated as a significant tidal estuary in the NEP and a component of the Oregon Coastal Salmon Restoration Initiative, Tillamook Bay and its watershed are ecologically and economically valuable to the State of Oregon. The Tillamook Bay NEP was funded by EPA to evaluate the condition of the bay and estuary, especially concerning water quality issues. Coordination with and comments from representatives from public groups and local citizens supplemented extensive input from agencies at federal, state, and local levels. The Comprehensive Conservation Management Plan presented the proposed actions and policies to achieve targets for solution of the problems identified since 1994. The four priority problems included: (1) critical habitat loss, (2) sedimentation, (3) bacterial contamination, and (4) flooding. The plan also included characterization of the bay, an analysis of the current policies which impact the priority problems, a financing plan, and a monitoring plan. The technical analysis and extensive review process of the NEP provided a significant resource for the foundation of the USACE General Investigation and Feasibility Study.

- *Tillamook Bay Environmental Characterization: A Scientific and Technical Summary, July 1998. Prepared by the Tillamook Bay National Estuary Project, Garibaldi, OR.*

  This document summarized the relevant facts and figures describing the natural features of the Tillamook Bay watershed. The report provided an overview of the coastal landscape, discussed human uses, and focused on the priority problems identified by the NEP: biological resources, water quality, sedimentation, and flooding.

- *The Oregon Plan for Salmon and Watersheds (Oregon Plan), Executive Order EO99-01, January 8, 1999. State of Oregon.*

The purpose of the Oregon Plan is to restore Oregon's wild salmon and trout populations and fisheries to sustainable and productive levels that would provide substantial environmental, cultural, and economic benefits and to improve water quality. The Oregon Plan is a long-term, ongoing effort that began as a focused set of actions by state, local, tribal and private organizations and individuals in October of 1995. The Oregon Plan first addressed coho salmon on the Oregon Coast, was then broadened to include steelhead trout on the coast and in the Lower Columbia River, and then expanded to all at-risk wild salmonids throughout the state. The Oregon Plan is described in two principal documents, the Oregon Plan dated March 1997, and the Oregon Plan for Salmon and Watersheds, Supplement I - Steelhead, dated January 1998.

- *Tillamook County Flood Hazard Mitigation Plan, November 1996. Prepared by Tillamook County.*

  This plan addresses the events and impacts associated with the February 1996 flooding in Tillamook County. While flooding was common throughout Oregon and the Northwest, Tillamook County sustained damages well beyond other watersheds, when compared to the local economy. Damages totaled $53 million. In addition to descriptions of historic flood damage reduction solutions within the county, the plan includes proposed policies and general actions to deal with flooding in the future. Non-structural flood reduction measures are a major component of the program. This document serves as Tillamook County's strategy for reducing future flood damages.

Numerous studies have been undertaken for the Tillamook Bay NEP, as listed below.

- July 2000 - Ecological interactions among eelgrass, oysters, and burrowing shrimp in Tillamook Bay, Oregon, year 2 (1999) report. Prepared by David K. Shreffler and K. Griffin.
- July 2000 - Identifying sources of fecal coliforms delivered to Tillamook Bay. Prepared by J. Moore and R. Bower.
- October 1999 - Tillamook Bay fish use of the estuary. Prepared by R.H. Ellis.
- October 1998 - Three Graces Intertidal program: A report on visitor use patterns at Three Graces Intertidal. Prepared by B. White.
- August 1998 - Sediment sources and accumulation rates in Tillamook Bay, Oregon. Prepared by J. Mcmanus, P.D. Komar, G. Bostrom, D. Colbert, and J.J. Marra.
- August 1998 - Reconnaissance survey of tide gates in Tillamook Bay vicinity. Prepared by J. Charland.
- March 1998 - A biological inventory of benthic invertebrates in Tillamook Bay. Prepared by J.T. Golden, D.M. Gillingham, V.H. Krutzikowsky, D. Fox, J.A. Johnson, R. Sardiña, and S. Hammond, Oregon Department of Fish and Wildlife.
- March 1998 - Forest roads, drainage, and sediment delivery in the Kilchis River watershed. Prepared by K. Mills, Oregon Department of Forestry.
- March 1998 - Bathymetric analysis of Tillamook Bay, comparison among bathymetric databases collected in 1867, 1957 and 1995. Prepared by J.A. Bernert and T.J. Sullivan.
- September 1997 - Invertebrate fauna of Tillamook Bay. Prepared by B. Houck, S. Kolmes, L. Fergusson-Kolmes, and T. Lang, University of Portland.

- July 1997 - Eelgrass ecology and commercial oyster cultivation in Tillamook Bay, Oregon. Prepared by K. Griffin.
- September 1996 - Determining abundance and distribution of eelgrass (*Zostera* spp.) in the Tillamook Bay estuary, Oregon using multispectral airborne imagery. Prepared by J.R. Strittholt and P.A. Frost, Earth Design Consultants.
- June 1996 - An environmental history of the Tillamook Bay estuary and watershed. Prepared by K. Coulton and P.B. Williams, Philip Williams and Associates, Ltd., with P.A. Benner, Oregon State University and assistance from the Tillamook Pioneer Museum.
- 1996 - Spatial analysis of the bridges of Tillamook County. Prepared by S. Kujack as a cooperative effort with Tillamook Bay Community College and Tillamook Bay NEP.
- November 1995 - Landscape change in the Tillamook Bay watershed. Prepared by J.R. Strittholt and P.A. Frost, Earth Design Consultants.
- July 1995 - Tillamook Bay watershed analysis framework. Prepared by W. Nehlsen, and T.C. Dewberry, The Pacific Rivers Council.
- July 1995 - Identification and distribution of subtidal and intertidal shellfish populations in Tillamook Bay, Oregon. Prepared by K.F. Griffin.
- June 1995 - Inventory of the management framework for Tillamook Bay National Estuary Project priority problems: Phase I of the base programs analysis. Prepared by G. Plummer.
- February 1995 - Fish and wildlife issues in Tillamook Bay and watershed: Summary of a Tillamook Bay NEP Scientific/Technical Advisory Committee forum. Prepared by J. Miller and R.J. Garono.

3.2.1 USACE General Investigation and Feasibility Study

The Tillamook Bay and Estuary, Oregon, General Investigation and Feasibility Study was authorized by a U.S. Senate Committee Resolution on June 5, 1997. The purpose of the study was to evaluate flood damage reduction and ecosystem restoration in the Tillamook Bay watershed in Tillamook County in northwestern Oregon. The report describes the progression of the study and the activities completed through 2004. It provides a status of the potential alternatives evaluated, including initial modeling results and preliminary cost estimates. The feasibility report was the final response to the study authority.

Fifty-nine potential alternative measures were initially considered. During the process to prioritize and narrow the measures, the sponsor decided to support only those alternatives providing both ecosystem restoration and flood damage reduction benefits, as well as having overall public support. This reduced the number of alternative measures to 33. Further evaluation with an area of focus in and around the City of Tillamook, and based on engineering and biological evaluation, further reduced this number to 14 potential alternatives.

A 1D, hydrodynamic model of the five rivers was developed as the primary evaluation tool for screening the 14 potential alternatives. This was the MIKE11 model, eventually moved to the HEC-RAS platform. Preliminary model runs were performed to increase the understanding of the system and to aid in the process of prioritization and narrowing of alternatives. From the modeling results, it appeared that some of the potential alternatives would not provide many benefits for flood damage reduction. The sponsor decided that these alternatives would no longer be considered for further evaluation. The Wetland Acquisition/Swale and Hall Slough alternatives were evaluated further because they had the greatest potential to provide both ecosystem restoration and flood reduction benefits.

After initial evaluation and modeling, the sponsor requested that the Modified Wetland Acquisition alternative be transferred to either the Continuing Authorities Program or to Section 536 of the Water Resources Development Act of 2000 (Public Law 106-541) for further evaluation and implementation.

Table 3.1 summarizes the timeline of events associated with construction of hydraulic modeling tools and execution of the USACE study.

Table 3.1 Hydraulic Modeling Timeline

Study Event	Date
Senate Resolution	June 5, 1997
Reconnaissance phase completed	August 1999
Feasibility Cost Sharing Agreement completed	July 1999
Initiated Feasibility Study	August 1999
Change of sponsor from TCSWCD to Tillamook County	February 17, 2000
Advisory Council established	May 2000
Notice of Intent in *Federal Register*	May 30, 2000
Public scoping meetings	July 25, 2000
MIKE 11 model completed	December 2001
Presentation of preliminary analysis using MIKE 11 model	March 2002
Updated plan for narrowing alternatives	April 2002
Public meeting presenting benefits of Hall Slough, Dougherty Slough and Wetland Acquisitions/Swale Alternatives	July 2002
Preliminary design and cost estimate for Hall Slough, Wetland Acquisition, and Modified Wetland Acquisition/Swale alternatives	August 2002
Decision to convert Modified Wetland Acquisition/Swale alternative to Continuing Authorities Program/Section 536	June 18, 2003
Model conversion to HEC-RAS completed	December 2003

3.2.2 Local Sponsor Studies

Project Exodus Final Report, February 2010, prepared by NHC and HBH Consulting Engineers for Oregon Solutions Design team under contract to Tillamook County.

NHC, in conjunction with HBH Engineering Consultants, was selected by the Oregon Solutions Design Team to analyze flooding on the Wilson River in Tillamook County, Oregon and develop solutions to reduce flood levels. This report documents the process, methods and results of the project. The selected alternative - Project Exodus - was presented, including project elements, flood reduction benefits, preliminary plans, cost estimates and a scope of work for implementation.

The HEC-RAS hydraulic model developed for the USACE General Investigation and Feasibility Study was updated and used as the primary technical tool in hydraulic evaluation of alternatives for Project Exodus.

A variety of previously proposed and new projects were evaluated for flood reduction benefits. Each alternative was evaluated against project objectives using modeling results and preliminary cost estimates. The alternatives analysis and modeling created an understanding of Wilson River flood behavior, including why different options did or did not reduce flood levels. Further refinement of those options that were most effective led to the First Flood Control Project, which contained three recommended elements. Two of the elements contained design options with flood reduction and cost differences.

The largest and most important project proposed was the Southern Flow Corridor. The southeastern portion proposed creating a flow corridor beginning downstream of Highway 101 between Hoquarten and Dougherty Sloughs and running westward to the Tillamook River. The flow corridor was created by constructing setback levees and removing existing levees within the project area. In the northwestern half of the Wetlands Acquisition Area further levee removals were proposed. Two options were presented (at the time of presentation they were called Project Exodus Alternatives 3 and 4). They differed in how the southern half of the Wetlands Acquisition Area was treated. The two alternatives share mostly common features and required the same land footprint. Key differences were in the length of new levee required and the area used for unconfined conveyance open to tidal influence, resulting in differences in flood level reduction, habitat restoration benefits and construction costs.

Two berm alternatives were presented to address nuisance flooding that originates from the Wilson River upstream of the Shilo structure and flows west through homes and commercial properties across Highway 101. The first alternative was to construct a new berm tying in from the railroad grade fill downstream to the Shilo structure. The 1600 foot long berm would be engineered to resist overtopping and prevent overbank flows up to around a 5-year frequency flood. The second alternative was to use a “guide berm” to still allow overbank flows through the area, but direct all the flow into Hall Slough rather than flowing west towards the highway. This berm would run south from the upper end of the Shilo structure and redirect flows that would otherwise flow west into Hall Slough. The upper end of the Hall Slough channel down to just past Highway 101 would be excavated in order to prevent a rise in water surface in this reach due to the increased flows.

The first alternative provided flood protection to homes along the south bank of the Wilson River, but caused a small rise in the river and on the opposite north bank. The second alternative showed no flood level increases, but had the potential for some adverse impacts to south bank properties. Estimated construction costs were roughly equal.

This proposed project involves lowering a section of high ground in a pasture that acts as a low dam and causes backwater under Highway 101 and upstream.

A separable element is the smallest project piece that may be constructed without causing adverse impacts. The Southern Flow Corridor and North Bank Wilson Field Grading project are separable elements. The South Bank Wilson River Berm is not considered a separable element. Due to the increases in flood levels in the Wilson River proper and on the north bank, it should not be implemented until the North Bank Project is completed.

This analysis and modeling effort concluded that there was no one "chokepoint" that causes most backwatering effects, rather each cross levee and obstruction in the corridor incrementally adds to the backwater effects.

Southern Flow Corridor – Landowner Preferred Alternative; FY 2013 Coastal and Marine Habitat Restoration Project Grant Application, February 2013, prepared by Tillamook County

Tillamook County proposed to permanently protect and restore 521 acres of tidal wetland habitats at the confluence of the Bay's two most productive salmon systems, the Wilson and Trask Rivers. This grant proposal focused on securing funding for the portion of the Project Exodus referred to as the Southern Flow Corridor, with some minor revisions.

Long term ecological and socioeconomic outcomes proposed in addition to direct restoration of tidal wetlands include:

- Improved freshwater and estuarine water quality, including reductions in temperature, dissolved oxygen, and turbidity
- Increased habitat complexity and availability across the range of tidal wetlands habitats
- Enhanced ecological function benefitting other aquatic, terrestrial, and avian species
- Reduced flooding in the Highway 101 business corridor, including measurable reductions in both flood elevation and duration

3.2.3 Findings and Conclusions

Review of previous study efforts indicates a clear evolution of project objectives to reflect local interests, funding source priorities, and continued refinement of technical information through analysis and data collection. The 2005 USACE General Investigation and Feasibility Study represents a watershed moment in this evolution. All studies before it relied on dated, incomplete, or historic anecdotal information about flood conditions in the project area. With construction of the hydraulic and hydrologic models for the USACE study, all subsequent efforts to quantify flood benefits from proposed actions that have evolved into alternatives evaluated in the current EIS have their basis in the USACE-constructed model.

SECTION 4 Site Visit

4.1 Purpose and Objectives

As an approximate representation of the physical system, hydraulic and hydrologic computer simulation models rely on a high-level conceptual understanding of the essential physical system elements. Typically, these include surface topography, land cover and vegetation, connectivity and routing between flow paths, hydraulic structures, floodplain obstructions, and dynamics that may include erosion and sedimentation that affect hydraulic performance.

The purpose of a site visit was to provide an independent assessment of these essential elements and their representation in the computer models. The site visit had the following specific objectives:

- Orient the review team to the project area
- Note conveyance channels and apparent high-water flow paths
- Observe major structures such as tide gates, levees, and culverts
- Characterize system connectivity and flow routing in the context of model development

4.2 Findings and Observations

Two hydraulic engineers and a geologist specializing in fluvial geomorphology participated in the site visit, held on August 12, 2014. The visit included access along roadways in the proposed restoration area, along Highway 101, and the upper end of Hall Slough. The portion of the levees in the lower section of the project area were also traversed on foot to observe channel conditions and drainage control structures such as tide gates.

The most notable features affecting hydraulic model construction and performance are the following:

- The numerous levees and gates designed to protect against high tide conditions but be overtopped in significant flood events
- The broad, flat floodplain region with multiple inter-connected channels and sloughs
- The vegetated land cover and channel conditions that affect the ease or difficulty of flow movements laterally across the floodplain.

Figure 4.1 through **Figure 4.4** show examples of these conditions.

Figure 4.1 illustrates the relationship between the Trask River channel and the overbank area, separated by a levee. The levee is expected to overtop during flood events (approximately the 5-year frequency), resulting in lateral exchange of flow between the two sides of the levee. The protected side also has potential to fill with water from upstream sources and spill into the river. In the 1D hydraulic model, this 2D exchange of flow is estimated using defined flow paths and parameters that characterize the roughness and hydraulic efficiency of the exchange at the levee.

Figure 4.1. Levee Separating Trask River From Floodplain

Figure 4.2 shows tide gates at the lower end of the proposed wetlands restoration area. Under current conditions, it is expected that these gates and surrounding levee embankment would be overtopped at approximately the 5-year recurrence flood event. The Landowner Preferred Alternative includes removal of this obstruction and use of this area as a primary flow path for water entering from upstream by both the Trask and Wilson Rivers.

Figure 4.2. Tide Gates

Figure 4.3 shows one of the slough side channels. Although exchange of flow between the wetland restoration area, slough channels, and main river channels occurs over a range of flow conditions, including relatively frequent “nuisance” floods, woody debris and heavy vegetation affects the efficiency of flow movement and varies depending on flood stage.

Figure 4.3. Slough Conveyance Reach

Figure 4.4 shows the confluence of a major slough flow channel with the Wilson River and upper Tillamook Bay. Across a range of flow conditions, the dominant regime would be expected to be strongly 2D in this area, with perpendicular fresh water flows and tidal influences affecting hydraulic performance.

Figure 4.4. Two-Dimensional Flow Conditions at Tillamook Bay Confluence

In summary, field observations indicate that hydraulic conditions in the Tillamook Bay system in the vicinity of the project area are complex, multi-dimensional, and stage-dependent to a significant extent. While systems of this type can be represented by a 1D hydraulic model, such an approach requires certain limiting assumptions that depend on subjective judgment. In many cases, these assumptions can be difficult to independently verify and can affect results, as described in later sections of this review.

SECTION 5 Workshop and Agency Communication

5.1 Public Scoping

The EIS documents public comments on the proposed project. This section briefly summarizes the nature of comments most relevant to the objectives of the hydraulic modeling efforts. The majority of letters, emails, and comment forms received expressed concerns related to flooding, with a total of 58 individual comments related to flooding. Specifically, three comments indicated that the proposed project would reduce flooding events; nine comments suggested the project would not reduce flood risk or that flooding could not be stopped. Approximately 13 comments contended that flooding would be reduced if the sloughs, rivers, and/or Tillamook Bay were dredged to remove sediment.

Most comments mentioned the potential impacts of flooding, either based on previous flood events or concerns about future flooding. In particular, five comments called out the need for hydraulic modeling or additional research to understand flood impacts. Three comments were related to maintenance of flood protection measures. Six comments suggested ways to reduce flooding, including storing water, addressing erosion, or implementing another method. Five comments suggested changes to nearby areas/sloughs as methods to reduce flood events.

One comment questioned whether the project meets FEMA's No-rise Certification. One comment expressed concern about floodwater flows once the project is in place, including a request to evaluate impacts when there is high tide and maximum river flows.

Approximately 30 comments were received regarding surface water and surface water quality. Several comments expressed concern that the project would raise water levels and negatively impact project area farms. Approximately 13 comments recommended dredging or sediment removal to reduce flooding, improve water quality, or allow natural interaction between brackish and fresh water. One comment expressed concern that the project would increase water velocity, which could cause damage to property and life. A number of comments expressed concern about where the diverted floodwaters would cause impacts and the extent of those impacts to property and public safety.

5.1.1 Federal Agency Scoping Comments

EPA provided comments on the Proposed Action, stating that the agency supports restoring natural processes for aquatic, wetland, and water quality restoration as well as climate change resiliency and flood risk reduction. The substantive points relevant to the hydrologic and hydraulic modeling included:

- EPA supports restoring natural processes, particularly where there may be a dual benefit such as flood risk reduction. The SFC proposed action appears consistent with the January 2014 SFC Effectiveness Monitoring Plan.

- EPA supports re-establishing natural hydrological processes that would allow re-establishment of ecosystem structures, processes, and functions.

- Re-establishing natural hydrologic process would support juvenile salmonids.

- Re-establishing natural hydrologic process would support sediment detention, production of organic matter, and habitat suitable formative plant communities.
- Restoring natural hydrologic process would reduce flood damage to property and roads, as well as decrease repetitive flooding, caused by loss of floodplain function and stream complexity.
- Removing levees that currently isolate the project area has the potential to facilitate natural marsh accretion and allow the site to keep pace with sea-level rise, fostering species' resilience and adaptability.
- The emphasis on flood risk reduction and environmental benefits is consistent with the 1999 Tillamook Bay CCMP, which calls for protection and restoration of 750 acres of wetlands.
- The proposed action would address the majority of the Tillamook Bay CCMP commitments and meet the nine actions aimed at protecting and enhancing wetlands, removing salmon migration barriers, reconnecting sloughs and rivers, and improving sediment storage and routing.

5.1.2 Local Agency Scoping Comments

The Tillamook County Soil and Water Conservation District provided a comment stating that they do not support the proposed action. The district is concerned that projects implemented to reduce flooding should include sediment removal from the sloughs running through and adjacent to the project area to produce an adequate amount of flow. The district added that the current flood protection system in place is working adequately well. Representatives outlined questions and concerns to consider in the EIS (those listed below are relevant to the hydrologic and hydraulic modeling).

- The new dikes designed to pass overtopping floodwaters would be prone to erosion.
- Have the benefits of the Wilson/Trask and Tone Road Spillway Projects that addressed the need to reduce the height and duration of nuisance flooding been modeled into the SFC project?
- Would the project have a negative effect on the lower Trask River and adjacent agricultural drainages?
- Would the storage behind the Beeler/Jones levee be adequate?
- Would there be increased water delivery from the lower Wilson River to the south? What effect would the project have on drainage of the Trask and Tillamook rivers?

The Stillwell Drainage District commented on concerns that the proposed action would have a negative effect on their ability to minimize flood impacts to their district as well as their ability to reduce flooding occurrences. They support the No Action Alternative. They provided several concerns regarding the proposed action. Those listed below are relevant to hydrologic and hydraulic modeling.

- Concern that the alternatives would increase flood damage and decrease life safety within the Stillwell Drainage District.
- The Stillwell Drainage District's levee has been effective in preventing flooding to date. The Stillwell Drainage District is concerned that the proposed action would increase the water level in the District.
- The Proposed Action would release water close to the Stillwell Drainage District (rather than into the bay closer to the mouth of the river) and would therefore require the Stillwell Drainage District to increase the height of their levee.
- The Proposed Action would increase water levels in the basin, which would require the Stillwell Drainage District to install larger lift pumps to remove water from within the district levee. The increased water in the basin would also slow the opening of the tidegates, which currently allow a large percentage of the water to escape.
- Because of the Proposed Action, the river side of the tidegates would need to be cleaned to increase flow rates when the gates reach a point when they function.
- The Proposed Action would change flow patterns and increase flow rates, which would impact the levee, particularly where the levee does not have rip-rap.

5.2 Workshop

Tillamook County enlisted NHC to perform several ongoing and related tasks to update certain field data for stream channel and levee measurements. NHC is also tasked with developing design materials for the proposed action alternative. The firm was also involved, along with WEST Consultants of Salem, OR and USACE Portland District, among others, in previous modeling work in the study area. A workshop was held on October 1, 2014 with FEMA and NHC staff to better understand the work to date and investigate several aspects of the modeling activities. The agenda of the workshop was:

- Introductions and respective assigned scopes of work
- Overview of the current model construction and design activities
- General description of system performance during flood events
- EIS comparative modeling objectives and understanding of the review task
- Identifying areas of risk and uncertainty relative to objectives
- One-by-one review of known efforts to address risk areas
- Gaps, limitations, and data needs

- Remaining questions and answers
- Path forward and action items

As a result of the workshop, additional model support materials and draft design drawings were provided to the review team. The workshop also informed the structure and content of subsequent sections of this review study, particularly Sections 6, 7, and 8.

5.3 Agency Communications

Additional formal and informal discussions, with USACE staff in particular, have been useful to capture the intent of earlier efforts and understand, to the extent possible, the rationale for decisions made during model construction and refinement.

5.4 Findings and Observations

Public and agency comments indicate significant reservations about the state of knowledge regarding how the proposed project would affect flood conditions in the project area. In some cases, this reflects specific testable concerns, such as expected velocities and water depths in the vicinity of specific levees and structures. In other cases, it reflects continued interest in additional alternatives, such as dredging, that have been considered but dismissed from detailed analysis in the EIS. While this review does not attempt to answer all of the questions and concerns raised, it does attempt to determine if the appropriate tools have been used to respond to the comments.

With respect to these tools, the hydraulic model in particular, discussion with contractor and agency staff makes clear that certain constraints on the budget and computational capabilities readily available in the initial stages of the USACE General Investigation and Feasibility Study still affect modeling approaches for the EIS and design efforts. Since the original MIKE11 model was constructed, incremental improvements have been made to the input data and flow routing. Fundamental limitations remain that affect the predictive ability of the modeling to address public comments and differentiate between alternatives.

SECTION 6 Uncertainty and Risk

The concept of uncertainty is frequently misunderstood (Riebeek 2002). To the general public and decision makers, uncertainty is typically interpreted as a sign of weakness. To scientists, uncertainty can be a statement of knowledge and useful information, and it can provide a context in which to discuss and prioritize an approach to facilitate decision making. Uncertainty is a lack of sureness about something…not a lack of knowledge (Clark and Newson 2008).

For simple projects or systems, it may seem reasonable to apply the historically popular view of uncertainty as a nuisance, which should be managed with an eye towards reducing it at all costs. Although some uncertainties can be reduced, many uncertainties cannot or would be too expensive to reduce. The convergence of three large rivers, combined with tidal effects, and vast interconnected floodplains is hardly a simple system, and one that can never be fully understood, or modeled with a high degree of certainty. Uncertainty will always be a reality in this complex system and decisions will need to be made in the face of it.

6.1 Types of Uncertainty

One of the keys to usefully articulating uncertainties and assessing their significance is having clear definitions (i.e., a typology) for segregating sources and types of uncertainty. Many useful typologies for uncertainty exist (Krupnick et al. 2006). For example, in a recent funding solicitation for looking at "Uncertainty Analyses of Models in Integrated Environmental Assessments," EPA (2006) highlighted different types of uncertainty articulated by Krupnick et al. (2006), such as stochasticity, parameter uncertainty, structural uncertainty, decision uncertainty, and linguistic uncertainty.

For this review, uncertainty is discussed using a well-established typology proposed by Rotmans and Van Asselt (2001) and later presented in the context of geomorphology and restoration by Sear et al. (2008). This typology is used because of its holistic consideration of uncertainty in terms of its sources and because this typology was developed for scenario modeling and decision support (Wheaton et al. 2008). The typology is explained below, and examples of sources and types of uncertainty specific to the project area are presented in subsequent sections.

6.1.1 Sources of Uncertainties

The ability to define and discuss uncertainties requires an understanding of the sources of uncertainty. Uncertainty in the Rotmans and Van Asselt (2001) typology stems from two sources: limited knowledge (as opposed to a lack of knowledge) and variability.

6.1.1.1 Limited Knowledge

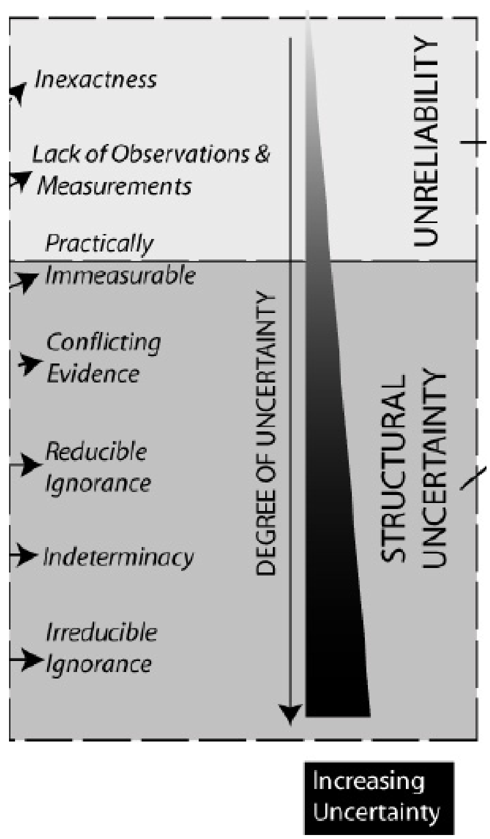
Uncertainty caused by limited knowledge results from a mix of limited data and limited understanding. For example, topographic and bathymetric data are required to describe a physical template, and local and reach-scale hydraulics and sediment transport are driven by physical processes, some of which are more easily (and accurately) measured than others. (Typically, discharge is easier to measure than bed shear stress and transport of bedload or suspended load.)

6.1.1.2 Variability

Uncertainties resulting from variability stem from inherent traits of natural systems. In general, uncertainty caused by variability encompasses a broader mix of sources (compared with uncertainty resulting from limited knowledge), including spatial and temporal variability (e.g., rainfall patterns and runoff response); nonlinear, random, and chaotic processes related to sediment supply and transport (e.g., mass wasting from hill slopes and bank erosion); and socio-political factors (e.g., land use decisions).

6.1.2 Types of Uncertainties

Types of uncertainties resulting from limited knowledge can be considered to span a continuous spectrum ranging from unreliability uncertainties at one end of the spectrum to structural uncertainties at the other end (Van Asselt and Rotmans, 2002; Sear et al., 2008). While continuous, this spectrum can be further subdivided into discrete subtypes as a means to facilitate communication about the types and sources of uncertainty and their significance in a particular context (**Figure 6.1**). In general, the degree of uncertainty increases as one moves along the spectrum from unreliability uncertainties to structural uncertainties.



(adapted from Van Asselt and Rotmans 2002)

Figure 6.1. Types of Uncertainty

These types of uncertainty are generally described in **Figure 6.2** and explained in more detail in the following sections.

Spectrum of Categories of Uncertainty	**Subcategories**	**Description**
Unreliability Uncertainty	Inexactness	*Related to error, imprecision, and accuracy* of the information / measurements acquired.
	Lack of observations and measurements	*Could have, should have, would have….but did not.* A real aspect in most projects is the pieces of information that we were unable to record or simply did not record.
	Practically Immeasurable	*We know what we do not know* – refers to phenomena or measurements that cannot as yet be undertaken perhaps because of scaling issues or the technology available at the time.
Structural Uncertainty	Conflicting Evidence	*We do not know what we know* – knowledge is inexact and different interpretations of the same phenomena / information exist.
	Reducible Ignorance	*We do not know what we do not know* – this is information / knowledge that is accessible but as yet we have not as a community discovered it.
	Indeterminacy	*Things we will never know*
	Irreducible Ignorance	*Things we cannot know*

(Source: Sear et al 2008)

Figure 6.2. Limited Knowledge Uncertainties

6.1.2.1 Unreliability Uncertainties

At the end of the spectrum where the degree of uncertainty is the lowest, unreliability uncertainties are generally related to measurement and can be divided into three subtypes: inexactness, lack of observations and measurements, and practically immeasurable (Van Asselt and Rotmans 2002, Sear et al. 2008). Definitions of each are presented below using descriptions from Sear et al. (2008) and Van Asselt and Rotmans (2002):

- Inexactness uncertainty is related to error, imprecision, and accuracy of the information/measurements acquired. In modeling, this is often called parametric uncertainty (i.e., uncertainty in input model parameters), which subsequently influences model outputs. Inexactness is typically constrained by increasing the accuracy of measurements, or, in models, by using a sensitivity analysis to look at the sensitivity of outputs to variations in the input.

- Lack of observations and measurements describes the pieces of information that could have been recorded but were not. It is typically constrained with additional data collection more frequently, at a more representative spatial resolution, or both.

- Practically immeasurable uncertainty refers to phenomena or measurements that cannot as yet be undertaken, perhaps because of scaling issues or the technology available at the time. It is typically one of the most difficult sources of uncertainty to constrain. Given enough time and resources, unreliability uncertainties are typically straightforward to reduce to acceptable levels. However, some uncertainty is practically immeasurable regardless of what tools and resources may be available.

6.1.2.2 Structural Uncertainties

The degree of uncertainty continues to increase as one moves toward the structural uncertainties end of the spectrum through the four subtypes: conflicting evidence, reducible ignorance, indeterminacy, and irreducible ignorance (Van Asselt and Rotmans 2002, Sear et al. 2008).

Structural uncertainties include key knowledge gaps fundamental to describing physical processes and state, and such uncertainties are compounded by uncertainty due to variability. Structural uncertainties are typically more difficult to address than unreliability uncertainties because structural uncertainties are not directly related to data measurement. Definitions of the four subtypes are presented below using descriptions from Sear et al. (2008) and Van Asselt and Rotmans (2002):

- Conflicting evidence uncertainty identifies where knowledge is inexact and where different interpretations of the same phenomena/information exist. It can sometimes be constrained with additional studies or long-term monitoring.
- Reducible ignorance describes information/knowledge that is accessible but has not yet been discovered/understood.
- Indeterminacy describes things that will never be known. That is, even though the principles and laws of natural processes may be understood, they cannot be fully predicted or determined.
- Irreducible ignorance describes things that cannot be known because the principles and laws of natural processes cannot be (unambiguously) determined by humans.

6.1.3 Capitalizing on Uncertainties Resulting from Variability

Recognition and acceptance of uncertainties due to variability provide a context to proceed in the face of uncertainty. Uncertainties due to variability stem from a variety of inherent traits of natural and human systems, which make exact prediction impossible. However, such variability can often be characterized very well from past records with standard statistical techniques. Some elements of uncertainties due to variability can be quantified better than others, and most of them include a range of possible or expected outcomes or responses, for which boundaries can be defined.

From a hydrologic, hydraulic, and sediment transport modeling perspective, natural variability makes exact prediction of all potential future scenarios virtually impossible. However, simulation modeling that is able to replicate recorded (measured) events and exhibit variability consistent with scenarios of recorded history can serve as an extremely useful decision support tool for weighing the likely and/or plausible future responses to specific future scenarios, including action alternatives. The primary structural uncertainty that arises with these uses of simulation models is the inability to predict the exact future scenario that will match the future reality. However, the use of simulation tools allows the range of possible future scenarios to be highly constrained on the basis of likelihood and/or plausibility.

6.2 Risk due to uncertainty

The significance of uncertainty relative to the EIS is a function of the project goals, objectives, and performance criteria as well as the spatial and temporal scales at which these apply. The significance of uncertainty is also a function of the tools proposed to help evaluate potential actions. (The primary tool being reviewed in this study is the hydraulic simulation model). Taken together, this can be viewed as risk to the overall project or EIS process due to uncertainty.

At this stage of the EIS process, significant uncertainties are defined as those that restrict the development and application of the simulation model and hinder selection of a preferred alternative. Specifically, these uncertainties include the inputs required to construct, calibrate, and validate the simulation model across a range of temporal (flow rates and durations) and spatial (in and off channel, floodplains) conditions in the project area where alternative actions may be implemented. The selection of “significant” data gaps is influenced by current knowledge and is expected to change as a result of input from external technical reviewers, local stakeholders, additional data collection, studies, and monitoring through the course of EIS review and design activities.

6.2.1 Identification of Significant Data Gaps and Other Uncertainties

As previously discussed, even if time and financial resources were unlimited, not all the uncertainties could be constrained. However, some of the limited knowledge uncertainties can be transformed to unreliability uncertainties, and some uncertainties resulting from variability can be addressed using the techniques described above.

Table 6.1 includes a total of 19 examples of uncertainties. The classification of significance, or risk, is a subjective decision (High, Moderate, Low) made by the review team using current information and assumptions. Four areas are identified as High significance, primarily associated with discharge rates and roughness. In addition to organizing the uncertainties by category, subcategory, and source, Table 6-1 also includes text describing the potential effects of each uncertainty on simulation modeling and on selection/evaluation of alternative actions, as well as recommendations on a potential approach to address each uncertainty.

Table 6.1. Uncertainties and Risk in Hydraulic Modeling

Category	Subcategory	Source	Uncertainty About	Potential Effect on Modeling	Potential Effect on Alternative Selection	Potential Approach to Address Uncertainty	Relative Significance
Limited Knowledge	Unreliability	Inexactness	Lack of continuous discharge measurements	Prevents use of actual measurements as boundary conditions	Under- and over-estimates of discharge (and consequently water surface elevations for alternatives)	Collect time-series discharge measurements during peak flows (rising, peak, and falling limbs)	High
			Floodplain roughness	Floodplain and channel roughness are required inputs to the hydraulic model. Without field data, global roughness values (that fail to account for site and reach features) are typically applied to the floodplain and channel, thereby reducing the quality of the model results.	An incomplete characterization of roughness would likely have a larger effect on the accuracy of model results at a smaller spatial scale than a larger scale. Therefore, if alternatives are proposed at a specific location, roughness through that reach should be described as accurately as possible.	Use tools such as LiDAR, aerial photo interpretation, and ground truthing to increase the resolution and quality of roughness parameters. Use sensitivity analyses to determine significance of roughness uncertainty on simulation model results.	High
			Channel roughness	Same as above	Same as above	Use sensitivity analyses to determine significance of roughness uncertainty on simulation model results.	Moderate
			Incorrect geospatial data	Model may inaccurately represent physical features and processes.	Alternatives may be located in inappropriate locations. Results of actions may not match intentions due to differences in physical	Where available, compare geospatial data with other sources.	Low

Category	Subcategory	Source	Uncertainty About	Potential Effect on Modeling	Potential Effect on Alternative Selection	Potential Approach to Address Uncertainty	Relative Significance
					environment from that assumed when developing alternatives.		
			Precision or exactness of datasets is unknown	Precision of model parameters may be inconsistent with source data, leading to imprecise conclusions.	Same as above	Make every reasonable effort to locate description of geospatial precision and exactness. Once located, record as embedded metadata. Ensure all data users are aware of metadata. If description of precision or exactness is unavailable, either use data with caution, or do not use data.	Low
		Lack of observations and measurements	Period of record of discharge measurements	Prevents use of actual measurements as boundary conditions	Under- and over-estimates of discharge (and consequently water surface elevations for alternatives)	Perform sensitivity analysis on discharge rates	High
			No discharge measurements at 40 tributary streams	Prevents use of actual measurements as upstream boundary conditions	Under- and over-estimates of discharge (and consequently water surface elevations for alternatives)	Collect manual discharge measurements during peak flows (rising, peak, and falling limbs); use other gages to create discharge and adjust so that simulated flows match observed flows and conduct	High

Category	Subcategory	Source	Uncertainty About	Potential Effect on Modeling	Potential Effect on Alternative Selection	Potential Approach to Address Uncertainty	Relative Significance
						sensitivity analysis. Consider hydrologic modeling for some ungaged tributaries, such as the Tillamook River	
			Lack of detailed location and geometry information for hydraulic controls such as levees and many culverts	Values used for input, calibration, and validation may not accurately represent local hydraulic conditions, especially at those locations where surface flow interaction between the channel and floodplain needs to be better quantified	Affects resolution and accuracy of results and is scale and location dependent.	Perform sensitivity analysis on key parametric inputs, such as levee inputs, and review model calibration results for conditions where poor geometry data has been “masked” by calibration parameters (e.g., roughness)	Moderate
			Vertical stability of river channels	Knowledge of the spatial scale of past changes in profile influence the spatial domain and modeling approach	Help determine if alternatives in specific locations are likely to be self-sustaining at the locations in which they are installed or if the river may scour and/or deposit and compromise the effectiveness of the alternatives.	Analyze repeat measurements of cross sections at USGS gages. Short-term assessments before, during, and after large events may reveal whether the system was in relative equilibrium. Long-term assessments may help detect the response to alternative actions.	Low

Category	Subcategory	Source	Uncertainty About	Potential Effect on Modeling	Potential Effect on Alternative Selection	Potential Approach to Address Uncertainty	Relative Significance
		Practically immeasurable	Lack of accurate discharge measurement at extreme flows	Limits confidence in discharge (and subsequent hydraulic calculations) at extremely high flows	Under- and over-estimates of water surface elevations for alternatives under these conditions	Perform sensitivity analysis on discharge rates	Moderate
			Measurements of point velocity and depth at high flows at sufficient frequency and distribution	Limits confidence in hydraulic and calculations at high flows	Under- and over-estimates of water surface elevations, velocities and shear stresses for alternatives under these conditions	Resources aside, this source of uncertainty is practically impossible to constrain using currently available technology. However, recognition of this source of uncertainty provides a framework to discuss, acknowledge, and account for its significance.	Moderate
	Structural	Conflicting Evidence	Choice of “best” routing scheme	Drives all outputs from the simulation model	Failure to accurately represent the hydraulic performance of the system to compare alternatives	Evaluate multiple modeling approaches and tools; include field monitoring and studying to complement modeling	Moderate
			Selection of appropriate simulation models	The process representation of physically-based models and selection of variables for empirical based models is a fundamental structural	Different models may suggest different outcomes from the same alternatives.	Using a mix of simulation models to get insight into different aspects of the same problems is advocated over over-reliance on a single model. If multiple models of different types are pointing	Moderate

Category	Subcategory	Source	Uncertainty About	Potential Effect on Modeling	Potential Effect on Alternative Selection	Potential Approach to Address Uncertainty	Relative Significance
				uncertainty. How representative is this of reality?		towards similar conclusions, a higher degree of confidence may be afforded in their plausibility and reliability.	
		Reducible Ignorance	Missing meta-data. Data development methods, description, source and limitations	Precision of model parameters may be inconsistent with source data, leading to imprecise conclusions.	Alternatives may be located in inappropriate locations. Results may not match intentions due to differences in physical environment from that assumed when developing alternatives.	Make every reasonable effort to locate description of geospatial precision and exactness. Once located, record as embedded metadata. Ensure all data users are aware of metadata. If description of precision or exactness is unavailable, either use data with caution, or do not use data.	Low
			Climate change	Changes to magnitude, timing, and duration of runoff and subsequent effects on hydraulics and sediment transport rates in channel and floodplain	Moderate, assuming range of possible scenarios are incorporated into simulation modeling and decision making	Consider potential range of climatic responses during the design life of the alternatives and conduct sensitivity analyses using the simulation model	Moderate

Category	Subcategory	Source	Uncertainty About	Potential Effect on Modeling	Potential Effect on Alternative Selection	Potential Approach to Address Uncertainty	Relative Significance
Variability	N/A	Natural and socio-political	Future watershed management actions	Same as above	Minimal, assuming no watershed management actions would be implemented to increase or decrease peak flows. If this assumption is incorrect, the potential effect could be larger and the relative significance would increase.	Engage local stakeholder and planners to ensure assumptions regarding future conditions are correct; conduct sensitivity analyses using the simulation model	Low
			Future watershed land use	Same as above	Same as above	Same as above	Low
			Future floodplain land use	Determines spatial scale of analysis, key areas of focus, and local parameters such as roughness		Engage local stakeholder and planners to ensure assumptions regarding future conditions are correct; conduct sensitivity analyses using the simulation model to evaluate the potential for floodplain storage of contaminated sediment	Low

6.3 Risk Mitigation Strategies

While beyond the scope of this review to fully resolve identified uncertainty risks, the following discussion highlights some examples of where the risks shown in Table 6-1 either have been or could be mitigated by specific actions, if desired.

6.3.1 Unreliability Uncertainties

Unreliable uncertainty is typically constrained with better measurement tools and targeted data collection efforts.

Lack of observations can be constrained with additional data collection, as illustrated in the following examples:

- Short periods of record, gaps in period of record, and absence of any discharge measurements for some tributaries limit the available discharge data required as an input to the hydraulic model. Placement and operation of gages at the mouths of some tributaries, would address uncertainty associated with the timing, duration, magnitude, and volume of flow to the project area.

- Lateral and vertical stability of conveyance channels influences routing of flood waters, velocities that impinge on levees, and the supply and transport of sediment. Specific questions, such as the following, can be addressed through targeted studies and data collection efforts: New instruments such as load scour cells can help describe localized bed changes, including dune migration.

Practically immeasurable uncertainty may be one of the most difficult sources of uncertainty to constrain, as illustrated in the following examples:

- Measurements of point discharges, velocities, near-bed shear stresses, and water surface elevations across a wide range of flows at points where surface water enters and leaves a main channel (including all tributaries and floodplains) would provide high-quality input and calibration and validation data for simulation models. Addressing this type of uncertainty would likely require a combination of opportunistic field sampling (e.g., during high-flow events) and simulation modeling.

6.3.2 Structural Uncertainties

In some cases, structural uncertainties can also be constrained with sensitivity analysis, specific studies, or long-term monitoring.

- Some of the structural uncertainty associated with the lateral flow exchanged processes in the Tillamook area were further constrained by collecting field survey data of the levees to reduce measurement errors associated with the LiDAR data.

- One hydrologic example of a conflicting evidence type of structural uncertainty is the choice of a representative flow event in terms of magnitude, duration, and frequency of recurrence. One approach could use an "average" runoff (a synthetic hydrograph created from some portion of the available period of record), and another approach might use a specific event observed in the recent past and still on the minds of local stakeholders. When evaluating and comparing alternatives, choices will need to be made between representative flows, such as a large peak-flow event or a large volume duration event. Different technical experts and local stakeholders will have different opinions.

- One example of a structural uncertainty (e.g., reducible ignorance) that could be transformed into a less fundamental unreliability uncertainty (e.g., lack of measurements and inexactness) is the limited understanding of the precise pathways and sources of flow between channels and floodplain reaches. One approach to tracking inundation patterns and pathways is the use of tracers (e.g., salts or dyes) during overbank flows (Hassan and Ergenzinger, 2003). The knowledge gained from this type of effort would help improve the performance of simulation modeling and help inform the selection and development of alternative actions.

- Simulation models can help to address many types of structural uncertainties by quantifying the relative differences in outputs using different fundamental equations, assuming the simulation model is capable of handling different equations. This approach to exploring structural uncertainty in model process representation is analogous to exploring parametric uncertainty in models (e.g., channel and floodplain reference parameters) by using sensitivity analysis. These results can help to inform the decision-making process about the relative sensitivity of findings from different models.

Sensitivity analysis is a tool that can be applied to constrain inexactness (e.g., parametric uncertainty) and its influence on model outcomes. The range of outcomes to such a sensitivity analysis can define tighter boundaries on plausible outcomes. At this stage of the Tillamook project, this is one of the best tools for helping to constrain the likely outcome of the various alterantives. Sensitivity analysis can be conducted at multiple levels. For example, sensitivity analysis can be conducted on inputs to a simulation model (e.g., flow and/or tidal boundaries), on individual parameters within a simulation model (e.g., channel and floodplain roughnesses), on equations embedded within simulation models, or on the simulation models themselves (e.g., different models use different numerical methods to represent the same physical processes).

Sensitivity analysis provides a means to define upper and lower bounds of, and relative differences between, probable outcomes. For example, if a model output varies only slightly in response to very different input parameter values, then that input parameter may be considered less significant to the decision-making process, and, therefore, additional monitoring resources would not need to be invested to more accurately define its value. If on the converse, the mode found to be highly sensitive to a given input or parameter, additional rsources may be needed to more accurately define the respective parameter.

A sensitivity analysis was perfomed in support of this peer review and at this stage of the project is the best available tool for quantifying uncertainty in the model predictions. The methods and findings are described in section 9.2. The sensitivity analysis presented in Section 9.2 is in addition to the sensitivity analysis performed by the model designers in response to the recommendations of this review and presented in Attachment A.

6.3.3 Variability Uncertainties

Changes to the timing, duration, and magnitude of precipitation cause changes in hydrology. Subsequently, sediment mobilization under varied hydrologic conditions is difficult to model and predict, and the rate of channel movement is determined by many factors operating at multiple spatial and temporal scales.

The effect of warming global temperatures and changing regional climate patterns may have an effect on the magnitude and timing of events which mobilize large volumes of sediment from watershed or tidal sources. This may result in changes to the hydraulic behavior of the system. Similarly, land management in forest areas as well as future public and private land development throughout the watershed, may change the timing and magnitude of peak flows in addition to the sediment supply. With input from technical experts, responses to a range of possible physical responses can be evaluated using a hydraulic model, and the variability in these results can help to inform the decision-making process.

In addition to considering the physical drivers, processes, and responses controlling the supply, transport, and deposition of contaminated sediment, long-term decisions for the project area also depend on other social factors (such as economics and politics) that also introduce variability and uncertainties.

6.4 Findings and Observations

The project area is located within an unusually complex hydrologic and hydraulic system. Even with substantial effort to collect data and construct analytical and simulation tools that represent that system, uncertainty exists about how it performs under current conditions and how it may perform under action alternatives.

Uncertainty regarding expected flood discharge timing and distribution of flows and parameterization of roughness and other factors that affect the efficiency of water movement through the study area, likely pose the largest risks to effective project decision-making by limiting the predictive ability of simulation models to compare alternative actions.

While some types of uncertainty are essentially unbounded, there are specific activities that could be taken to mitigate these risks. This generally will take two forms: 1) sensitivity analysis to properly bound the impacts of uncertainty on resulting information about alternative performance, and 2) collection and application of additional primary data about discharge rates, water surface elevations, geometry and flow paths. Sensitivity analysis can be performed largely with tools already developed. Additional data collection requires more intensive effort and investment to gain greater confidence in model results and interpretation.

SECTION 7 Hydrology

7.1 Hydrology Methods and Tools

Inflows from the upstream watersheds are the primary driver of flooding in the Tillamook area; namely the Wilson, Trask, and Tillamook watersheds and small local tributaries. However, many of these inflows are not measured. Of the three largest rivers flowing into the Tillamook area, two are gaged, the Wilson and Trask Rivers –smaller tributaries are ungaged. All ungaged inflows must therefore be estimated.

There are 40 ungaged tributary inflows that require estimates of the historic flow rates, for each time-step, for all events being modeled. The approach used to estimate ungaged tributary inflows was to scale the gaged flows from the Wilson and Trask Rivers by the ratio of their respective drainage areas. This is an approach often used to adjust flows from a gaged location to other ungaged locations on the same river or similar and nearby watersheds. A fundamental assumption to this approach is that the two respective watersheds have similar runoff characteristics, including drainage area, slope, soil types, vegetative cover, elevation, and precipitation inputs. With this approach, the ungaged basin will be assigned a hydrograph that is the same shape as the gaged basin and the revised magnitude will be scaled up or down according to the relative difference in drainage area. Applying this approach between basins with different watershed characteristics would introduce systematic bias and errors in the estimated flows. While this technique may roughly account for the correct mass of water, it fails to account for the differences in the time of concentration and average slope of the watershed, which when combined can underestimate the peak flow rate and delay the timing of peak flow. The resulting estimates for tributary inflows should be considered highly uncertain and known to be biased toward delayed and reduced peak flows. The implications related to the model’s ability to simulate broad-scale flooding (i.e. predicting approximate peak water levels) are likely small. At a local level or small reach scale, the impact could be larger.

7.2 Historic Events and Measurements

Using gaged historic floods is a logical way to characterize the nature of flooding in the area. However, when using this approach there should be some acknowledgement that future floods of the same peak flow recurrence interval could produce different flooding extents and associated water levels. There are other variables that influence the nature of flooding besides the peak flow magnitude, especially in a complex system such as Tillamook where multiple rivers converge in a tidal zone. The influence of the tidal cycle is one of the obvious controlling factors – the timing of the flood wave propagation relative to the timing and magnitude of the tidal cycle would affect the resulting water levels in the lower reaches of the system. Other factors that affect the nature and extent of flooding include the relative timing of peak flow occurrence on the three large rivers, the antecedent conditions, the duration of the flood, and potential levee failures. It is important for stakeholders to keep this in mind when attempting to compare one event to another or when trying to identify the effects of any flood control action through monitoring or observation.

Hydrographs can either be model-generated (i.e. synthetic floods), or gaged historic flows. The use of gaged historic flows is usually preferable, assuming the available flow record includes floods that are of the appropriate magnitude. Selection of specific flood events, or design flows, should be tied to the modeling objectives. The Tillamook model uses gaged flows for the two of the three largest rivers (Trask and Wilson rivers) and synthetic flows for the Tillamook River and the smaller tributaries. The three largest measured historic floods are: 1999, 2001, and 2007. The recurrence intervals of these floods are estimated to range from 1-2 years to 22 years.

7.3 Model Construction and Parameterization

Synthetic flows are typically developed in cases when gaged flow data are unavailable, or when the magnitude of the available data are insufficient. To characterize the larger less frequent floods, a synthetic 100-year flood event was developed – all inflows in this scenario are synthetic.

The main inflows for the Wilson, Tillamook, and Trask River systems were obtained from the ongoing Flood Insurance Study for the 100-year flood. Estimates of tributary inflows were derived independently using scaling factors based on Oregon regional flow regression equations from USGS.

7.4 Calibration and Validation

It does not appear that any independent calibration or validation of hydrologic rainfall-runoff modeling was performed as part of activities related to hydraulic model construction.

7.5 Results and Limitations

The range of flood events being considered is sufficient for the purposes of evaluating the flood reduction benefits associated with the EIS alternatives. Using historic flood events to characterize the potential benefits of a future condition relies on the assumption that future flows would be similar to those that have occurred in the past. It does not directly account for the impacts of future climate change. Simulating a range of flood conditions is likely to address at least a portion of expected future conditions, although the frequency of events may not be well characterized.

The use of gaged historic flows and the choice of specific design flows are reasonable; however, the methods used to develop the synthetic flows for the un-gaged rivers is relatively crude and includes expected systematic bias.

SECTION 8 Hydraulics

8.1 Hydraulics Methods and Tools

The software selected to model the complex hydraulics in the lower Tillamook basin is the HEC-RAS version 4.1, a 1D model developed by the USACE. HEC-RAS is a broadly used and accepted 1D hydraulic model. However, it is limited in its ability to model complex multi-dimensional processes (2D and 3D).[1] When river flows are contained within the rivers banks, the flow field is mostly 1D (parallel to the banks), but when river levels rise above the banks water flows outwardly onto the floodplain; this scenario is a 2D process that is difficult to simulate with a 1D model. In the floodplains surrounding the City of Tillamook the hydraulics are even more complex—water not only flows outwardly onto the floodplain but it can even flow into adjacent waterways. In the Tillamook model, these 2D processes are estimated using lateral structures (specifically weirs) that allow flow to leave the main channel and flow onto adjacent floodplains or sloughs. This quasi-2D approach is commonly used but how well it works (in measures of accuracy) depends on the complexity of the system, the quality of the input data, and the quality of the schematization. The only way to know how well a quasi-2D model, or any model, replicates reality is to perform model validation. The accuracy of the calibration, or specifically the resulting residuals, typically represents the most favorable estimate of the model's accuracy. Application to other events or different project conditions can be expected to perform at or below the level of calibration.

8.2 Historic Events and Measurements

The gages on the Wilson and Trask Rivers have recorded several moderately large floods, most notably 1999 and 2007, with recurrence intervals of 5 years and 22 years respectively. These events have been used to characterize the system for moderate floods. Synthetic flows were developed to characterize the larger infrequent floods (100-year floods) because no data exists in the historic record. The 100-year event is therefore a hypothetical scenario. A more detailed discussion of the flows used in the model is included in Section 7.

A series of observed floods was simulated in the model, along with a synthetic 100-year event. Hydrology was already defined for the 1999 and 2001 events from the USACE study. Gage data for the 2006 and 2007 floods was obtained from the USGS.

8.3 Model Construction and Parameterization

The model schematization is defined by a network of model elements that represent the flow paths and physical connectivity of the river system. This review summarizes generally how the model is laid out, provides comments on the appropriateness of the model schematization, and highlights critical assumptions and limitations associated with the layout. Model parameterization refers to the data (i.e. geometry), settings, and coefficients assigned to each model element. This review of model parameters comments on the appropriateness of selected

[1] HEC-RAS version 5.0 now includes 2D capabilities, but that capability was added after the Tillamook model was developed.

coefficients and highlight those that have the greatest impact on results and those that have the highest levels of uncertainty.

The model has many parallel river reaches which convey flow downstream through cross sections. The model also routes flow laterally to the floodplains using lateral structures (specifically weirs). This is a generally acceptable way to simulate 2D processes with a 1D model; however, inherent in this approach subjective decisions are made about where the flow paths are and where the hydraulic controls are located.

The key parameters associated with the cross sections are the geometry[2] and the roughness. The cross section spacing is fairly coarse (requiring interpolated sections to support model stability) which has some bearing on how accurate the resulting water surface profiles are. The model only computes water levels at cross sections so the continuous profiles of water surfaces that are often shown are actually mostly composed of interpolations between the computed points.

The most important parameter for cross sections is the roughness parameter which is a Manning's n value in this case. No documentation was found describing how the n values were originally determined or how they were adjusted during calibration so this review can only provide general comments about the values shown in the final model. In general, the roughness values are defined at a reach-scale. The majority of the values used in the model are within a reasonable range.

Many of the values used for *channel* roughness are higher than expected for a low gradient silt/sand bed river system (i.e. n values greater than 0.1 in some areas of Hall Slough, or 0.07 throughout Hoquarten Slough). There are also a few sharp jumps in roughness values, which is often an indication of a problem in the schematization. The channel values in Hall Slough change from 0.1 to 0.03 just downstream of Highway 101. The model designer notes that Hoquarten Reach 3 in channel values of 0.07 were used because it is a small channel with overhanging brush. There may be physical explanations for other localized discontinuities but no documented explanations were available (note: explanations were provided subsequent to this review and are presented in Attachment A). While there maybe a few outlier roughness values, they shouldn't have much impact on the *relative* comparison of the flood benefits associated with the SFC alternatives because the roughness values are consistent between the existing and proposed conditions.

The areas that convey considerably more flow as a result of the proposed alternatives should be scrutinized more carefully because the results in these areas would be more sensitive to the selected roughness values. One area of particular importance is the reach named "*Doug tras 0.85*" which lies between Dougherty Slough and Hall Slough. This reach conveys significantly more flow in the SFC alternative than the No Action Alternative and so the predicted change in water levels is particularly sensitive to the selected roughness values. A roughness value of 0.04 was assigned to the entire area downstream of Highway 101; this n value is not consistent with other similar land cover areas in the model, shown in many places with a roughness value of

[2] This review does not include a review of the survey data nor QA or QC of the data input to the model.

0.07. This issue was discussed with the model designer and a response is included in Attachment A.

The lateral structures that control the lateral routing of flow are most heavily influenced by the geometry of the weir crest and the weir coefficient (C_d). The geometry of the weir crest should be defined by a section-line representing the highest topography separating the respective flow paths. This controlling section-line is easy to identify on features such as roads and levees but it becomes increasingly difficult to identify in areas that are relatively flat or void of clearly identifiable features.

In the Tillamook model, many of the lateral structures (i.e. the levees) are located on the top of the river banks, which make them easy to delineate but makes them susceptible to elevation errors because the topographic data is sourced from LiDAR, which is frequently biased due to dense vegetation. Many of the levees were surveyed in later modifications to the model using traditional field methods to verify and correct the levee elevations so this should reduce the uncertainty.

The other primary parameter that has a large effect on flow routing over these weirs is the weir coefficient. A cursory sensitivity analysis showed that the model results are moderately sensitive to this parameter, so careful attention should be given to its parameterization. The weir coefficient is an empirical value that generally ranges between 0.1 and 2.2. The guidance used for selecting the weir coefficient comes from the collective body of research, mostly flume studies, which have evaluated the weir coefficients for various weir shapes under a range of hydraulic conditions.

Unfortunately there are relatively few studies that have looked at lateral weirs, because most studies consider the case of in-line structures. USACE, the developers of HEC-RAS, have published guidance summarizing their understanding of the research to date. According to this guidance, the lateral structures used to define levees or roads should have a weir coefficient between 1 and 2.2 depending on the height of the levee above the adjacent ground. Areas that are natural high ground but not shaped like a levee should be 0.5 to 1.0, and areas that are not elevated above adjacent ground (like a removed levee) should be 0.1 to 0.5.

The current Tillamook model uses 1.0 for nearly all lateral structures in both the existing and proposed conditions. There are a few select locations where a value of 2 or 2.61 has been used but the majority were parameterized with a value of 1.0. These values may be appropriate for the smaller levees in the existing condition, but a value of 1.0 is too high for the weirs representing the areas where levees have been removed in the action alternative scenarios. Using a lower weir coefficient would increase the water levels and thus lower the currently reported flood reduction benefits. (This concern is addressed in Attachment A.)

In summary, the model schematization is a reasonable representation of the system and most of the parameterization is defensible. The areas of concern in regard to parameterization are the following:

1) The roughness value of 0.04 assigned to the entire *Doug tras 0.85* reach appears too low for dense brush and inconsistent with other pasture areas in the model. This assumption may lead to a slight overstatement of the flood reduction benefits associated with the SFC alternative.
2) The discontinuities in channel roughness in Hall Slough and *Doug tras 0.85* are a concern. If the discontinuity was required for calibration, it could be an indication of a different underlying problem unless there is a physical explanation for it.
3) The weir coefficient parameterization is overly generalized and, more importantly, the coefficients are not revised in the action alternative scenarios to account for the change in geometry of the removed levees. The levee removal areas should have lower weir coefficients. Lower weir coefficients would produce higher water levels and thus show less of a flood reduction benefit.

The model's sensitivity to these and other parameters is discussed in Section 9.2. These issues were also discussed with the model designers and their responses are presented in Attachment A. Revised model results were presented in the Draft EIS.

8.4 Boundary Conditions

Boundary conditions are arguably the most important model input—boundary conditions have the greatest influence on results, and thus deserve careful examination. All open boundaries require a user-defined boundary condition, specifically, a discharge or water level for each time step. Boundary conditions are often referred to as *forcing functions* because they are imposed on the model by the user and the model simply computes the response to those conditions within the model domain.

In the Tillamook model there are 50 boundary conditions, most of which define the inflows and water levels in small tributaries and sloughs. These boundary conditions have only a minor effect on broad-scale flooding. The four boundary conditions that have the greatest effect on flooding are the flow boundaries for the Wilson River, Trask River, Tillamook River, and the downstream water level in Tillamook Bay.

The tidal boundary differs from the gaged flow boundaries in that tidal cycles are predictable and repeat themselves. Therefore, it is possible to characterize the range of potential tidal cycles that could occur coincident with a flood. Pairing different tidal cycle scenarios with the historic gaged flow scenarios would be a good way to characterize the tidal influence on flooding.

In summary, the boundary conditions are defined appropriately in the model but there is some uncertainty and systematic bias associated with the un-gaged flow inputs (described in Section 7), limitations associated with the use of only gaged tidal boundaries, and uncertainty in the characteristics of the synthetic 100-year flood event.

8.5 Calibration and Validation

The HEC-RAS model was calibrated to an in-bank event (May 2001, ~1- to 2-year flood[3]) and an out-of-bank event (November 1999, ~5-year flood). A verification run (November 2001) using the November 1999 Manning's n values and geometry varied by ±2.1 feet. However, the November 2001 discharge values were between those in the November 1999 and May 2001 simulations, and different Manning's n values were used when calibrating these two latter events. The 2006 and 2007 floods, which were substantially larger, were then simulated to verify the calibration. In addition to the high water marks supplied by USACE, a set of oblique aerials taken of the 1999 flood by George Best in conjunction with the LiDAR data enabled the development of further high water marks as well as validation of flow paths. Finally, model results were compared with qualitative witness observations of various floods to ensure flood behavior was being modeled correctly.

The data available at the time of review for calibration is rather limited. The calibration data are peak stage measurements at 16 locations in 2001 and 20 locations in 1999. Calibration was also performed for 2006 and 2007 events. The number of stations and their spatial distribution is reasonable; however, there are only two data points at each station (peak stage for two events), and there is no date or time associated with the occurrence of peak stage, except for three locations in the 2001 event. In this system it is particularly important to get the timing of flood wave propagation right because basin-wide flooding is influenced by coincident flooding on all three major rivers. Time-series data is for calibration is limited and important for the model's ability to route flows correctly.

There is limited documentation describing the calibration process so this review can only make generalizations about what was observed in the final calibration. The calibration residuals (difference between modeled and measured) for peak water level calibration are mostly within ±1 foot with a few values as high as 2 and 3 feet. **Table 8.1** and **Table 8.2** summarize residuals for the 2001 and 1999 events.

Table 8.1. Summary of Calibration Residuals for 2001 event

River	Station	Measured (ft)	Modeled (ft)	Residual
Doughtery Slough	5642	12.7	13.7	1.0
Doughtery Slough	15177	19.8	20.3	0.5
Doughtery Slough	19960	26.1	24.7	-1.5
Hall Slough	11991	14.8	13.8	-0.9
Old tras	1363	10.3	11.3	1.0
Tillamook River	0	12.5	11.2	-1.3
Tillamook River	12710	9.0	11.3	2.3
Trask River	8275	13.0	12.2	-0.8

[3] The label of a 1- to 2-year recurrence interval is used here because others have characterized the 2001 flood in this way. However, the true recurrence interval is most likely to be more frequent than this. Statistical analysis using annual peak flow data cannot be used to accurately describe the recurrence frequency of small floods. Partial duration analysis is required.

River	Station	Measured (ft)	Modeled (ft)	Residual
Wilson River	10897	13.6	13.2	-0.5
Wilson River	17799	18.7	18.2	-0.5
Wilson River	19166	21.1	20.5	-0.5
Wilson River	22468	23.2	22.8	-0.4
Wilson River	30434	28.9	28.5	-0.5
Wilson River	42970	36.9	38.0	1.1
Wilson River	53996	50.9	51.2	0.3
Wilson River	55147	52.7	53.2	0.5

Table 8.2. Summary of Calibration Residuals for 1999 event

River	Station	Measured (ft)	Modeled (ft)	Residual
Doughtery Slough	5641	12.66	13.74	1.1
Doughtery Slough	15177	21.4	21.9	0.5
Doughtery Slough	20045	27.6	26.8	-0.8
Hall Slough	6004	14.0	13.1	-0.9
Hall Slough	8773	13.8	13.3	-0.5
Hoquarten	10769	15.7	14.8	-0.9
Till oldt 0_30	7927	14.1	14.5	0.3
Till oldt 0_31	10509	18.1	14.6	-3.4
Tillamook River	12710	12.3	13.1	0.8
Tillamook River	31147	13.9	14.0	0.0
Tillamook River	39200	14.1	14.1	0.0
Trask River	3559	14.8	14.2	-0.6
Trask River	9246	19.0	18.3	-0.7
Trask River	19496	26.7	26.4	-0.3
Trask River	26367	31.5	30.6	-0.9
Trask River	34523	38.9	38.6	-0.3
Wilson River	18829	21.2	20.7	-0.5
Wilson River	22605	23.4	23.5	0.1
Wilson River	30434	29.5	29.8	0.3
Wilson River	55095	57.5	57.2	-0.3

Residuals are more often negative than positive meaning the model under-predicts water levels more often than it over-predicts them, although this may not be representative of the whole system, only the measured points. The final Manning's roughness values are constant over relatively long distances, which suggest that only reach-scale adjustments were made, rather than fine-scale adjustments. This is a prudent approach, given the lack of data that would be needed for fine-scale adjustments. The final roughness values are also only carried out to the hundredth decimal point, which suggests that the roughness values were only broadly adjusted. These observations together suggest that the calibration efforts were relatively modest. The calibration would be improved through finer-scale adjustments but that wouldn't necessarily mean the model would be more reliable. A modest calibration is prudent given the lack of calibration data to help guide and justify calibration adjustments.

It should also be noted that the model is only calibrated to the condition of the river system in 1999-2001 and tested with 2006 and 2007 flows, which was prior to the installation of the flood gates that were installed in 2008 and that help drain the wetland area between the Wilson and Tillamook Rivers. This area is represented in the model as a river reach called *Doug tras 0.85*. This reach is critically important in the SFC alternatives because it is responsible for the majority of the flood reduction benefits suggested by the model; however, it is an uncalibrated component of the model.

Berm failures were common in virtually all floods. These failures cannot be modeled, but they can change the flow distribution and flood levels during an event. Especially in small floods, such berm failures may cause significant increases in flood levels not reflected in modeling.

Due to these uncertainties, calibration focused on ensuring the model reasonably simulated the full range of floods rather than trying to exactly match one specific event. In general, calibration within the main Wilson River channel was consistent over the range of floods and less so in the overbanks. The Wilson River in the vicinity of the Highway 101 bridge is one exception. The model was unable to be calibrated here using the range of expected roughness values for a channel of its form. The observed high water marks and witness accounts show the bridge creates a large backwater effect the model had difficulty in replicating.

8.6 Results and Limitations

Conventional wisdom could lead to the conclusion that increasing the conveyance of the estuary would reduce stage at the river mouths during a high riverine flow event. However, based on the modeling results, estuary-based alternatives were not effective for reducing the stage at the river mouths during high riverine flow events. The best method for reducing river stage and alleviate coastal flooding around Tillamook is to (partially) restore the floodway for each of the major coastal rivers discharging into the bay.

Based on the model results, inland flooding near the City of Tillamook was found not to be related to conveyance issues within Tillamook Bay. The only feasible way to reduce inland riverine flooding from the bay would be to change to hydraulic characteristics of the rivers and associated floodways.

The sensitivity of the model to the tidal boundary condition was tested by running the 1999 (5-year) flood with the observed tides increased and decreased by 2 feet. Based on insensitivity to tidal conditions, neither a coincident tidal-riverine frequency analysis nor further ADCIRC modeling was performed.

In summary, the modeling approach selected for the Tillamook model relies on commonly used methods and assumptions; however, the approach does have some limitations that should be noted. The complex hydraulics that exist in the Tillamook area are inherently multi-dimensional and the ability of the 1D HEC-RAS model to accurately simulate those processes to the degree needed to differentiate and quantify project benefits is limited. However, the model has over 50 HWMs from four floods spread out over the floodplain that it does a reasonable job of reproducing, suggesting that the model reasonably simulates the hydrodynamics. Model validation is required for proof of the model's predictability. Results of the 2006 and 2007 verification model runs were not available at the time of this review. (Results of these verification model runs are presented in Attachment A.)

It is important to keep in mind that the modeling approach was selected with the primary goal of being able to simulate the *relative* benefits of alternative flood reduction actions but not necessarily predict the precise absolute values of peak water levels at all locations.

SECTION 9 Related Studies

9.1 Sediment Transport and Geomophology

The catch-all phrase “geomorphology and sediment transport” as used here refers to the set of inter-related processes that govern the movement of sediment in the river and consequent changes in topography. Spatial and temporal changes in sediment transport result in deposition and erosion, leading to changes to the shape of the channel and floodplain (“geomorphology”); these changes, in turn, directly impact hydraulics. For example, sediment deposition reduces the threshold discharge for overbank flooding, leading to more frequent flooding. Without considering geomorphic changes, the predictions of the hydraulic model would become less reliable over time in the future to the extent any such geomorphic changes do occur.

This section provides an evaluation of the question of whether future geomorphic changes are expected to impact future flooding patterns, and how these changes might the affect the reliability of the hydraulic model predictions. The evaluation is drawn entirely from a cursory and focused literature review of the likely impacts of geomorphic changes on hydraulic model predictions.

The review considers a time scale out to 2100, which is understood to be the approximate time scale of interest for the performance of the Southern Flow Corridor (SFC) Project. FEMA assumes a project life of 50 years to assess costs and benefits.

9.1.1 Evidence of Recent Trends of Channel Change

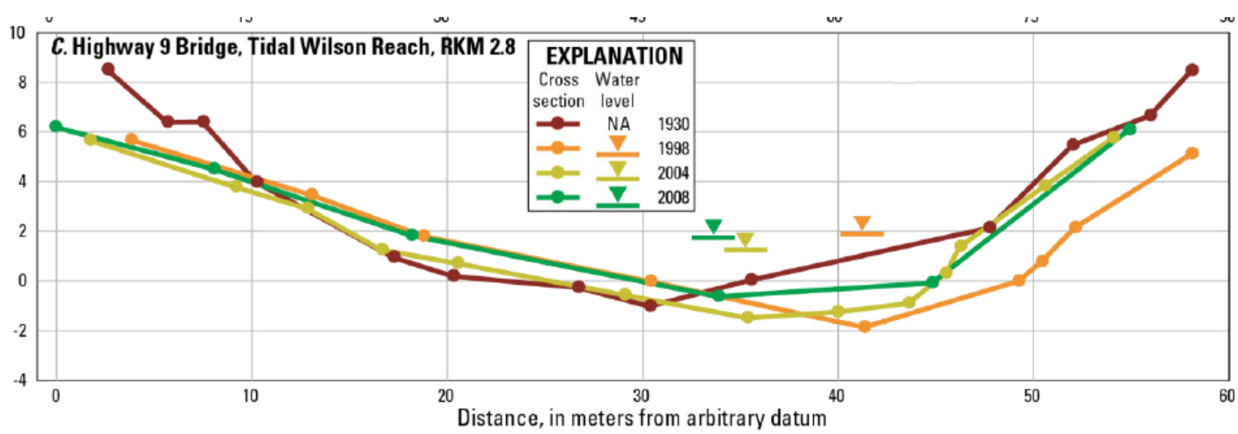
Sedimentation in Tillamook Bay has been a practical issue pertaining to flooding and navigation for at least the 160-year duration of European American settlement, and probably was a factor in the location of Native American villages, fishing grounds, and other uses. Several studies have documented sedimentation and channel changes, and evaluated their natural and anthropogenic causes (Tillamook Bay Taskforce, 1978; Coulton et al., 1996; McManus et al., 1998; Pearson, 2002; Komar et al., 2004; Jones et al., 2012, and other studies). Coulton et al. (1996) and Jones et al. (2012) both compiled historical information regarding channel changes in the Tillamook Bay and its rivers. Among the conclusions drawn from their historical compilations are these observations that relate to hydraulic changes:

- The USACE reported as early as 1902 that copious quantities of sediment (gravel, sand, and mud) were delivered to the bay annually by the Tillamook Bay tributaries. This implies that sediment loads were typically high, even prior to the era of massive logging and fires.
- As late as the early 20th century, the Wilson and Trask Rivers were so clogged with wood that they flooded far more frequently than they would otherwise, and contained log jams more than 200 m long. At that time, USACE reported that one of the most serious troubles with the bay is caused by the large number of snags and fallen trees that are carried in on floods, which eventually sink on the shoals and become buried in the same. This appears to suggest that a large amount of the material underlying the present river channel and floodplain may consist of buried wood.

- The USACE reported that log jams in the Wilson River caused floodwaters to flow south towards the Trask River. This flooding pattern prompted the USACE to remove wood and build dikes in the late 1800s. This observation is relevant to the findings of the current hydraulic model, which predicts similar behavior even in the absence of present day log jams on the Wilson River (V. Collins, NHC, personal communication, 2014). It is possible that the buried logs referred to in the previous bullet may be one reason why the Wilson River is locally at a higher elevation than the Trask River, causing floodplain flow towards the south.

While historic accounts clearly suggest the lower rivers were characterized by frequent flooding and sedimentation in the channels, quantitative evidence is more ambiguous. Pearson (2002) compared longitudinal profiles of the five Tillamook Bay tributaries in 1978 and 2000. Although the profiles were not shown in that report, the author reported that the rivers were generally aggrading but that they all have both aggrading and degrading reaches.

Jones et al. (2012) compiled and analyzed numerous data sets relating to sediment transport and geomorphology of the Tillamook Bay tributaries, extending well up into their watersheds. They observed that the tidal portions of the Wilson and Trask Rivers are transport limited, and are most heavily impacted by watershed conditions that affect the supply and transport of fine-grained sediment (sand and silt) – implying that the tidal portions of these rivers would be sensitive to 20th century logging and wildfires. They observed that the amount of exposed bar area in the tidal portions of these rivers was small due to the lack of gravel in the tidal portion of the system. However, they found that exposed sand bar area decreased substantially over the past several decades due to vegetation colonization. They also compiled long term repeat cross section surveys of all the rivers, but only one cross section was available in the tidal Wilson River. As shown in **Figure 9.1**, they found a barely detectable amount of aggradation since 1930 at the Highway 9 bridge.



Source: Jones et al. (2014)

Figure 9.1. Repeat Cross Section Survey at Highway 9 on the Tidal Wilson River

<u>Summary and Relevance to Hydraulic Model:</u> Historical accounts document an overall pattern of aggradation (sediment deposition) in the lower Trask, Tillamook, and Wilson Rivers. If this trend continues into the future, aggradation could increase flooding in the project area in a manner not considered by the current hydraulic model.

9.1.2 Factors Contributing to Future Channel Changes

Future changes in the shapes of channels and their flood hydraulics would depend on the sediment balance of the project area over both time and space: channels would aggrade where and when sediment supply exceeds transport capacity, and channels would erode where the reverse is true. Complex interacting factors would affect the sediment balance of the lower Trask, Wilson, and Tillamook Rivers. Of all the possible drivers, the following ones are considered to be the most important factors affecting future geomorphic changes and flooding in the project area:

1) **Changes over time in the supply of sediment** from the watershed (e.g., due to fires, land use and climate changes).

2) The **effect of sea level rise**. Sea level rise would not only increase flooding in the tidal zone by its hydraulic effect, but this base level rise would also cause sedimentation upstream of the retreating shoreline.

3) **Active tectonics**, due to plate movements near the subduction boundary. Active tectonics can affect the base level and change patterns of sedimentation and erosion, and land surface shaking can trigger landslides, affecting sediment supply from the watershed.

There has been a large amount of research on all of these topics around Tillamook Bay over the last several decades, resulting in numerous reports, research papers, and government documents. A thorough literature review of all this material was beyond the scope of the current effort, but a cursory review was conducted. This review focused on the likely impact of the three factors listed above on the future reliability of the hydraulic model.

9.1.3 Changes in Sediment Supply

Sediment accumulations and shoaling in Tillamook Bay have been related to changes in the condition of the upper watersheds (TBNEP 1978, Coulton et al. 1996, McManus et al. 1998, Pearson 2002, Komar et al. 2004, Jones et al. 2012, and other studies). In summary, these studies agree that the five rivers draining into Tillamook Bay – the Wilson and Trask Rivers being the two largest – have naturally high sediment loads due to the heavily weathered volcanic and sedimentary bedrock, steep slopes, seismic activity and heavy rainfall in their watersheds. Superimposed on this naturally high background sediment supply have been human impacts such as widespread forest removal and burning by Native Americans, and heavy logging by Euro-Americans.

In addition, two high magnitude low-frequency events in the past several centuries temporarily increased the already-high sediment loads to the rivers:

1. The earthquake and tsunami of 1700. The tsunami brought significant ocean-borne sediment well into the Bay (McManus et al. 1998, Komar et al. 2004, Peterson 2013), causing sediment deposition at the mouths of the bay rivers. The earthquake also probably also triggered numerous landslides in the watershed.

2. The series of extraordinary wildfires collectively known as the Tillamook Burns, in 1933, 1945, and 1951, severely burned nearly all the steep, mountainous portions of the Wilson and Trask watersheds. As a result, sediment loads increased by a large but unquantified amount (Coulton et al. 1996). These fires were followed by a major reforestation effort, presumably reducing the watershed sediment supply back to pre-burn levels by the 1970s (Jones et al. 2012)

Komar et al. (2004) provide the following simplified conceptual model of the recent history of river and ocean sediment supply to the Tillamook Bay, showing both natural and anthropogenic influences (**Figure 9.2**)

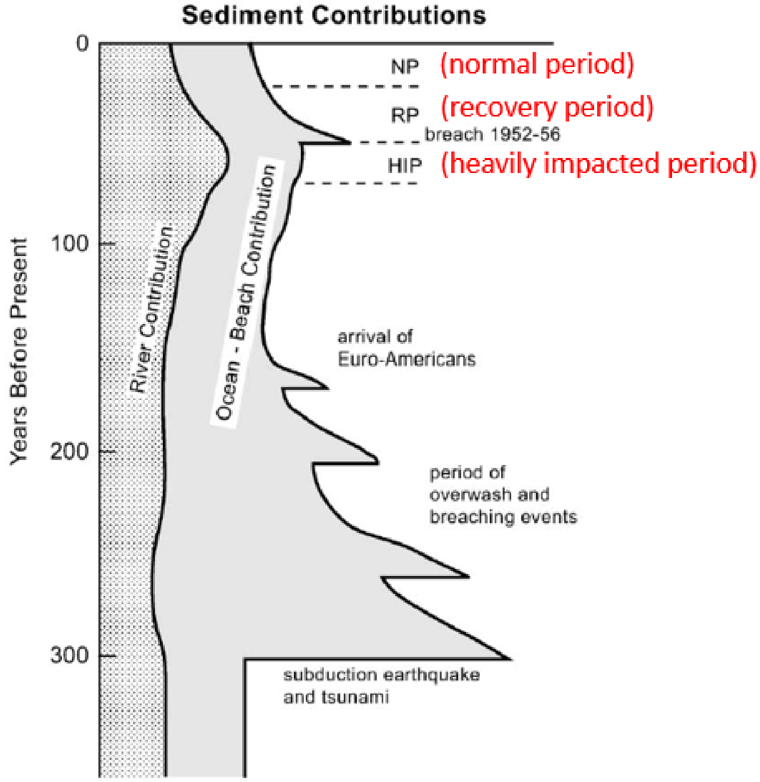


Figure 9.2. Sediment Contributions

Modified from Komar et al. (2004; Figure 10 of that paper). Red text added to interpret abbreviations in the original figure; these periods refer to Euro-American and wildfire impacts to the watershed sediment supply described in that paper.

Summary and Relevance to Hydraulic Model:

Although the sediment supply may have recovered from the most recent set of perturbations to the sediment supply in the early and mid-20th century, current sediment delivery to Tillamook Bay tidal zone is currently high and would remain so for the foreseeable long term future. During the design life of the SFC project, it is also reasonable to expect that the project area may also receive sudden pulses of sediment supply due to future landscape disturbances.

The abundant and episodic sediment supply would likely contribute to future sedimentation in the lower portions of these rivers. This would reduce the threshold flood discharges and increase flood frequency in ways not presently accounted for by the hydraulic model due to changes to channel geometry.

9.1.4 Sedimentation and Sea Level Rise

The project site and adjacent channels are near or, in some locations, below sea level; therefore, the project area would be impacted by sea level rise. This has been true in the geologic past, and the anticipated near term acceleration of sea level rise would almost certainly affect flooding in the project area in the future. In addition to the direct hydraulic effect of rising sea level, the rise in base level would also cause sedimentation in some areas, possibly increasing flooding well upstream of the tidal zone.

A substantial amount of information is available regarding past sea level rise and sedimentation in the Tillamook Bay (Glenn 1978, Bernert and Sullivan 1998, McManus et al. 1998). Overall, deep coring in Tillamook Bay showed that from 9,000 to 7,000years before present (BP) – a period of rapid sea level rise – sediment deposition rates were on the order of 2 cm/year, keeping up with rising sea level (Glenn 1978). After about 7,000 years BP, deposition rates dropped by an order of magnitude, to about 0.2-0.3 cm/yr. This latter range of values is viewed by Kumar et al. (2004) as the “natural” rate of sediment accumulation, prior to the arrival of Euro-Americans, presumably with a stable base level. An independent estimate of the sedimentation rate using repeat bathymetric data computed that the deposition rate averaged about 0.5 cm/year between 1867 and 1995 (Bernert and Sullivan 1998, McManus et al. 1998), consistent with the longer term rate shown in the deep cores. Based on ^{14}C and ^{210}Pb dating of a large number of Tillamook Bay cores, McManus et al. (1998) estimated sedimentation rates on the order of 0.2 to 0.4 cm/year over the past 500 or so years. They inferred that a period of higher sedimentation rate, perhaps 0.7 cm/year, between 1867 and 1954 corresponded to elevated sediment supply from the watershed, due to logging and the Tillamook Burns.

While the exact amount of future sea level rise is not known with certainty, ongoing global warming is expected to increase sea level by 0.5 to 1 meter over the next century (Vermeer and Rahmstorf 2009). In a low-gradient tidal system such as Tillamook Bay, even the “best case scenario” for sea level rise of 1 m would be a significant reduction in the water surface gradient over many miles, causing sedimentation in the channels in and well upstream of the tidal zone. A sediment transport and morphology model would be required to predict the specific changes in channel form as a result of sea level rise; however, it is likely to have a major impact on sediment transport and geomorphology, and on flooding, over the next 100 years.

Summary and Relevance to Hydraulic Model: Sea level rise would increase flooding directly by raising the water surface elevation in the project area, and indirectly by inducing sedimentation through base level rise. Data show that the sediment supply is abundant enough to keep up with rising sea levels. Therefore, it is reasonable to expect the river bed to aggrade 1 meter over the next century. This would lead to a reduction in flood conveyance capacity compared with what is assumed in a static-bed hydraulic model.

9.1.5 Active Tectonics

The Tillamook Bay is located at an active subducting plate margin; therefore, it is prone to major earthquakes and resultant tsunamis, as well as more gradual changes. No discussion of aseismic subsidence of Tillamook Bay were found during this cursory literature review, but it is reasonable to expect that such subsidence may occur and partially account for the basin containing Tillamook Bay.

Abrupt burials of tidal marshes correlated with Cascadia earthquakes have been found in the geologic record (Atwater et al. 1995), showing that earthquakes can significantly impact patterns of sediment transport and geomorphology and therefore impact flooding in coastal Oregon. Land elevations in coastal bays may drop by 1 to 2 meters in these coseismic subsidence events, which have a recurrence interval in Oregon of a few hundred years (Darienzo et al. 1994), the last of which was in 1700 AD.

Summary and Relevance to Hydraulic Model: Coseismic subsidence of 1 to 2 meters, typical for coastal bays in Cascadia earthquakes, could impact flooding by changing the land surface elevation, and by affecting patterns of sedimentation and erosion in tidal channels. An event of this magnitude is relatively likely to occur over the next 1 to 2 centuries. If such an event does occur, its impact on flooding would depend on the specific land movements in the vicinity of the project area.

9.1.6 Summary Conclusions

Geomorphic changes due to sediment transport, deposition, and erosion would probably have a significant effect on the hydraulics and flooding potential over the lifetime of the SFC project. The most likely changes over the next 1 to 2 centuries would probably consist of in-channel sedimentation, due to high watershed sediment yields and rising sea level. This would probably increase the frequency, magnitude, and duration of overbank flooding within and upstream of the project area compared with the predictions of a hydraulic model that does not consider geomorphology and sediment transport. In addition, future landscape perturbations such as earthquakes, wildfires, and land use changes, which are likely but not certain to occur in the next 1 to 2 centuries, would probably also increase the flood frequency, magnitude, and duration.

Although the magnitude of these future changes is not known, to the extent that such geomorphic changes do occur over the lifetime of the project, they would cause the hydraulic model to tend towards under-prediction of future flood event frequency for any long term scenarios if sedimentation reduces conveyance in channels and overbank areas.

The relative benefits of no action and action alternatives under changed climate or sediment conditions as described above are difficult to characterize without additional study. While it may be anticipated that under the No Action Alternative flooding conditions in the project area would worsen over time, the performance of an action alternative relative to other action alternatives being considered cannot be assessed with analysis performed to date.

9.2 Sensitivity Analyses

A cursory sensitivity analysis was performed to broadly characterize the model's sensitivity to select input parameters. Having an understanding of which parameters the model is most sensitive to, in combination with knowing which parameters are the least well known, provides valuable insight into the model's overall uncertainty.

The analysis only considered a select set of parameters which were believed to have the greatest potential for affecting model results and that could be tested relatively easily. There are other components of the model that may have a strong influence on results but are not easily investigated such as the cross section spacing or alternate model schematizations. The analysis was limited to evaluating the model's sensitivity to: roughness, weir coefficients for lateral weirs, weir flow submergence factor, lateral structure stability factor. Tributary flow and Theta were also identified as possible test variables.

The model's sensitivity to roughness was investigated by factoring the channel roughness in two of the primary rivers (Wilson and Trask) by ±50% for the existing condition and comparing the range of results against each other and in relative comparison to the base model parameterization. **Figure 9.3**, screen captures from the HEC-RAS model, demonstrates this effect. Not surprisingly, the model results are moderately sensitive to roughness and the sensitivity increases in the upstream direction. Water levels on the larger rivers are more sensitive to reductions in roughness compared to increased roughness because as water levels rise in response to increases in roughness, flows are able to spill out laterally, which reduces the local discharge and keeps water levels from rising linearly. However, water levels on the adjacent smaller systems behave in the opposite manner; they rise more relative to increased roughness because they receive more flow from the larger rivers. **Figure 9.4** indicates the change in discharge in the Wilson and Trask rivers based on changes in roughness. The change in discharge is a result of changed diversion into alternate flow paths. A 50 percent variation in roughness can produce 2 to 3 feet of change in water levels at Highway 101. A 50 percent variation likely provides conservative bounds on roughness variability. The actual uncertainty is likely closer to 30 percent.

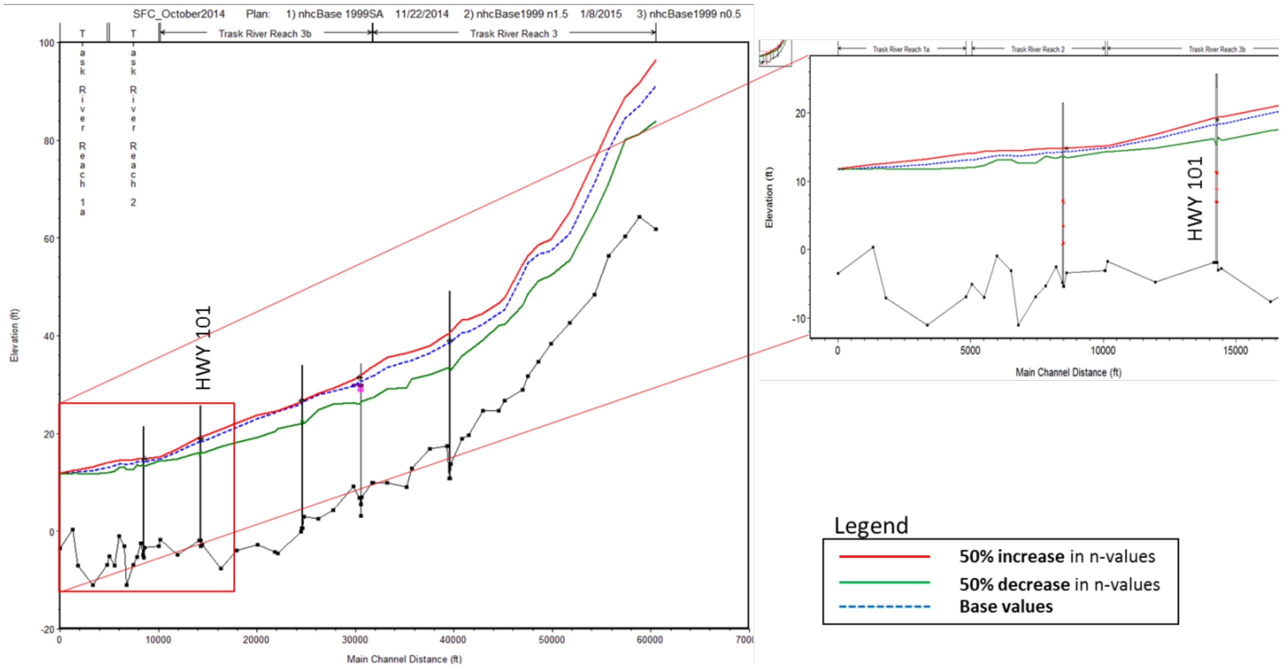


Figure 9.3. Sensitivity to Roughness on the Trask River (1999 Event)

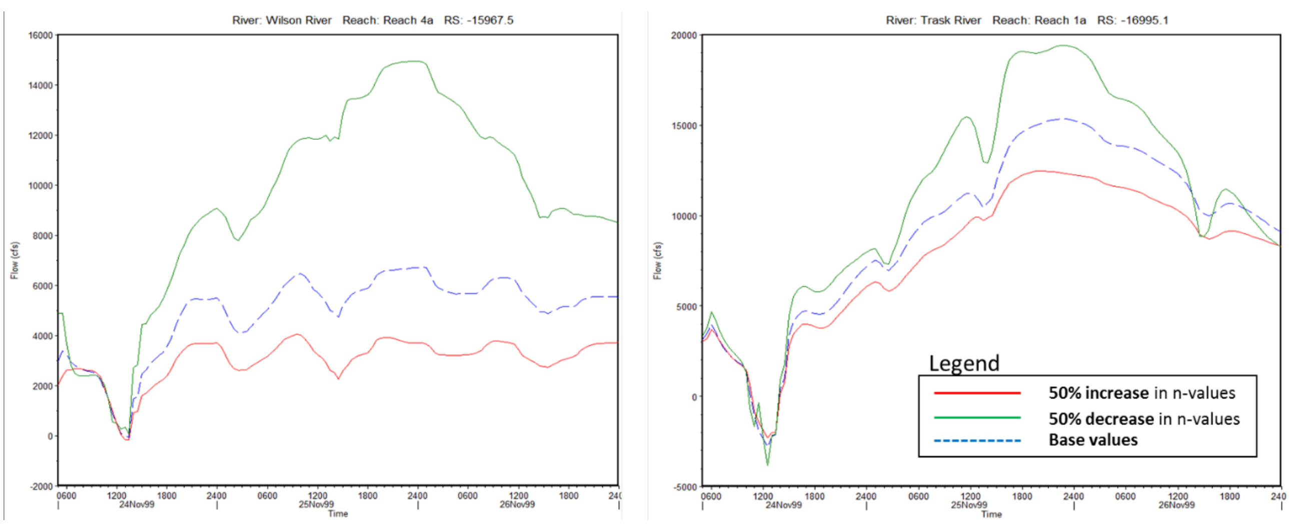


Figure 9.4. Flow Routing Sensitivity to Roughness on the Wilson and Trask Rivers (1999 Event)

One of the parameters known to have a strong influence on the magnitude of lateral flow exchange is the weir coefficient (C_d). The weir coefficient is an empirical parameter derived from laboratory data and varies as a function of the weir shape, its orientation to flow, and the flow characteristics. The range of typical values used to parameterize a lateral weir is from 0.1 to 2.2. Higher values are used to represent tall levees/roadways that convey water efficiently over the crest. Low values are used to represent natural ground that has little to no elevation difference across it. The Tillamook model is broadly parameterized with a weir coefficient of 1.0 in most areas (118 of 138 weirs) for both existing and alternative conditions which is a value that is typically used to represent levees/roads/or elevated natural ground that is 1-3 feet above the adjacent ground. To test the model's sensitivity to this parameter, several scenarios were considered: a high global value of 2.0, a low global value of 0.5, and version of the SFC alternative that parameterizes the levee removal areas with a weir coefficient of 0.25 and left all the other weir coefficients unchanged. Results from the two scenarios representing the upper and lower bounds show an impact of (+/-) 0.5 feet at Highway 101. The version of the SFC alternative that had a weir coefficient of 0.25 in the levee removal areas shows a localized increase in peak water levels of approximately 2 inches in the areas immediately adjacent to levee removals. This demonstrates that the model is moderately sensitive to the weir coefficient. **Figure 9.5** indicates the effects of this change.

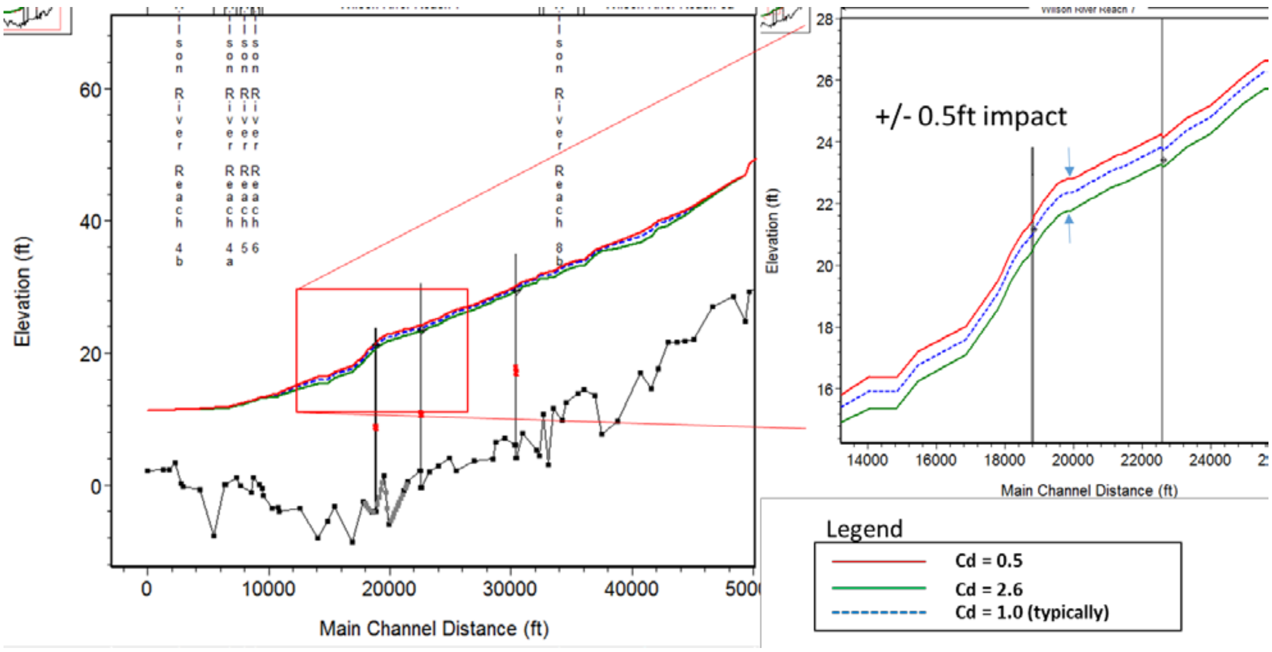


Figure 9.5. Sensitivity to Weir Coefficient (Cd) on the Wilson River

We also tested the model's sensitivity to several of the global parameters that can influence the model's computations. Specifically the weir flow submergence factor, lateral structure stability factor, and Theta (the implicit weighting factor).The weir flow submergence factor and lateral structure stability factor can range from 1-3. Both these parameters were varied over the entire range and the model results show virtually no sensitivity to either parameter. The Theta factor can theoretically vary from 0.6 to 1.0 however, many models become unstable at lower ranges. In theory, lower Theta values produce higher model accuracy but lower the model stability. Therefore, it is good practice to use the lowest value possible value without introducing instability. The Tillamook model uses values of 1.0 for all scenarios. We tested the impact of reducing Theta to 0.8 and the model results were unaffected, the model crashed when tested at a value of 0.7.

In summary, the model is most sensitive to two empirical coefficients, the Manning's n value (roughness parameter), and the weir coefficient for the lateral structures. Both of these parameters are relatively poorly constrained. While the Manning's roughness coefficient is well studied, it is an empirical coefficient that in a 1D model needs to include the combined flow resistance from all sources including skin friction and form drag. It is often used as a catch-all calibration factor to make up for other deficiencies in the model (not recommended). Uncertainty in the roughness coefficients could be reduced if better calibration data were available. The weir coefficients for lateral weirs are less studied but the data that do exist show that the coefficient varies as a function of the weir (representing a levee or high ground) height above adjacent ground and the shape/type of feature being modeled. This variability is not reflected in the Tillamook model. Please note that the Manning's n and weir coefficient sensitivity testing were completed by NHC and are presented in Attachment A of this appendix.

SECTION 10 Alternatives Assessment

A summary of alternatives and relative confidence in reported results.

No Action Alternative

In the context of floodplain management, the No Action Alternative reflects flooding probability and inundation areas similar to current conditions. However, over the course of the design life of the project, flooding damage is expected to change due to increased economic use of flood-prone areas and trends in flood processes.

The Highway 101 corridor between Hoquarten and Dougherty Sloughs is in the lowest area of the floodplain. Flood flows would continue to overtop the south bank of the Wilson River upstream and flow down and over the highway here at significant depths. In addition, the land is now at elevations only 1-2 feet above wintertime high tides and is open to tidal influence via the sloughs that bound it. Projected sea level rises would result in wintertime high tides and storm surges that may inundate the highway corridor itself in the future. It is not cost feasible to reduce upstream flood flows; to do so would require a levee system along the entire Wilson River to the mouth of the canyon. Nor can levees or fill be used to protect against increasing sea levels as these would block the riverine flood flows. Beyond implementing the project, either relocation or elevation with flow-through foundations appear to be the only viable alternatives for flood mitigation of structures in this area.

The farmlands west of Highway 101 depend on the levee system to protect them from tides. Much of the land has subsided and now lies below mean high tide elevations. Projected sea level rises would require these levees to be raised for tidal protection, but to do so would increase flood levels upstream. Of greatest concern here would be the levee along the north bank of Hall Slough. This is currently set as low as it can be while providing tidal protection. Elevation of this levee would cause increased backwater flooding on Highway 101 between Hall Slough and the Wilson River.

Some of the lands along Highway 101 north of Hall Slough are also at low elevations and at risk from sea level rise and levee height increases along Hall Slough. However, the area rises quickly towards the Wilson River, and does not have the large, deep flows across it as the area to the south does. There are options for adapting to sea level rise in this area that would not cause adverse effects elsewhere.

As with most rivers, the levee and berm system along the Wilson River has a significant effect on flood levels and behavior. The current level of flood protection for the majority of land, buildings, and infrastructure in the valley, including the Highway 101 corridor, depends on an assemblage of privately built and maintained berms of varying quality. Flood levels along the river do not differ greatly under different flows. The—the difference between a 5-year and 100-year flood is less than 1 foot for much of the reach;—therefore, floodwaters overtop the south bank at relatively shallow depths regardless of flood magnitude. As these overbank flows join and flow west in the lower southern edge of the floodplain the differences in depth become greater. On Highway 101 at Hoquarten Slough, the difference in flood level between a 5-year and 100-year flood is almost 3 feet. Having a significant breach in a berm increases floodplain flows and flood levels. For instance, this may cause flood levels expected for a 10-year event to occur during a 5-year flood.

The flood reduction benefits due to these berms extend beyond the properties they are built on. Conversely, these structures can cause increases in flood levels that extend well beyond their immediate location.

Alternative 1: Southern Flow Corridor - Landowner Preferred Alternative (Proposed Action)

Hydraulic modeling of Alternative 1 shows a flood reduction of up to 1.5 feet during floods from small, infrequent events through a 100-year event. Indirect benefits would also include fewer road closures and associated business disruptions. The area of flood level reduction would be over 3,000 acres and would encompass the lower Wilson, Trask, and Tillamook River floodplains.

Flood level rises due to Alternative 1 are predicted in one area in small floods, east of the new Middle Dike. This area is benefited under current conditions by the large flood storage volume available in the wetlands acquisition area. In smaller, more frequent floods, flows between Hall and Dougherty Sloughs would fill the reduced storage volume more rapidly. Although the new dike would have substantially larger flood gate capacity, these would not begin to operate until water levels inside exceed those outside, so water levels would quickly rise to somewhat above the flood/tide level outside. At this point, the flood gates would begin to operate and discharge water. It is important to note that these increases would only occur in very small floods; in larger floods, the area would benefit from flood level reductions similar to the rest of the floodplain.

Alternative 2: Hall Slough Alternative

The Hall Slough Alternative consists of a high flow inlet from the Wilson River and enlargement of Hall Slough through most of it length. Alternative 2 would reduce nuisance flooding in the Highway 101 corridor up to a 2-year flood.

Hall Slough is a side channel of the Wilson River. The slough’s origins are upstream of Highway 101 near the Wilson River Loop Road, and its downstream end comes back into the Wilson River about 2 miles downstream (near the mouth of the Wilson River). Hall Slough was connected to the Wilson River at its upstream end before 1950. At that time, a bridge was in place that crossed Hall Slough on the Wilson River Loop Road. Since then the slough has been filled at its upstream end, the bridge removed, and a small culvert placed through the Wilson River Loop Road to drain the area behind it. During a flood event floodwaters flow over along the left bank of the river near the historic Hall Slough entrance and flow down the Wilson River Loop Road to Highway 101, where they flow south along the highway and eventually cross and flood the highway. These nuisance floods occur frequently and may be controlled by reestablishing the historic slough connection to the Wilson River.

The measures modeled with MIKE11 included connecting the slough to the Wilson River at the upstream end, setting back dikes, establishing new levees along the slough, and deepening the slough. Initial modeling results using the November 1999 flood event showed that the slough would carry approximately 1,000 cubic feet per second (cfs) of floodwater that would have previously flooded Highway 101. This alternative also lowered the duration of flooding on Highway 101 by approximately 4 hours. Although this alternative would not control flooding for all floods in excess of the nuisance floods, it would help to control the common flooding in the Highway 101 area.

In the MIKE11 model, the slough was deepened throughout to maintain a positive slope to the bay and to be tidally active throughout its length. A conceptual overflow structure also was placed at the slough's upper end to allow flows from the Wilson River to enter Hall Slough when the river reached an elevation of 15.4 feet NAVD88 (North American Vertical Datum of 1988). Wilson River flows would then be allowed in Hall Slough via a weir structure. In order for increased flows in Hall Slough to remain within the slough, the slough was widened and deepened from its upstream end down to the Goodspeed Road bridge. Also, small levees would be needed in a few low spots along the slough. The Hall Slough bridge at Highway 101 would be lined with vertical concrete walls and deepened to pass flows of 1,000 cfs. Hall Slough downstream of Goodspeed Road would be unchanged other than the dike on the right bank would be setback for riparian plantings.

Modeling was performed using the January 25, 2002 flood which represents an annual event on the Wilson River. Modeling results showed that overflows from the January 2002 flood that had flowed across Highway 101 and into the fields behind Fred Meyer would be contained in Hall Slough.

Alternative 3: Southern Flow Corridor – Initial Alternative

This alternative consists of removing extensive levees and fill and constructing setback levees to create an unobstructed flood pathway out to Tillamook Bay. In general, the concept of this alternative is similar to the Proposed Action. Removal of the numerous levees and fills within the flow corridor provides the conveyance capacity increase that results in reduction of flood levels over a wide area of the lower Wilson River floodplain.

In general, material would be removed to slightly below natural floodplain/marsh level. This elevation is around 8-9 feet at the mouth of the Wilson River, increasing to more than 10 feet farther upstream. Lowering areas further than this could provide some additional flood level reduction, but the cost increase would be large and the benefits temporary as the tides and river would rebuild the lands back up to natural elevations.

The project provides flood level reductions across most of the lower Wilson River floodplain at all sizes of floods. Some small flood reductions extend up the Tillamook and Trask systems.

Flood level rises due to the project are predicted in localized areas just inside the new levee system north of the southern flow corridor. This area is benefited under current conditions by the large flood storage volume available in the wetlands acquisition area. In smaller, more frequent floods, flows between Hall and Dougherty Sloughs would fill the reduced storage volume more rapidly. Although the new levee would have substantially larger flood gate capacity, the flood gates would not begin to operate until water levels inside exceed those outside, so water levels would quickly rise to somewhat above the flood/tide level outside. At this point the flood gates would begin to operate and discharge water out. This increase is only shown in the 2001 flood – by the 1999 flood (~5-year event), the project is providing flood level reductions here.

SECTION 11 Findings and Conclusions

A significant investment has been made over the past decades by local, state, and federal entities cooperating to better understand flood conditions in the project area and identify possible cost-effective improvements.

To characterize the modeling efforts, we begin by stating some important facts about the physical system as it is currently understood:

- Flooding conditions in the project area are defined across a wide range of events by the 2D movement of water, out of defined channels and along overland flow paths, exchanging flood waters between rivers and sloughs as hydraulic gradients may allow.

- Situated at the confluence of three hydraulically connected rivers, a tidal estuary, and in the vicinity of numerous small tributaries, the timing and volume of peak flows from each of these sources affect both localized and regional flooding conditions in the project area.

- Sensitivity of the system to flood magnitude varies significantly by location in the project area. In some locations, the difference between a 5-year and 100-year flood water surface may be less than a foot. In other locations, it may vary by 3 feet or more. Differences depend primarily on distance from Tillamook Bay, local channel and floodplain conveyance, levee performance, and hydraulic structures.

- The levee system located between the Wilson and Trask Rivers effectively precludes river flows from spilling out laterally onto the historic floodplain. Constraining all the flow to the main river channels leads to higher in-channel flow rates which leads to elevated river levels. Flow currently enters the backside of the leveed wetland area through ovebank flow paths upstream of Highway 101. These flows then drain from behind the levee through a series of flood gates located at the far west end of the wetland. However, the flood gates do not have enough capacity to convey peak flood flows. The water levels behind the levee then begin to rise because the flows going into the backside of the levee are greater than those flowing out at the flood gates. These two phenomena are the primary reasons why flooding has increased in th areas immediately adjacent to the levees, relative to the pre-levee condition. Flooding upstream of Highway 101 has also been increased as a result of the highway and other roadways the restrict floodplain conveyance.

- The project area exhibits a high potential for dynamic changes over time in sediment transport and hydraulic function due to watershed and tidal processes that change channel geometry and local water velocities.

The sum effect of these well-documented conditions is an exceptionally difficult natural system to simulate with a 1D hydraulic model. Perhaps more importantly, the predictive capability of a computer model to simulate highly variable conditions or specific alternatives may be limited by a variety of factors. Confidence in model performance is always highest within the range of conditions used for calibration and validation. In this case, the alternatives under consideration consist of large scale levee removals and may each be reasonably considered sufficiently unique that the comparative capacity of the model is limited.

With that in mind, the model review presents these specific findings:

- The type of data collected for model calibration (peak stage except for the 2001 event) limits the ability to assess timing of flows. When considered with the scaling and regression-style hydrologic estimates for minor tributaries, confidence intervals on flow estimates at a specific frequency can be expected to be relatively large. This means that when estimating an event (e.g., 5-year flood), the expected peak flow from a tributary stream as well as the timing and volume of its contribution to the aggregate flow condition in the study area are uncertain and may be significantly different than modeled.

- When the estimated flow regime is applied for a measured historic event, the resulting water surface elevations can generally be described as ±1 foot, but may vary locally by as much as 3 feet from the measured peak water surface at the same location. This confidence interval, or uncertainty in the modeled predictions, is about the same magnitude as the predicted reduction in water level. While it is likely that calibration residuals (difference between measured and modeled values) may be similar for the No Action Alternative as well as all action alternatives, that assumption can't be proven. However, confidence in the relative change in water level is much greater than the confidence in absolute water level. This means that there is a high degree of confidence that the actual flood levels will go down, but less confidence in the predicted magnitude of that reduction.

- The use of a one-dimensional hydraulic model requires expert construction of geometry and flow paths and selection of a significant number of parameters, many of which are empirical in nature and can't be field measured or verified with the data available. To a large degree, this construction has been done with a high degree of skill and following best practices within the limitations of the modeling platform. In a few cases, the selection of values was questionable, at least for comparison of alternatives.

- The model consists of a large number (over 100) flow paths and 50 boundary conditions. Each of these either requires or creates localized hydraulic constraints that characterize model performance. These are made up a combination of measured data, empirical and theoretical parameters, and fixed assumptions. These localized conditions control the velocity and water surface elevations in their vicinity and interact to control movement of water globally through the model. Data is only sporadically available, and the calibration effort did not attempt, to model localized hydraulic conditions such as may be found in and around a specific levee or hydraulic structure. Because of the complexity of the model and the limited amount of data available for calibration, the model is a better predictor of generalized conditions across larger areas than of specific results at particular locations.

- Limited water-level time-series data constrains advancement of a conceptual site model that describes the hydraulic characteristics of the system. The lack of water-level time-series data over multiple events also limits the reliability and predictive capability of the model. Time-series water-level data are essential for “training” the model to replicate reality; without such data the model cannot be calibrated to the extent it could be for a system of this complexity and a potential project of this scale. The calibration efforts to date are modest at best (limited by lack of data).

Returning to the stated modeling objectives introduced at the beginning of this study, findings are included after each bullet item:

- *Establish a basis for comparing risk to life and property among all alternatives during flood events due to a range of estimated flood depths, durations, and velocities.*

  The model is generally suitable as a comparative tool for flood benefits between alternatives. The prediction of specific water elevations, especially in localized areas, has a confidence interval of approximately one foot. Duration is a minor component of benefits for proposed project actions. No velocity measurements are available to assess the accuracy of the model to predict possible impacts.

  However, it is also noted that the limited observed time series data from the 2001 flood shows a good match to predicted flood timing and duration. While there is no data on velocity to evaluate margins of error, there is also no claimed benefit from changes to velocity due to the project.

- *Establish a basis for comparing natural hydrologic and sediment transport processes among all alternative.*

  There does not appear to be strong evidence that the model was constructed with the intent to simulate sediment processes or used for that purpose. There is a high degree of uncertainty associated with the model-predicted flow rates which translates to an equally large degree of uncertainty in the model-predicted velocities. This model cannot be used to simulate sediment transport processes. Based on review of available study literature, it is likely that sediment processes may materially affect the performance of alternatives during expected design life.

- *Characterize the spatial variability of inundation frequency within the project area to compare relative impacts of all alternatives on agricultural lands and proposed habitat areas.*

  Spatial variability of inundation cannot be directly reported as an output result of a 1D model simulation, but has been approximated for study purposes. Given the 1D approximation of an essentially 2D flow regime in the study area and the documented results of calibration performed at reach scale, localized inundation characteristics of timing and depth of flow should be considered within a relatively wide range of confidence around reported results. Furthermore, there are a few important caveats that need to be understood when viewing inundation maps developed from a 1D model. There are additional errors (beyond errors in model accuracy) that are introduced by attempting to map the results spatially, a great level of interpolation is required, and because such maps are often made to represent the maximum flood stage the temporal component is neglected so the resulting map doesn’t reflect an actual moment in time. A better way to interpret results from a 1D model is to look at the water-surface profiles over the entire hydrograph—this tells a more complete and accurate story.

- *Characterize the performance of levees and the local movement of flood waters within the project area to compare alternative impacts on channels, overland flow, tide gates, sloughs and wetlands*

  The model construction simulates the effects of hydraulic structures, levees, tide gates, and channel and overland flow paths. The net effect of these elements has produced results for historic events that can be measured against calibration data, generally at ±1 foot. However, hydraulic performance at or near any individual channel or structure has not been calibrated at this localized level and in many cases, no measurements exist to support that effort. While it is reasonable to infer certain characteristics of the existing system performance based on observation and model results, predicted hydraulic effects at specific locations are likely to vary considerably from the calibrated model and may not be comparable between action alternatives. There is however a higher level of confidence that the ***sign*** of the relative change is correct. That is, there is a high degree of confidence that the actual flood levels will go down, but less confidence in the predicted magnitude of the reduction in response to levee removal. The level of confidence in the model-predicted relative changes varies by location — the relative impacts are greatest in the immediate vicinity of the levee removals and the effect tapers off in the upstream direction. Therefore, there is less confidence that there would be a real impact in the areas that are not immediately adjacent to a levee removal.

It is likely that some of the stated objectives above, particularly with respect to localized hydraulic conditions and potential velocity impacts, could only be defensibly simulated using a 2D model. However, velocity is not an important parameter for the function of the proposed project. The following are some recommendations that may increase confidence in the reported results of the modeling activities, using available data and tools.

1. Perform additional sensitivity analysis regarding flow contributions from un-gaged sources to determine if enhanced hydrologic methods are warranted to address timing of flows.

2. The roughness value of 0.04 assigned to the entire *Doug tras 0.85* reach appears too low for dense brush. This assumption leads to a slight over statement of the flood reduction benefits associated with the SFC alternatives.

3. Review the discontinuities in channel roughness in Hall Slough and *Doug tras 0.85*. If this discontinuity was required for calibration, it could be an indication of a different underlying problem, unless there's a physical explanation for it.

4. The weir coefficient parameterization is overly generalized and more importantly the coefficients are not revised in the action alternative scenarios to account for the change in geometry of the removed levees. The levee removal areas should have lower weir coefficients. Lower weir coefficients would produce higher water levels and thus show less of a flood reduction benefit.

These recommendations were discussed with the model designer and are addressed in Attachment A. In addition, revisions were made to the hydraulic model used for analysis and the results were reported in the Draft EIS, and subsequent documents reflect those changes that were made as part of this review process. For example, the predictions of flood reduction with the Proposed Action as presented in the Draft EIS reflect the revised model results that came from this review and the discussion between the peer review hydrologists and the model designers. This appendix has presented the model review and recommendations for improvement. Attachment A presents the model designers' response to the recommendations, and the EIS presents the results of the revised model.

As described in Attachment A, the model designers performed additional sensitivity analyses and reviewed the roughness values used and the observed discontinuities in the channel roughness values. Attachment A describes the results of the sensitivity analyses and the adjustments that were made in the roughness values, and it provides a physical explanation for the discontinuities. Attachment A also addresses the issue of weir coefficients identified in this review.

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Attachment A:

Southern Flow Corridor Hydraulic Model Accuracy and Sensitivity Response Memo

16300 Christensen Road, Suite 350 | Seattle, WA 98188 | 206.241.6000 | www.nhcweb.com

nhc
northwest hydraulic consultants

NHC Ref. No. 200184

05 March 2015

Port of Tillamook Bay
4000 Blimp Boulevard, Suite 100
Tillamook, OR 97141

Attention: **Aaron Palter**
Project Coordinator

Via email: apalter@potb.org

Re: **Southern Flow Corridor Hydraulic Model Accuracy and Sensitivity**

Dear Aaron:

This memorandum summarizes our analysis of the HEC-RAS model sensitivity as requested by FEMA and its contractors as an outcome of the hydraulics review. In addition, we have included analysis of calibration errors and discuss project resiliency under future changes to climate, sea level, and sedimentation. These factors together help to form our understanding of the model accuracy, precision, and robustness, and consequently the certainty of flood damage reduction benefits to the area.

1 OBSERVED DATA AND SIMULATION ERRORS

The draft Hydraulics Peer Review Memo presented calibration data for only the 2001 and 1999 floods, and incorrectly noted there were no observed time series data to evaluate flood timing. There is additional high water mark data from the 2006 and 2007 floods, and three observed time series gage records for the 2001 flood, which we discuss in this section. Simulation errors for high water marks from the four different floods were calculated by flood and as a group (Table 1, Figure 1). Errors are biased slightly low (mean error less than zero), and decrease with increasing flood magnitude. A review of the largest positive and negative errors reveals they tend to occur in repeat locations, mostly where the model is not capable of accurately simulating sheet flow. Using root-mean-square-error (RMSE) as the primary error statistic, 68% of the errors are within +/-1.1 feet of observed water levels, and 95% (2 SD) are within +/-2.2 feet. We expect this error to be same in the with-project condition.

Table 1: Model Error Statistics

Flood	N	RMSE (ft)	Mean (ft)	Mean Absolute (ft)	Max (ft)	Min (ft)
1999	19	1.12	-0.26	0.77	2.73	-3.42
2001	16	1.40	-0.18	1.05	2.26	-4.02
2006	11	0.85	-0.14	0.68	1.11	-1.89
2007	8	0.94	0.10	0.78	1.83	-1.42
All	**54**	**1.14**	**-0.16**	**0.83**	**2.73**	**-4.02**

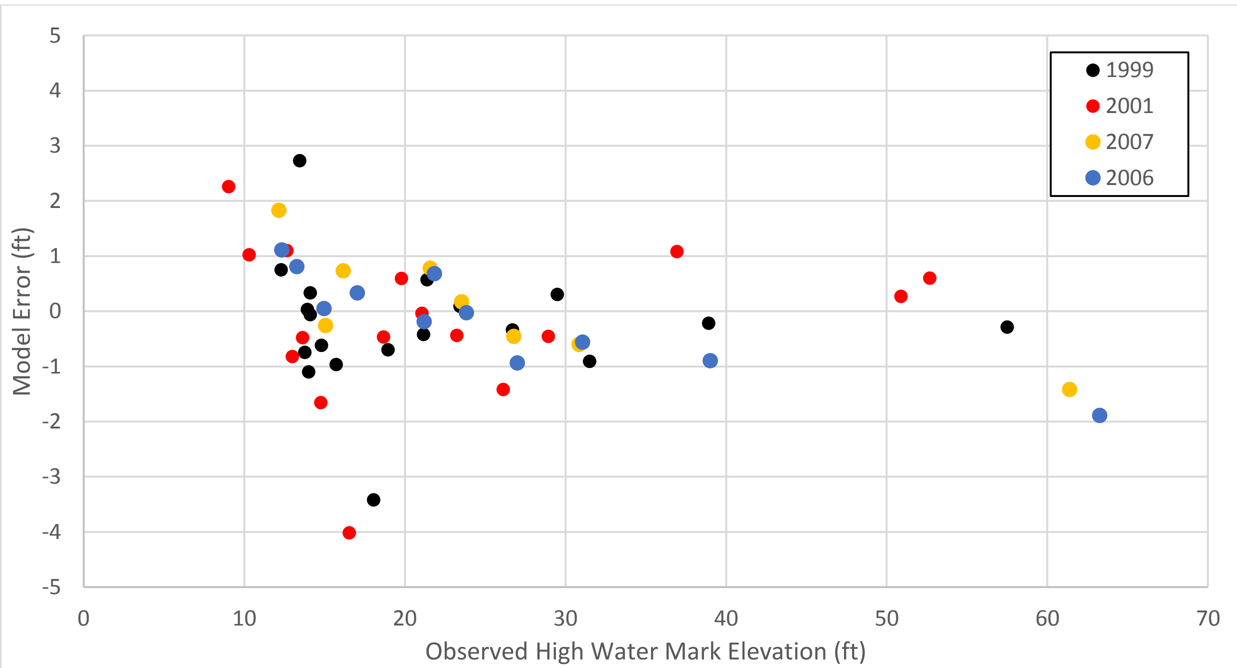

Figure 1: Model Calibration Error

Observed stage hydrographs for the 2001 flood event at three sites in the lower river are shown in Figure 2 to Figure 4. All three sites show a good match with the timing of the flood and the tidal-river interactions. Water surface elevations are somewhat undersimulated at all sites through the event. The large errors in the Geinger gage at the beginning of the simulation are due to an imposed high base flow required for model stability. Note that the time of peak flow is rarely during the peak stage due to tidal interaction, so the error at the largest flow in each lower panel is not necessarily the error that occurred at the peak stage.

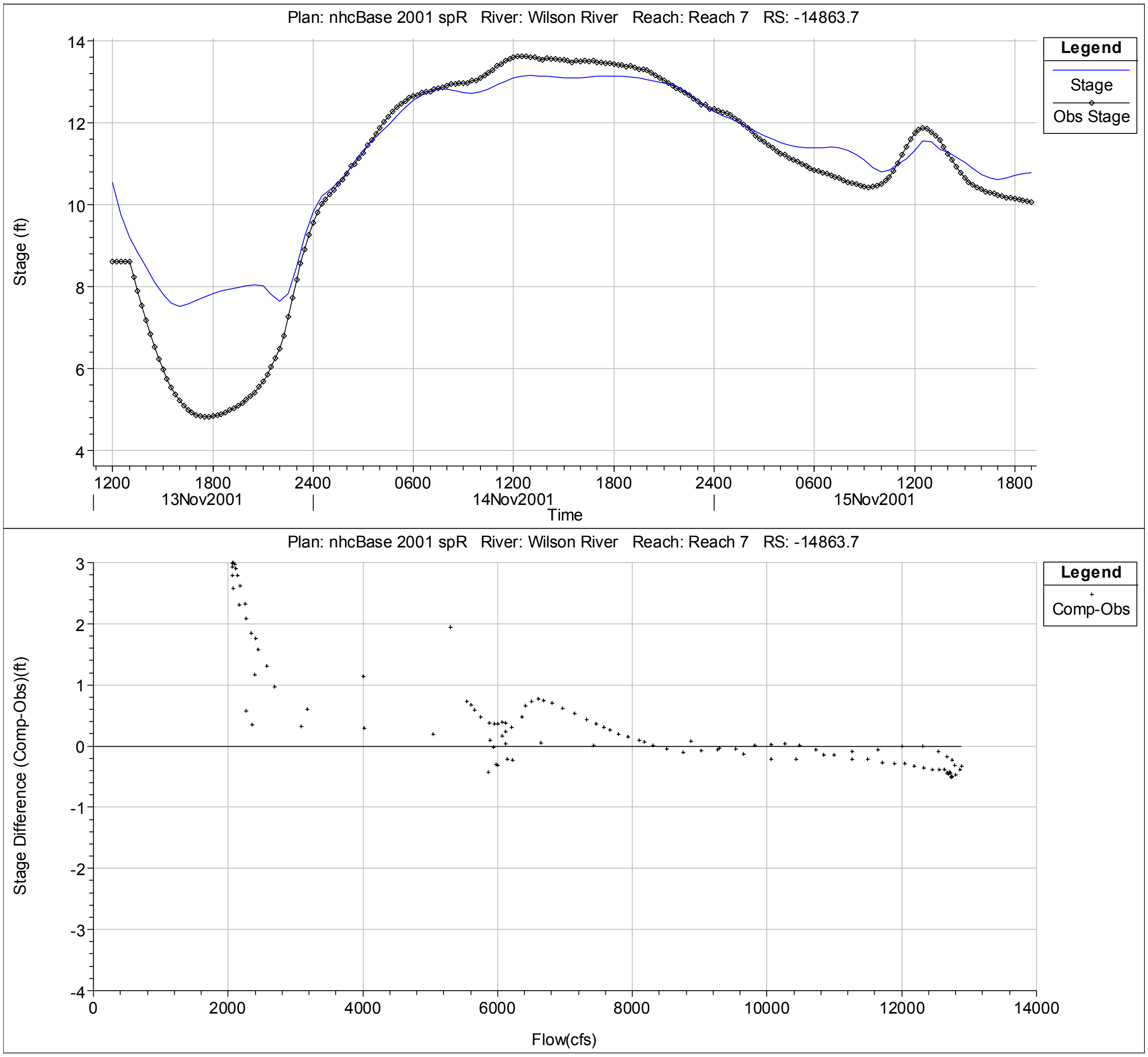

Figure 2: Observed and Simulated Stage Hydrograph (top) and Error (bottom), Wilson River at Geinger Gage, 2001 Flood

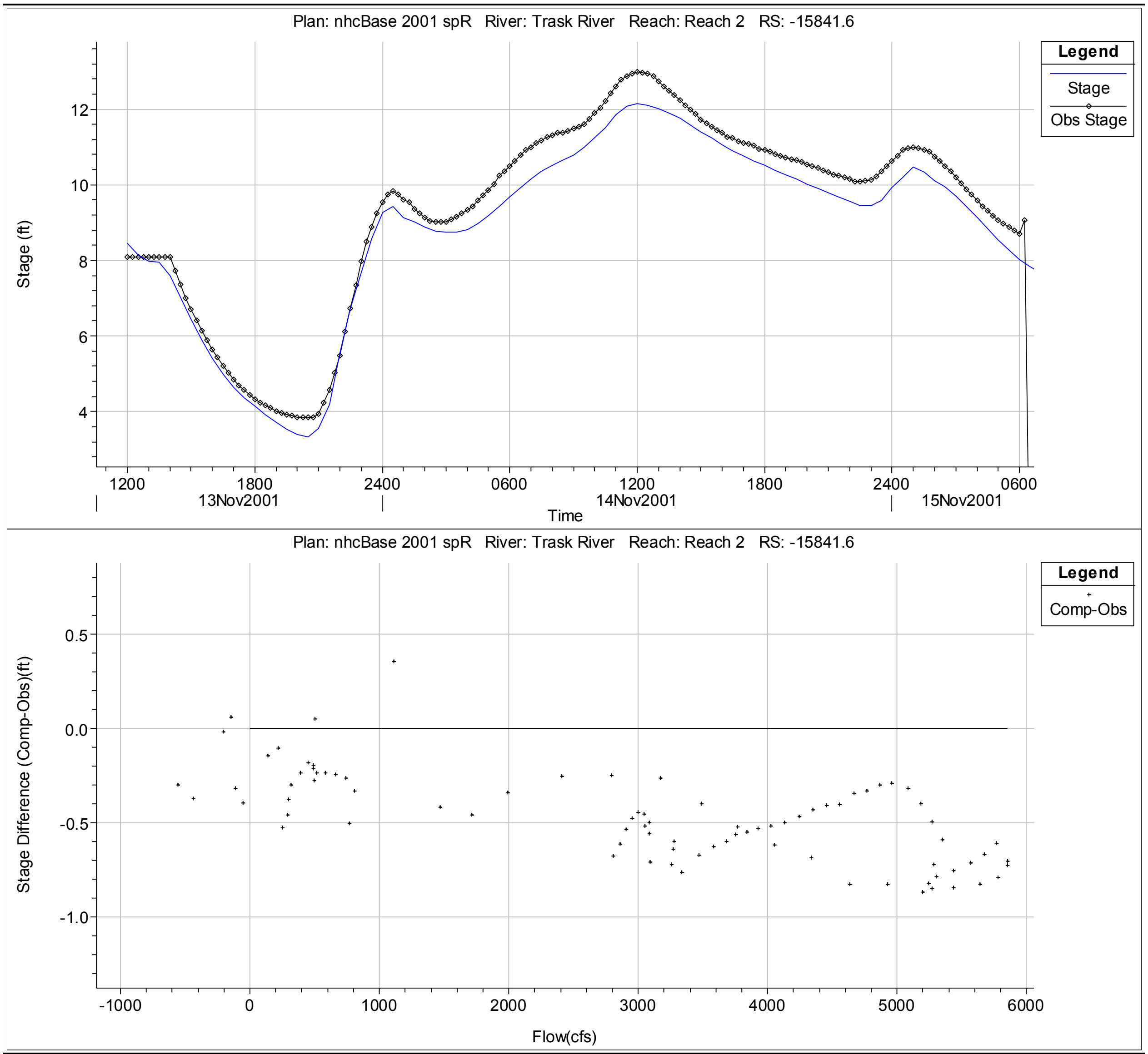

Figure 3: Observed and Simulated Stage Hydrograph (top) and Error (bottom), Trask River Carnahan Gage, 2001 Flood

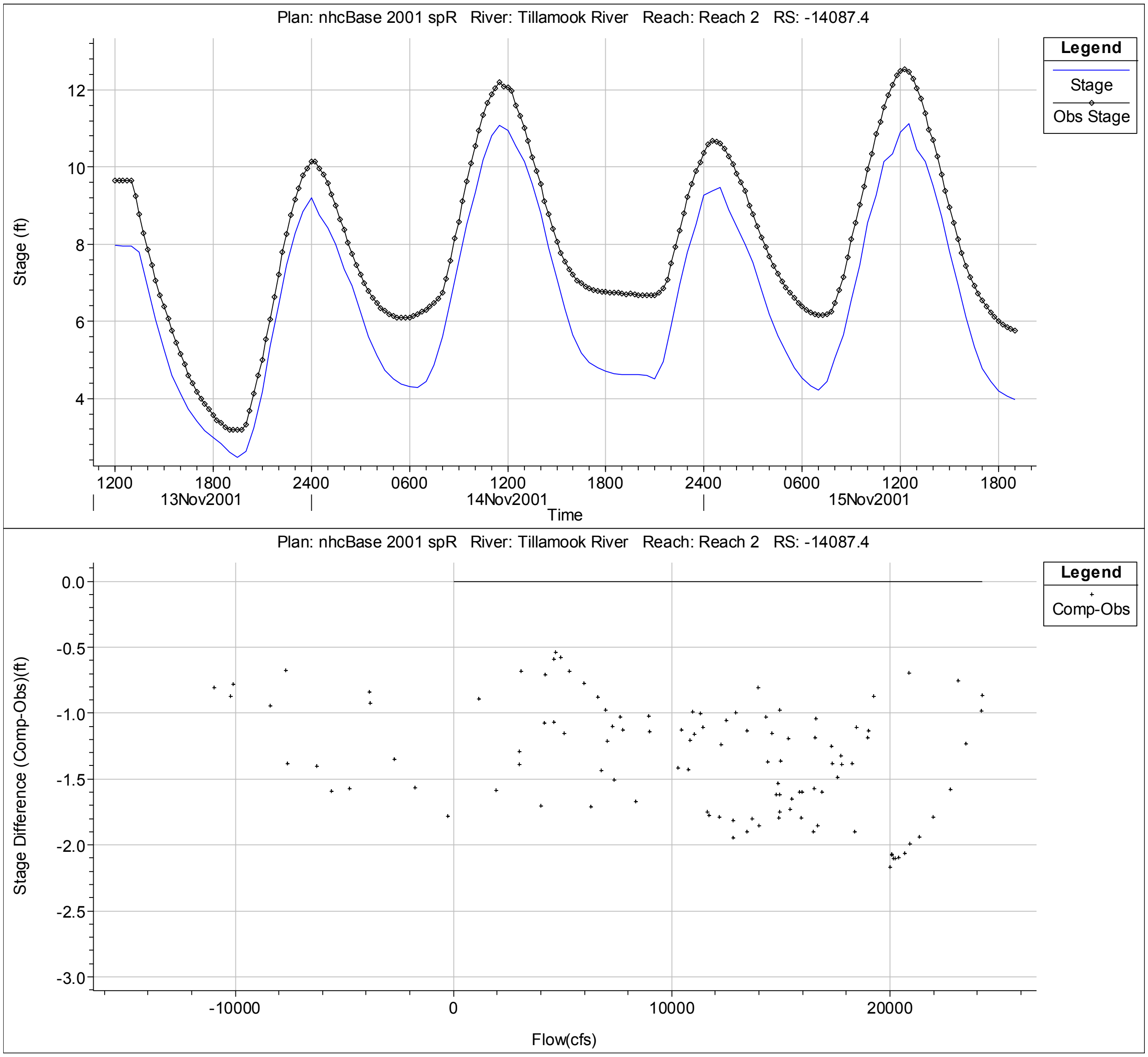

Figure 4: Observed and Simulated Stage Hydrograph (top) and Error (bottom), Tillamook Bay Dick Point Gage, 2001 Flood

2 SENSITIVITY ANALYSIS

We completed three sets of sensitivity analyses. Summary results are presented in Table 4 for statistics based on outputs at all cross sections in the model. Comments on each sensitivity run are as follows:

Lateral Weir Coefficients: We have responded in detail to this item previously. The results for the entire model are included in the table below. Please note our previous response used data from the project area of influence, so the values are somewhat different.

Overbank Roughness: We agree with the comment that overbank roughness values for pasture (the dominant landcover in the lower river floodplains around Tillamook) should be consistent. In the original model the Doug-Tras 0.85 reach roughness was set to 0.04, while the rest of the floodplain pasture reaches were set to 0.07 (the original value in the Corps model). We used professional judgement and standard references in considering what the appropriate roughness should be for pasture. Key factors in selecting floodplain roughness were:

- Winter pasture in the area consists of short to medium length grass (Figure 5)
- The floodplains are generally smooth with little surface variation at the scale that could affect form roughness (Figure 5)
- Depths of flooding are at least 4-6 feet in most important conveyance corridors

Estimated roughness values from two standard references are presented here. Table 2 shows the Arcement (1989[1]) method values, with our selections for Tillamook highlighted. In this method, the values for each component are summed.

Figure 5: Typical winter pasture (Wetlands Acquisition Area Feb 23, 2015)

[1] Arcement, George J., 1989. Guide for selecting Manning's roughness coefficients for natural channels and flood plains. USGS Water Supply Paper 2339.

Table 2: Arcement (1989) roughness values

Bed Material	Median Size of bed material (in millimeters)	Base *n* Value: Straight Uniform Channel[1]	Base *n* Value: Smooth Channel[2]
Sand Channels			
Sand[3]	0.2	0.012	--
	.3	.017	--
	.4	.020	--
	.5	.022	--
	.6	.023	--
	.8	.025	--
	1.0	.026	--
Stable Channels and Flood Plains			
Concrete	--	0.012-0.018	0.011
Rock Cut	--	--	.025
Firm Soil	--	0.025-0.032	.020
Coarse Sand	1-2	0.026-0.035	--
Fine Gravel	--	--	.024
Gravel	2-64	0.028-0.035	--
Coarse Gravel	--	--	.026
Cobble	64-256	0.030-0.050	--
Boulder	>256	0.040-0.070	--

[Modified from Aldridge & Garret, 1973, Table 1 --No data
1Benson & Dalrymple --No data
[2] For indicated material; Chow(1959)
[3] Only For Upper regime flow where grain roughness is predominant

Flood-Plain Conditions	*n* Value Adjustment	Example
Degree of Irregularity (n_1)		
Smooth	0.000	Compares to the smoothest, flattest flood-plain attainable in a given bed material.
Minor	0.001-0.005	Is a Flood Plain Slightly irregular in shape. A few rises and dips or sloughs may be more visible on the flood plain.
Moderate	0.006-0.010	Has more rises and dips. Sloughs and hummocks may occur.
Severe	0.011-0.020	Flood Plain very irregular in shape. Many rises and dips or sloughs are visible. Irregular ground surfaces in pasture land and furrows perpendicular to the flow are also included.

Effect of obstruction (n_3)		
Negligible	0.000-0.004	Few scattered obstructions, which include debris deposits, stumps, exposed roots, logs, piers, or isolated boulders, that occupy less than 5 percent of the cross-sectional area.
Minor	0.040-0.050	Obstructions occupy less than 15 percent of the cross-sectional area.
Appreciable	0.020-0.030	Obstructions occupy from 15 percent to 50 percent of the cross-sectional area.
Amount of vegetation (n_4)		
Small	0.001-0.010	Dense growths of flexible turf grass, such as Bermuda, or weeds growing where the average depth of flow is at least two times the height of the vegetation; supple tree seedlings such as willow, cottonwood, arrow-weed, or saltcedar growing where the average depth of flow is at least three times the height of the vegetation.
Medium	0.010-0.025	Turf grass growing where the average depth of flow is from one to two times the height of the vegetation; moderately dense stemy grass, weeds, or tree seedlings growing where the average depth of flow is from two to three times the height of the vegetation; brushy, moderately dense vegetation, similar to 1-to-2-year-old willow trees in the dormant season..
Large	0.025-0.050	Turf grass growing where the average depth of flow is about equal to the height of the vegetation; 8-to-10-years-old willow or cottonwood trees intergrow with some weeds and brush (none of the vegetation in foliage) where the hydraulic radius exceeds 0.607 m.;or mature row crops such as small vegetables, or mature field crops where depth flow is at least twice the height of the vegetation.

Table 2 summarizes the range of values using the Arcement method and from the Chow tables.

Table 3: Pasture Roughness Estimates

Source	Category	Min	Normal	Max
Chow (1959[2])	Pasture, no brush, short grass	0.025	0.030	0.035
	Pasture, no brush, high grass	0.030	0.035	0.050
Arcement	See Table 2	0.032	0.044[1]	0.056

1. Calculated as average of minimum and maximum values

Based on these values we decided that the 0.04 'n' value is more appropriate for use in pasture areas than 0.07, and changed overbank roughness values throughout the model to reflect this. Two exceptions were the upper end of Hall Reach 1, where higher roughness was needed for stability, and Hall RB 3.00, where the reach is a mix of pasture and buildings along the Highway 101 commercial strip.

The mean difference in flood depths was near zero. The largest changes occurred in Trask River reaches upstream of the project area of influence, and in the Till 0.15 reach, which is consistently sensitive to small variations in model parameters. Changes in the core project benefit area were under 0.1 feet.

Tributary Inflow Time Shift: We compared the time of peak on the Wilson River to the time of maximum rainfall at the NOAA Coop Station 358504 (Tillamook 12 ESE OR US) for the 1999, 2001, and 2006 floods. Where there was more than one rainfall peak, we selected the earliest one. Rainfall peaked 20, 12, and 12 hours, respectively, before the Wilson River peak for these events. Accounting for lag times and variable tributary basin sizes, we selected 8 hours as an appropriate time shift. All tributary inflows to the model except the Tillamook River were shifted 8 hours earlier. The Tillamook River basin is large enough that we left that inflow as-is. We only simulated the 1999 flood with the shift, as we have consistently seen this smaller flood is more sensitive to parameter changes than the larger events. Results showed this sensitivity run had the least effect of the three.

[2] Chow, V.T., 1959, Open-channel hydraulics: New York, McGraw-Hill, 680 p.

Table 4: Summary of Sensitivity Analysis

		100-yr			1999 (6-yr)		
		$Diff_s$-$Diff_o$	Diff Base $_{(s-o)}$	Diff SFC $_{(s-o)}$	$Diff_s$-$Diff_o$	Diff Base $_{(s-o)}$	Diff SFC $_{(s-o)}$
Revised Lateral Weir Coeff.	S.D.	0.09	0.14	0.14	0.09	0.56	0.47
	Mean	0.05	-0.07	-0.03	0.00	-0.04	-0.04
	Median	0.00	-0.03	-0.01	0.00	0.01	0.00
	Max	0.42	0.83	1.19	0.95	0.15	0.14
	Min	-0.22	-0.40	-0.39	-0.08	-6.12	-5.20
0.040 Overbank Roughness	S.D.	0.25	0.20	0.19	0.21	0.21	0.41
	Mean	0.03	-0.06	-0.03	0.02	-0.01	0.01
	Median	0.00	-0.01	0.00	0.00	-0.01	0.00
	Max	2.57	0.33	1.16	2.18	1.72	3.89
	Min	-0.02	-1.41	-1.05	-0.03	-0.73	-0.73
Trib Time Shift	S.D.				0.03	0.05	0.06
	Mean				0.01	-0.07	-0.05
	Median				0.00	-0.06	-0.04
	Max				0.16	0.02	0.04
	Min				-0.01	-0.29	-0.29

Notes:

2. Subscripts: s = sensitivity run, o = original model run
3. Diff-Diff = the difference in flood depth reduction between the sensitivity run and the original model.
4. Diff-Base = the difference in flood depth between the sensitivity run and original model existing conditions.
5. Diff-SFC = the difference in flood depth between the sensitivity run and original model with-project condition.

In updating the model with new bathymetry and levee crest elevations last year, we also have another de-facto sensitivity analysis. Comparing the old and new models with these changes showed similar minor changes in peak flood elevations despite many of the channel cross sections exhibiting significant aggradation.

Overall, none of the parameters varied in the sensitivity runs affected peak flood levels to any significant degree. Mean changes in the magnitude of flood level reduction are near zero for all three scenarios. The lowered overbank roughness run exhibits the largest variation in flood depths, but the standard deviation here is only 0.2 feet. The other two scenarios have substantially lower variances. In many of the simulations there are a few locations where large differences are consistently seen, the Till LB 0.15 reach being the most obvious. We have noted the sensitivity of this reach in past modeling. The levee elevations and available storage in this overbank reach are such that small changes in river water levels can create large changes in levee overtopping volumes and consequent flood depths in the reach. The changes are small under any of the sensitivity runs in the core project benefit area of the lower Wilson River and Highway 101.

3 PROJECT LIFESPAN AND EFFECTIVENESS

Three main factors have been identified that may affect project effectiveness in the future:

Channel Aggradation: Comparison of cross sections in the lower Wilson, Trask, and Tillamook Rivers between c. 2002 and 2014 showed aggradation in most of them. This is not surprising given the setting at the head of Tillamook Bay, a natural deposition area. Aggradation will decrease channel conveyance, thereby spilling more water overbank. As the SFC has been shown to provide increasing flood level reductions with increasing flows, channel aggradation is not expected to impair project function.

Increased Peak Flows: Hydrologic modeling of changes to flooding in the Puget Sound area due to climate change generally predicts around a 30% increase in peak flow. This will tend to increase overbank flow similar to channel aggradation, which the SFC is effective at handling. Therefore, no impairment from increased flows is expected for the project; for a given flood frequency peak flows will be greater and the project will provide proportionately greater flood level reduction.

Sea Level Rise: Sea level rise (SLR) is the factor most likely to reduce the effectiveness of the project over time. Relative sea level rise predictions Oregon and Washington are mitigated by tectonic uplift; the following table show projections for sites bounding Tillamook.

Table 5: Regional Sea Level Rise Projections (in) relative to 2000

	2030		2050		2100	
Location	Mean	SD	Mean	SD	Mean	SD
Seattle	2.6	2.2	6.5	4.1	24.3	11.5
Newport	2.7	2.2	6.8	4.1	24.9	11.1

Adapted from Table 5.3 - Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future. Committee on Sea Level Rise in California, Oregon, and Washington; Board on Earth Sciences and Resources; Ocean Studies Board; Division on Earth and Life Studies; National Research Council. 2012

The effect of SLR on project effectiveness was investigated by varying the tidal boundary conditions for the 1999 flood simulation. This flood was selected as tidal impacts are greater in smaller events; larger floods will push tidal impact farther towards the bay. The observed Garibaldi tides were increased and decreased by one and two feet and the changes to water surface profiles examined.

In general, an increase of 1 foot did not substantially change project effectiveness over the majority of the area currently benefited. At 2 feet, most of the benefits below Highway 101 on the Wilson River were lost. Flood level reductions remained about the same along the Highway Corridor and upstream.

It appears likely that the project will remain near fully effective through 2050, when only an additional 6 inches of SLR is predicted. As the rate of rise accelerates beyond this, the lower portions of the project benefit area will see decreasing effectiveness. By 2100, only the Highway 101 corridor and areas upstream will still be receiving project benefits.

The analysis is somewhat conservative because the 1999 tide that was adjusted was very high. There were six floods greater than 20,000 cfs on the Wilson River in water years 2000-2013. The average high tide in these floods was 10.0 feet NAVD88, but the November 1999 tide was 11.2. Thus, an 'average' high tide occurring during a river flood appears to be around a foot lower than was simulated. This would suggest that the average impacts in 2100 from SLR rise would be closer to the one-foot rise scenario than the two-foot scenario, and that fairly widespread project benefits will still exist in 2100.

In summary, project effectiveness under mean SLR scenarios should be good for at least 50 years, and some, possibly most of the benefits will remain in 2100.

4 SUMMARY OF MODEL AND PROJECT PERFORMANCE

We have presented all the available high water marks and observed time series data available. Calibration errors for the hydraulic model average close to zero (i.e. are balanced high and low) and have a RMSE of 1.14 ft. The three time series available for comparison show timing and river-tidal interaction patterns are well reproduced, but water levels tend to under-simulated.

Sensitivity testing of lateral weir coefficients, overbank roughness values, and tributary inflow timing showed the model was relatively insensitive to all three factors. Mean changes in flood depth reduction were near zero in all cases. Larger changes were limited to a few specific reaches or areas outside the project area of influence.

We believe that the project will continue to provide flood damage reduction benefits under increased peak flows and/or channel aggradation in the future. The effects of sea level rise were evaluated and the project should provide good benefits past 2050, and possibly to 2100, using the latest mean SLR predictions.

In summary, we believe the analysis of the model has shown that it is well calibrated, accurate, insensitive to changes in key parameters, and resilient to future changes in climate, sea level, and sediment. As a result, we have a high level of confidence in the model predictions of flood level reduction due to the Southern Flow Corridor project.

Sincerely,

Northwest Hydraulic Consultants Inc.

Prepared by:

Vaughn Collins, P.E.
Senior Engineer

Appendix F
Mercury Risk Memorandum

Memorandum

To: *Kate Stenberg, CDM Smith Project Manager*

From: *Steve Dent, CDM Smith Environmental Engineer/Scientist*

Date: *December 29, 2014*

Subject: *Comparison of Mercury Conditions Related to the Southern Flow Corridor Project, Tillamook, OR*

This memorandum addresses the question of whether or not the tidal wetland restoration activity at the Southern Flow Corridor Project is expected to result in concerning levels of methylmercury (MeHg) formation. MeHg is the form of mercury that accumulates in the aquatic food-web. This question is raised due to concern over observed increases in MeHg production and subsequent food-web accumulation from restored salt marshes around the San Francisco Bay area, a water body greatly impacted by historic gold and mercury mining activity. The Southern Flow Corridor Project is located alongside Tillamook Bay, which is not impacted by elevated mercury loading, and a restored wetland within this aquatic ecosystem would not be expected to result in problematic increases in food-web mercury uptake.

Mercury Cycle in Tidal Wetlands

The restoration of drain tiled farm land back to tidal wetlands in areas with elevated mercury sediment has been shown to increase the accumulation of mercury in the local aquatic food web (Yee et al. 2008; Davis et al. 2003). In most cases, flooding land to reestablish wetlands, both freshwater and saltwater, will generate zones of productive sediments. Productive sediment zones are highly active with sulfate reducing bacteria, one of the key environmentally relevant microorganisms known for methylating mercury as a byproduct of their metabolism (Benoit et al., 2003). Considering free MeHg is short lived, MeHg production is commonly quantified as the fraction of MeHg of total mercury (Gilmour et al., 1998). MeHg in sediment above 1 percent is considered enhanced in terms of MeHg production. In tidal wetlands, MeHg fraction of total mercury has been observe to be over 6 percent (Hollweg et al., 2009; Benoit et al., 2003), illustrating the intensity of the productive aquatic system.

San Pablo Bay is an example of a tidal system with a number of salt marshes along its perimeter and tributaries. For example, the Gambinini, Mid-Petaluma, and Black John tidal marshes located on the tidal reach of the Petaluma River, a tributary to San Pablo Bay, have elevated MeHg values at ≥5 micrograms per liter (µg/kg) or ≥1.7 percent MeHg of total mercury (Yee et al., 2008). Sediment concentrations within the bay are heavily impacted by runoff of historic hydraulic mining debris that contained high concentrations of mercury. Studies have quantified sediments within the Bay averaging 350 µg/kg total mercury (Table 1). In a study of sediment from 259 stream basins downgradient of historic gold or mercury mines, the U.S. Geological Survey (USGS) reported concentrations averaging 175 µg/kg and a maximum of 4,500 ug/kg, which can be used as a relative metric for mercury impacted sediments (Scudder et al., 2009). Results from the San Pablo Bay sediments suggest it is on the higher end of mercury contamination, or at lease well above the average, compared to other impacted sediment basins around the United States. Based on the high capacity of salt marsh productivity and elevated mercury methylation, heavy mercury contamination can readily translate into elevated MeHg concentrations in the sediment as seen with tidal marshes along the Petaluma River. Considering this, the general understanding is that the conversion of agricultural land to restored salt marsh in areas such as within the San Pablo Bay would result in enhanced mercury uptake in the food-web (Davis et al., 2003).

Table 1. Total Mercury in Sediment/Soil

	Tillamook Bay Sediments[a], n=8	Coast Range Sediment/Soil[b], n=125	National Bed Sediment (unmined basins)[c], n=86	National Bed Sediment (mined basins)[c], n=259	San Pablo Bay Sediments (mercury impacted tidal restoration)[d], n=6
	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
Mean	14	45	89*	175**	350
Max	30.4	310	2480	4520	400

[a]National Coastal Assessment-Pacific Insular, EMAP-West Coast

[b]Oregon Department of Environmental Quality (ODEQ), 2013

[c]Scudder et al., 2009

[d]Hornberger et al., 1999 and Marvin-DiPasquale et al., 2003

*Median = 30 µg/kg

**Median = 49 µg/kg

Mercury Conditions at the Southern Flow Corridor Project

Concentrations of mercury around the Southern Flow Corridor Project, Tillamook Bay, are significantly lower than concentrations observed around constructed wetlands that have had issues with exacerbating mercury accumulation in the aquatic food-web (Table 1). Tillamook Bay sediments are relatively low in total mercury concentrations, with an average of 14 µg/kg and a maximum of 30 µg/kg. The average concentration for the greater Oregon Coast Range sediment is approximately 45 µg/kg, with a maximum of 310 µg/kg, indicating that the area around Tillamook Bay is on the low end of mercury concentrations for the region. In the USGS study of national basin sediments, average mercury concentrations of 89 µg/kg were found in unmined basins and175 µg/kg in mined sediment, putting Tillamook on the low end as compared to both mercury impacted and unimpacted sediments nationally. Finally, Tillamook Bay sediment is more than an order of magnitude lower than total mercury concentrations found in and around San Pablo Bay, an area that has tidal salt marshes with concerning concentrations of MeHg.

While it is expected that the generation of MeHg will most likely increase with the introduction of restored wetlands for the Southern Flow Corridor Project relative to current conditions within the agricultural lands, the increase would not be expected to generate MeHg to a level of concern. The concentrations of total mercury in Tillamook Bay are low for both the values typically found in unimpacted sediment basins nationally and in sediment within the Oregon Coast Range.

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Appendix G
Biological Resources Technical Memorandum

Biological Resources Technical Memorandum

Southern Flow Corridor Project

DR-1733-OR

Tillamook County, Oregon

April 2015

This document was prepared by

CCPRS

Fast Response. Smart Recovery.

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Acronyms and Abbreviations

µs	microsiemens
API	area of potential impact
APP	Avian Protection Plan
BA	biological assessment
BGEPA	Bald and Golden Eagle Protection Act
BMP	best management practice
CCMP	Comprehensive Conservation Management Plan
CFR	Code of Federal Regulations
CRC	Columbia River Crossing
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
dbh	diameter at breast height
DPS	Distinct Population Segment
DSL	Oregon Department of State Lands
E&S	E & S Environmental Chemistry, Inc.
EFH	essential fish habitat
EIS	environmental impact statement
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FEMA	Federal Emergency Management Agency
FR	Federal Register
ft	feet
FWCA	Fish and Wildlife Coordination Act
HOT	Highest Observed Tide
LWI	Local Wetland Inventory
m	meter

MBTA	Migratory Bird Treaty Act
MMPA	Marine Mammal Protection Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NEPA	National Environmental Policy Act
NHC	Northwest Hydraulic Consultants
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NWA	Noxious Weed Act
NWI	National Wetlands Inventory
OAR	Oregon Administrative Rules
ODA	Oregon Department of Agriculture
ODFW	Oregon Department of Fish and Wildlife
ORBIC	Oregon Biodiversity Information Center
ORS	Oregon Revised Statutes
PCE	Primary Constituent Element
PDC	Project Design Criteria
PFMC	Pacific Fishery Management Council
PROJECTS	Programmatic Restoration Opinion for Joint Ecosystem Conservation by the Services
SFC	Southern Flow Corridor
TBNEP	Tillamook Bay National Estuary Project
TEP	Tillamook Estuaries Partnership
UGB	urban growth boundary
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

SECTION 1 Introduction

The purpose of the biological resources investigation is to describe the existing resources in the vicinity of the Southern Flow Corridor (SFC) project and evaluate potential impacts on these resources. Biological resources, including vegetation, fish and wildlife, threatened and endangered species, and designated critical habitats, may be protected by federal, state, and local laws and policies. The biological resources investigation also addresses the Oregon Conservation Strategy, a non-regulatory program intended to provide a long-term, big-picture "blue print" for conserving Oregon's natural resources to maintain or improve environmental health for today and for future generations (Oregon Department of Fish and Wildlife [ODFW] 2006).

This technical memorandum outlines the process of data collection and data analysis that was used for drafting the biological resources sections of the environmental impact statement (EIS). Federal, state, and local regulations that provide the legal authorities are described in Section 2. A description of current conditions, also in Section 2, provides baseline conditions, the starting point for analyzing the No Action Alternative, and changes that would occur under the action alternatives. The memorandum describes data sources, approaches for conducting the impact analysis, results of the impact analysis, and measures to mitigate potential adverse impacts, followed by a summary of conclusions.

The study area supports a number of threatened or endangered species, and the Proposed Action has the potential to significantly improve long-term conditions for some species of fish and wildlife while other species may be negatively impacted. Effects on terrestrial wildlife species listed as threatened or endangered under the federal Endangered Species Act (ESA) will be addressed in detail in a separate biological assessment (BA) prepared by the U.S. Fish and Wildlife Service (USFWS) and summarized in the EIS.

Non-listed species such as Bald eagles and migratory birds are protected under other laws as described in Section 2.1.1. Protection of these wildlife would include the implementation of avoidance and minimization measures as tracked through compliance with permits issued by USFWS. Proposed avoidance and minimization measures are described in greater detail in Section 4.1.

Scoping comments from federal and state agencies, stakeholders, and the public assisted in identifying issues that should be addressed in evaluating biological resources (Federal Emergency Management Agency [FEMA] 2014). Comments were received about potential project changes to the physical environment (i.e., transport of contaminants, sediment transport and deposition, hydraulics, filling of drainage ditches, removal of or breaches in levees, and changes to area of tidal and flood influence) that might affect (adversely or beneficially) habitat for fish, avian communities and other wildlife, and restoration of plant communities. Commenters recognized the SFC study area has been altered by humans over the past 125 years. Comments were raised about potential benefits of restoring historical ecological processes and functions compared with potential benefits of No Action.

Objectives of the biological resources evaluation include the following:

- Identify important biological resources within the study area.
- Conduct a reconnaissance-level field review of the study area to describe potential fish and wildlife habitat conditions and plant communities that may be affected by the project.
- Describe potential impacts on biological resources that may result from the project's action alternatives, including short-term construction impacts, transitional period impacts, and long-term impacts.
- Propose mitigation measures to avoid, minimize, and compensate for significant detrimental impacts.

Potential effects of four project alternatives are evaluated:

- No Action Alternative
- Alternative 1, Southern Flow Corridor – Landowner Preferred Alternative (also referred to as the Proposed Action)
- Alternative 2, Hall Slough Alternative
- Alternative 3, Southern Flow Corridor – Initial Alternative (also referred to as Alternative 3)

Detailed descriptions of the alternatives appear in Section 3 of the EIS.

SECTION 2 Methodology

The framework for evaluating impacts involved a number of steps described in this section. Impact evaluations were conducted within the context of federal, state, and local statutes, regulations, and guidance. The regulatory framework provides the legal basis for making determinations of significance. The area of potential impact defines the spatial extent for the analyses and is the area for which baseline conditions were described. The impact evaluation evaluated the potential effects of the action alternatives to assess potential changes (detrimental and beneficial) on vegetation, fish, and wildlife as compared to conditions under the No Action Alternative.

2.1 Regulatory Framework

Impact evaluations were conducted within the context of the following federal, state, and local statutes, regulations, and guidance.

2.1.1 Federal Authorities and Regulations

Endangered Species Act (ESA) (7 United States Code [U.S.C.] 136; 16 U.S.C. 1531 et seq.)

Section 7 of the federal ESA (16 U.S.C. § 1536) requires federal agencies to consult with USFWS or the National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS), as appropriate, to ensure actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of threatened or endangered species or result in the destruction or adverse modification of critical habitat. A biological assessment was drafted by USFWS to provide an evaluation of potential effects to Marbled murrelet under the Proposed Action, and a separate evaluation is being conducted by NMFS for Oregon Coast coho salmon and other species under their jurisdiction.

Section 9 of the federal ESA (16 U.S.C. § 1538) prohibits the "take" of any plant, fish, or wildlife species listed under the federal ESA as endangered unless otherwise authorized by federal regulations. Under the federal ESA, "take" is to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct.

Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801-1884)

Also known as the Sustainable Fisheries Act (Public Law [P.L.] 104-297), MSA designates essential fish habitat (EFH) for certain commercially managed marine and anadromous fish species. The EFH provisions of the MSA are designed to protect fisheries habitat of commercially managed species, including anadromous fish species, from being lost because of disturbance and degradation. The MSA requires all federal agencies to consult with the Secretary of Commerce on activities or proposed activities that are authorized, funded, or undertaken by that agency that may adversely affect EFH. MSA consultation is typically conducted between the lead federal agency and NMFS in conjunction with ESA Section 7 consultation.

Fish and Wildlife Coordination Act (FWCA) (16 U.S.C. 661 et seq.)

The FWCA provides the basic authority for USFWS involvement in evaluating impacts on fish and wildlife from proposed water resource development projects. It requires that fish and wildlife resources receive equal consideration to other project features. It also requires federal agencies that construct, license, or permit water resource development projects to first consult with USFWS and NMFS and the respective state fish and wildlife agency regarding the impacts on fish and wildlife resources and measures to mitigate these impacts. Under the FWCA, USFWS would prepare an FWCA report that includes an evaluation of impacts on fish and wildlife from the project and required mitigation measures and other recommendations to address these impacts.

Pacific Coast Salmon Fishery Management Plan (Pacific Fishery Management Council 2014)

The Pacific Coast Salmon Management Plan guides management of salmon fisheries in federal waters off the coast of Washington, Oregon, and California. The plan covers the coastwide aggregate of natural and hatchery salmon encountered in ocean salmon fisheries and provides management objectives and allocation provisions for Chinook, coho, and pink salmon. The plan also includes identification of EFH for Chinook, coho, and pink salmon in ocean, estuary, and freshwater and contains recommendations for measures to avoid or mitigate for impacts on salmon EFH and a description of the social and economic fishery characteristics.

Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703 et seq.)

The MBTA protects selected species of birds that cross international boundaries (i.e., species that occur in more than one country at some point during their annual life cycle). The law prohibits anyone to pursue; hunt; take; capture; kill; attempt to take, capture, or kill; possess; offer for sale; sell; offer to purchase; purchase; deliver for shipment; ship; cause to be shipped; deliver for transportation; transport; cause to be transported; carry or cause to be carried by any means whatever; receive for shipment, transportation, or carriage; or export, at any time, or in any manner, any migratory bird or any part of an active nest or egg of a migratory bird. The MBTA (Division E, Title I, Section 143 of the Consolidated Appropriations Act, 2005, (P.L. 108-447) amends the MBTA such that non-native birds or birds that have been introduced by humans to the United States or its territories are excluded from protection under the Act. It defines a native migratory bird as a species present in the United States and its territories as a result of natural biological or ecological processes.

Marine Mammal Protection Act (MMPA) (16 U.S.C. 1361 et seq.)

The MMPA prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas and the importation of marine mammals and marine mammal products into the U.S. Take includes harassment or harm. If a project could result in harassment, then the project would require an Incidental Harassment Authorization to be issued by NMFS.

Clean Water Act (CWA) (33 U.S.C. 1251 et seq.)

CWA is the primary federal law protecting the quality of the nation's waters, including lakes, rivers, coastal wetlands, and groundwater. The primary objective of the CWA is to maintain or improve the nation's water quality, in part, by reducing or preventing discharges of both point and nonpoint sources of pollution. The primary principle is that any pollutant discharge into the nation's waters is prohibited unless specifically authorized by a permit; permit review is the CWA's primary regulatory tool. Several sections of the CWA apply to this project: Section 303 (Water Quality Standards and Implementation Plans), Section 401 (Water Quality Certification), Section 402 (National Pollutant Discharge Elimination System), and Section 404. Section 404 of the CWA authorizes the United States Army Corps of Engineers (USACE) to issue permits for the discharge of dredged or fill material into any water of the United States (U.S.), including wetlands (33 U.S.C. 1344). The United States Environmental Protection Agency guidelines (40 Code of Federal Regulations [CFR] 230 et seq.) and USACE regulatory guidelines (33 CFR 320 et seq.) are the substantive environmental criteria used to evaluate permit applications submitted to USACE.

Executive Order 11990 – Protection of Wetlands (42 Federal Register [FR] 26961)

Protection of Wetlands requires federal agencies to take action to minimize the destruction or modification of wetlands by considering both direct and indirect impacts on wetlands. Furthermore, Executive Order 11990 requires that federal agencies proposing to fund a project that could adversely affect wetlands consider alternatives to avoid such effects. FEMA's regulations implementing Executive Order 11990 are codified in 44 CFR § 9.

Executive Order 11988 – Floodplain Management (42 FR 26951)

Floodplain Management requires federal agencies to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative.

Bald and Golden Eagle Protection Act (BGEPA) (16 CFR 668)

The BGEPA requires measures to prevent the harassment and take of Bald eagles resulting from human activities. The BGEPA provides for the protection of the Bald eagle and the Golden eagle (as amended in 1962) by prohibiting the take, possession, sale, purchase, barter, transport, export, or import of any Bald or Golden eagle, alive or dead, including any part, nest, or egg, unless allowed by permit.

Noxious Weed Act (NWA) (7 U.S.C. 2801 et seq.)

NWA established a federal program to control the spread of noxious weeds, giving the Secretary of Agriculture the authority to designate plants as noxious weeds by regulation and prohibiting the movement of all such weeds in interstate or foreign commerce except under permit. The Secretary was also given authority to inspect, seize, and destroy products and quarantine areas, if necessary to prevent the spread of such weeds. The Act also authorized the Secretary of Agriculture to cooperate with other federal, state, and local agencies; farmers associations; and private individuals in measures to control, eradicate, or prevent or retard the spread of such weeds.

Executive Order 13112 Invasive Species (64 FR 6183)

Invasive Species requires federal agencies to prevent the introduction of invasive species; provide for their control; and minimize the economic, ecological, and human health impacts that invasive species cause. Specifically, Executive Order 13112 requires that federal agencies not authorize, fund, or implement actions likely to introduce or spread invasive species unless the agency has determined the benefits outweigh the potential harm caused by invasive species and all feasible and prudent measures to minimize harm have been implemented.

Tillamook Bay National Estuary Project Comprehensive Conservation Management Plan (CCMP)

The Tillamook CCMP was published in 1999 and sets forth a 10-year action plan for the protection and enhancement of Tillamook Bay's natural resources.

Coastal Zone Management Act (CZMA) (16 U.S.C. 33)

It is the national policy to preserve, protect, develop, and where possible, restore or enhance the resources of the nation's coastal zone for this and succeeding generations. Additionally, the act encourages and assists states to exercise effectively their responsibilities in the coastal zone through the development and implementation of management programs to achieve wise use of the land and water resources of the coastal zone, giving full consideration to ecological, cultural, historic, and esthetic values as well as the needs for compatible economic development. At a minimum, programs should provide for the protection of natural resources, including wetlands, floodplains, estuaries, beaches, dunes, barrier islands, coral reefs, and fish and wildlife and their habitat, within the coastal zone.

Management of coastal development should minimize the loss of life and property caused by improper development in flood-prone, storm surge, geological hazard, and erosion-prone areas and in areas likely to be affected by or vulnerable to sea level rise, land subsidence, and saltwater intrusion and the destruction of natural protective features such as beaches, dunes, wetlands, and barrier islands.

In Oregon, the Department of Land Conservation and Development administers the CZMA and is responsible for certifying projects are consistent with the Act.

2.1.2 State Authorities and Regulations

Oregon Endangered Species Act (Oregon Revised Statutes [ORS] 496 et seq.)

Project activities that may impact or take plant species protected under the Oregon Endangered Species Act require consultation with the Oregon Department of Agriculture or Oregon Department of Fish and Wildlife, and compliance with the no net loss policy for impact mitigation.

Fish Passage (ORS 496.138)

Fish passage rules prohibit constructing and maintaining any artificial obstruction across any waters of the state that are inhabited, or were historically inhabited, by native migratory fish without providing passage for native migratory fish. For the SFC project, potential actions that could trigger fish passage review and permitting could be construction of tide gates, modifying or constructing new culverts or bridges, or constructing new channels in a manner that would prevent stranding or entrapment.

Timing of In-Water Work to Protect Fish and Wildlife Resources

ODFW under its authority to manage Oregon's fish and wildlife resources publishes guidelines for timing of in-water work (ODFW 2008). The guidelines provide the public a way of planning in-water work during periods of time that would have the least impact on important fish, wildlife, and habitat resources. Work within waters of the state is generally limited to the in-water work windows unless variances are granted for specific activities.

Fish and Wildlife Habitat Mitigation (ORS 496.012, ORS 496.138, ORS 506.109, ORS 506.119)

It is the fish and wildlife habitat mitigation policy of ODFW to require or recommend, depending upon the habitat protection and mitigation opportunities provided by specific statutes, mitigation for losses of fish and wildlife habitat resulting from development actions. Priority for mitigation actions is given to habitat for native fish and wildlife species. Mitigation actions for nonnative fish and wildlife species may not adversely affect habitat for native fish and wildlife. ODFW applies the requirements of the mitigation policy when implementing its own development actions and when developing recommendations to other state, federal, or local agencies regarding development.

Oregon Conservation Strategy

The Conservation Strategy is an effort to use the best available science to create a broad vision and conceptual framework for long-term conservation of Oregon’s native fish and wildlife as well as various invertebrates and native plants. It is a guide, as opposed to a regulation that requires compliance, for conserving the species and habitats that have defined the nature of Oregon and is intended to help ensure Oregon’s natural treasures are passed on to future generations. The Conservation Strategy outlines goals and strategies for conservation, identifies key conservation issues, and identifies habitats and species of special concern.

Oregon Removal-Fill Law (ORS 196 et seq.)

In recognition of the ecological functions and benefits of wetlands to the public, the Oregon legislature created a policy to protect and conserve wetland resources and other waters (streams and lakes) of the state. Through its review and permitting authority, the Oregon Department of State Lands regulates removing material from or depositing material into waters of the state. Mitigation may be required when removal or fill is unavoidable. The law has provisions for permitting restoration projects.

Oregon Noxious Weed Control Law (ORS 561)

The Noxious Weed Control Law authorizes the Oregon Department of Agriculture (ODA) to protect Oregon’s natural resources from the invasion and proliferation of exotic noxious weeds, including the implementation of weed control and management projects.

Oregon State-Wide Planning Goals and Guidelines (Oregon Administrative Rules [OAR] 660-015-0000[1-6, 8-14], OAR 660-015-0005, and 660-015-0010[1-4])

There are 19 statewide planning goals that outline Oregon’s land use policies. The goals are accompanied by guidelines on how a goal may be implemented. The goals relate to citizen involvement, land use planning, natural resources, recreation, economic development, housing, transportation, and energy.

2.1.3 Local Authorities and Regulations

The Tillamook County Comprehensive Plan (1982-2004) and the implementing Land Use and Land Division Ordinances were prepared and adopted by Tillamook County in compliance with Oregon's Statewide Planning Goals and Guidelines, statutes, and administrative rules. The plan and implementing ordinances provide findings, policies, and regulations that protect resource lands and manage growth in Tillamook County.

Tillamook County land use regulations apply to the use of public and private lands in the County and include designation of areas within the urban growth boundaries, rural development, farmlands, forest resource management, and coastal zone management, in compliance with Statewide Planning Goals.

2.2 Thresholds of Significance

Context and intensity were considered when assessing significance of impacts. Context is provided at various scales of the geographic and biophysical setting, including local, landscape, regional, national, or global. Intensity is the severity or magnitude of the effects, both detrimental and beneficial, within the geographic and biophysical context. For biological resources, intensity or magnitude is analyzed in terms of effects to individuals at a local level; a population at a landscape or regional level; or a species in a regional, national, or global scale. Intensity or magnitude also has a temporal component (for example, short term, transitional, or long term,), and the level of effect was described in terms such as, but not limited to, behavioral harassment, physiological harm, or lethal for animals and change in species composition, structure, or diversity for plant communities.

Authorities and regulations listed in Section 2.1 provide the thresholds that would trigger issues requiring analysis of significance. If an action that could affect a regulated resource is so minor, after environmental commitments, that it would not trigger a permit review, then it is unlikely to be a significant action. Actions that would trigger a regulatory review may not be significant if they can be avoided or minimized through implementation of environmental commitments or standardized mitigation measures (for example, statutory wetland mitigation that may be required under a federal Section 404 dredge permit or Oregon Department of State Lands removal-fill permit). However, if an action would exceed regulatory standards, environmental commitments cannot be implemented, and standard mitigation measures are not feasible, then a detrimental effect would be considered significant.

With respect to biological resources, an action could be significant if the results of the action would directly or indirectly cause permanent loss, degradation, disturbance, or fragmentation to the habitats of native species or their populations that might be expected to occur naturally within the project area in the absence of landscape modifications such as levees. Detrimental effects on sensitive habitats, natural communities, and special status species that are afforded protection under federal law or regulation were evaluated for context and intensity.

Table 2.1 defines terms and criteria used in describing the scale of impacts on biological resources. The scale of impacts applies to the consequences of both beneficial and detrimental impacts.

Table 2.1. Assessment Criteria by Scale of Impact

Impact Scale	Criteria
None/Negligible	The resource area would not be affected, or changes would be either non-detectable or, if detected, would have effects that would be slight, temporary, and local. Impacts would be below regulatory standards, as applicable.
Minor	Changes to the resource would be measurable although the changes would be small, temporary, and localized. Impacts would be within or below regulatory standards, as applicable. Environmental commitments would reduce potential adverse effects.
Moderate	Changes to the resource would be measurable and have both localized and regional scale impacts. Impacts would be within or below regulatory standards, but historical conditions would be altered on a short-term basis. Environmental commitments would reduce potential adverse effects, and mitigation measures would be necessary to reduce significant effects.
Major	Changes would be readily measurable and would have substantial consequences on a local and regional level despite environmental commitments. Impacts would exceed regulatory standards. Mitigation measures to offset the adverse effects would be required to reduce impacts though long-term changes to the resource would be expected.

2.3 Area of Potential Impact

The area of potential impact (API) is the spatial extent for each alternative where there could be effects on biological resources, including vegetation, wetlands, fish and wildlife, and threatened and endangered species, and their critical habitats. For this project, it includes portions of the City of Tillamook, Tillamook Bay, the Tillamook River, Trask River, and Wilson River as well as Blind Slough, Hall Slough, Dougherty Slough, Hoquarten Slough, and Nolan Slough (**Figure 1**).

The API, at a minimum, includes the project footprint, or the area in which construction would occur. The API can extend beyond the project footprint to the limits of potentially significant project effects. The API is ultimately defined by the spatial limits of thresholds that could have significant impacts on vegetation, wetlands, fish and wildlife, and threatened and endangered species. For example, the API would extend downstream of the footprint to include a measurable stream turbidity plume to the point where a threshold of significance (as defined in regulations and rules) would no longer be exceeded. Similarly, noise thresholds during construction, in air or underwater, may extend the API to a larger area than the project footprint.

The API defines the study area for this evaluation and is comprised of the composite footprint of the three identified action alternatives: the Proposed Alternative, the Hall Slough Alternative, and Alternative 3. All detrimental effects are assumed to be expressed within this footprint after considering the environmental commitments described in Section 4 of this document. Although beneficial effects of action alternatives probably would be expressed across Tillamook Bay, the waterbody outside the project footprint is not included in the API.

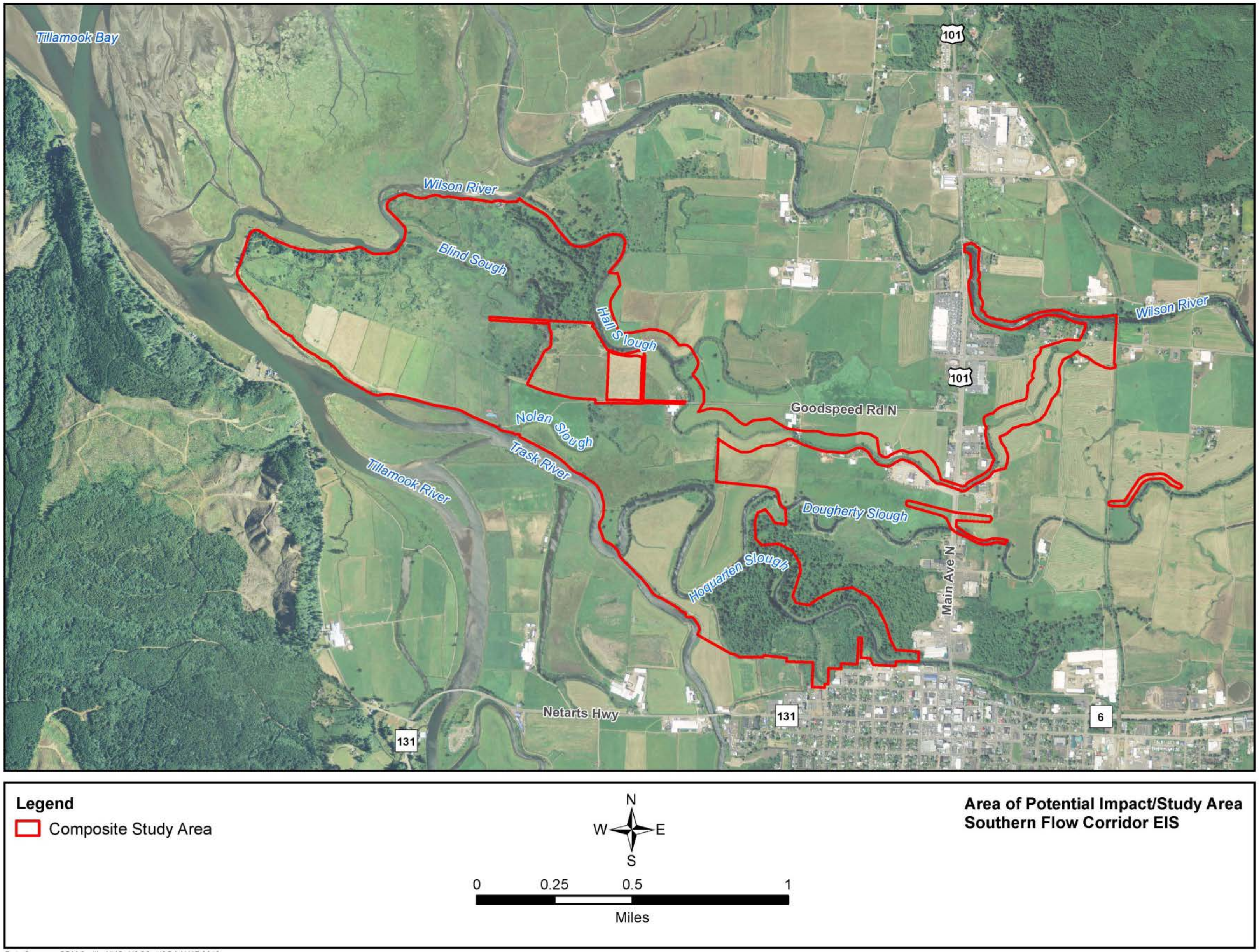


Figure 1. Area of Potential Impact (API)/Study Area Map

2.4 Data Collection Methods

Methods involved reviewing existing data, qualitatively observing field project site conditions (i.e., field reconnaissance), and analyzing potential impacts on vegetation, wetlands, fish and wildlife, and threatened and endangered species. Biological studies were completed or are in progress for the SFC project. Except for the field review described in Section 2.4.2, this National Environmental Policy Act (NEPA) evaluation is based on data collected by the applicants, cooperating natural resources agencies, and from publicly available scientific literature.

2.4.1 Existing Data Review

Baseline information was used to analyze potential impacts (detrimental and beneficial) on biological resources (generally) and federal ESA-listed species (specifically) of the SFC project. The following information was obtained from publicly available sources and from data provided by the applicants:

Physical Environment

- Tidal elevations
- Elevations or topographic mapping of interior landscapes currently protected by levees
- To the extent available, frequency, duration, and depth of daily and seasonal (1- to 2-year events) flooding in landscapes currently protected by levees based on project-specific hydraulic modeling
- Historic aerial photographs/maps and descriptions of the geophysical environment
- Wetland boundaries
- General mapping of land use, aquatic, riparian, wetland, and upland habitats in the study area
- Locations, descriptions, and condition of tide gates
- Literature-based models of potential sea level change as a result of climate change

Biotic Environment

- Fish presence and distribution
- Terrestrial and aquatic wildlife presence and distribution
- Description and mapping of plant communities
- Descriptions of response of plant and animal communities at other projects (case studies) in coastal Oregon where levees have been breached, removed, or set back to restore historic floodplain habitat

According to USFWS, ESA-listed species of plants are not present in the study area, and protocol surveys for rare plants are not required. USFWS drafted a biological assessment for their trust resources (USFWS 2015a) and concluded no detrimental effects for plants. Presence and distribution of fish and wildlife and threatened and endangered species was obtained from existing literature and personal communications with natural resource agency staff (NMFS, USFWS, and ODFW).

The following sources were used for the biological resources study:

- project-specific reports and data completed or in progress by others, including baseline monitoring and wetland delineation results
- draft biological assessment prepared by USFWS
- project-specific and programmatic biological opinions issued by NMFS and USFWS for similar types of projects
- Oregon Biodiversity Information Center (ORBIC) database
- U.S. Department of Commerce tide charts
- project-specific (as available) and U.S. Geological Survey topographic mapping
- case studies of similar projects where estuarine levees have been breached or removed
- descriptions of species, their distribution, and status from agency reports, scientific literature, and species recovery plans
- U.S. Natural Resources Conservation Service soil mapping
- University of Oregon and U.S. Army Corps of Engineers map/aerial photography libraries
- National Wetlands Inventory
- Other pertinent scientific literature.

2.4.2 Field Review

A reconnaissance-level field verification of the study area was conducted on June 30, 2014 to visually assess existing habitat conditions. The field review encompassed areas where construction disturbance would occur under the action alternatives. Participants in the field visit included Jay Lorenz/CCPRS (Lead Biologist), Peggy O'Neill/CCPRS (Botanist/Wetlands Biologist), Casey Storey/WHPacific (Fish and Wildlife Biologist), Robin McClintock/CCPRS (Cultural Resources Scientist), and Paul Levesque/Tillamook County (Tillamook County Chief of Staff). Weather on the day of the site visit was clear and dry.

Tillamook County led the field trip, taking the group to various vantage points to observe the current levee network, field and forest habitats, sloughs, and rivers. Tillamook County provided the group with historical information about how the levees were originally created and other general land-use history. Biology staff took notes on general habitat and kept a list of incidental bird observations. No Bald eagles or Bald eagle nests were observed during the site visit.

2.5 Impact Analysis Methodology

This impact analysis evaluated four alternatives: the No Action Alternative, the Proposed Action, the Hall Slough Alternative, and Alternative 3. Each action alternative was compared to the No Action Alternative.

Scoping comments from the public and resource agencies informed the issues to be addressed in the EIS. The EIS focuses broadly on the wide range of habitats and species that could be affected by the Southern Flow Corridor project.

Each action alternative was evaluated against the No Action Alternative to assess potential changes to vegetation, fish, and wildlife as a consequence of the activities associated with each alternative. Oregon priority habitats/species and federal- and state-listed species were called out as subsets of the general habitat and species analysis. The observed effects of other similar projects in Oregon, Washington, and California were also used as a basis for predicting potential effects of the Southern Flow Corridor project. Analogous projects also provided temporal references to describe the pace of potential changes over time.

Several approaches were taken to project what future conditions may result from the various alternatives. Historical aerial photographs, historical records, and project-specific studies were reviewed to inform what “native” conditions may have existed prior to construction of levees and current land uses. Descriptions of existing plant communities and fish habitat at reference sites (in the vicinity of the project as well as analogous projects) were cited to describe “native” communities as well as inform the future conditions that may result as a consequence of habitat restoration. Analogous projects were used as case studies to inform potential changes and future conditions. The evaluation generally assumed that potential impacts from removal of levees and restoring tidal habitat would be similar in nature at temporal and landscape scales to the analogous projects. Site-specific hydraulic modeling conducted by the applicants, along with data on tidal elevations, were used to establish expectations for the effects of water depths that would affect what plant communities have the potential to grow under the changed or restored water regimes.

Effects of each alternative were quantified to the extent practicable and their significance evaluated against standards described in Section 2.2 above. Furthermore, comparisons were made among the alternatives to evaluate relative levels of significance among alternatives. For example, the evaluation compares the area of restored wetland habitat in floodplains among the various alternatives.

For each action alternative, the impact analysis included summaries of direct, indirect, and temporal impacts. Temporal effects were categorized as follows:

- Short term: effects occurring during construction; a period of 1 to 2 years
- Transitional: 2 to 10 years, depending on the resource; the period when plants, fish, and wildlife establish and adapt to new physical site and habitat conditions
- Long term: 10-50 years, the time frame it takes to reach and sustain a new dynamic equilibrium or restoration goal

Environmental commitments applicable to all action alternatives were acknowledged and considered for avoiding and minimizing potentially detrimental significant adverse impacts.

SECTION 3 Affected Environment

Topography of the Tillamook Bay area is typical of the Pacific Northwest coast where the terrain is characterized by steep upland slopes, which provide sediment and organic material to the alluvial plain and estuary below. Much of the lowlands were historical floodplains and wetlands that were drained and diked for agricultural purposes. Tillamook Bay area has a coastal, temperate rainforest climate influenced by the Pacific Ocean, with a mean annual precipitation of around 90 inches per year in the lower elevations (Taylor and Hatton 1999).

The proposed project lies within the Coast Range (Level III) ecoregion (Franklin and Dyrness 1988; Omernik and Gallant 1986; Thorson et al. 2003) (**Figure 2**). This ecoregion is ecologically diverse, has a marine-influenced climate, and receives plentiful precipitation three seasons of the year. Within the Coast Range ecoregion, the proposed project is located in the Level IV subdivision, Coastal Lowlands.

The Coastal Lowlands ecoregion occurs in the valley bottoms of the Oregon and Washington coast and is characterized by marine estuaries and terraces with low gradient, meandering streams. The Coastal Lowlands ecoregion contains beaches, dunes, and marine terraces below about 400 feet elevation. Wet forests, lakes, estuarine marshes, and tea-colored (tannic) streams are characteristic features of the landscape.

Current conditions reflect the human-caused changes to the landscape that have occurred since Euro-American settlement began in the 1850s. The study area was historically a tidal marsh (Coulton et al. 1996). As there were no roads, navigation by water was the primary method of transportation through the low-lying areas. Channel dredging began in the late 1880s to facilitate navigation in Hoquarten Slough (Levesque 2010). Dredged material was side-cast onto riverbanks, the original formation of dikes. Pile dikes were present in scattered locations in the 1890s (Levesque 2010). Farming, clearing forestlands, and draining wetlands continued through the early part of the 1900s. Coulton and others (1996) provide a figure (**Figure 3**) showing the land portions of the study area surrounded by dikes in the 1950s.

Most of rivers entering the area of Tillamook Bay reach flood stage each winter. In the 1970s, FEMA established the 100-year flood level at 9.0 feet (National Geodetic Vertical Datum of 1929 reported in Coulton et al. 1996). The 100-year flood level overtops most dikes and levees, which were constructed primarily as a byproduct of dredging to facilitate navigation rather than engineered primarily for flood control. Trampling by cows, burrowing by muskrats and beaver, and erosion left dikes susceptible to over-topping and breaches during severe flood events (Coulton et al. 1996). Despite the lack of modern engineering, the dikes and draining of wetlands enabled agricultural development. The combination of dredging, diking, and interior ditching to drain wetlands converted historical tidal marshes to freshwater wetlands and managed agricultural land that has been in place between the Wilson and Trask rivers for over 60 years (Tillamook Bay National Estuary Project [TBNEP] 1998b).

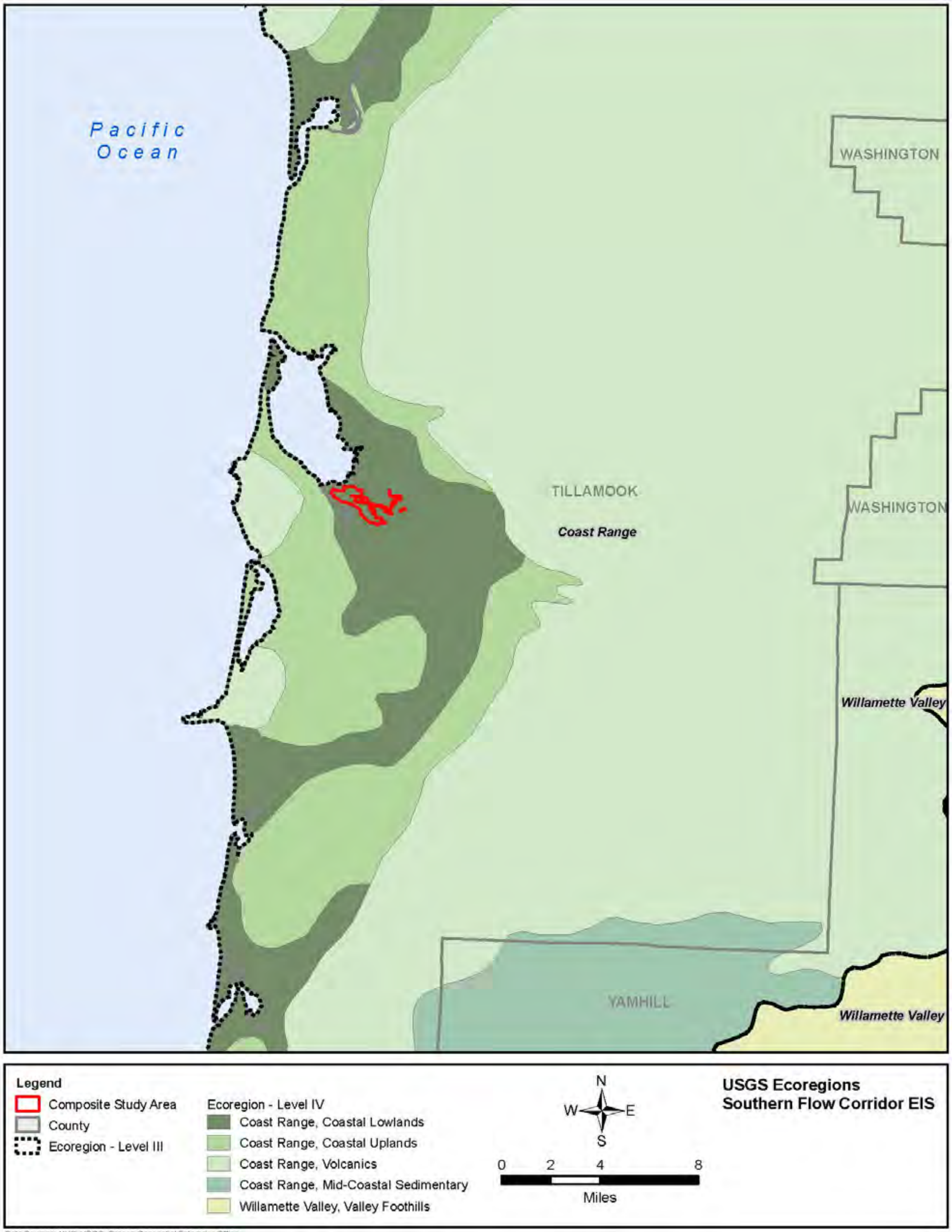


Figure 2. Ecoregions Map

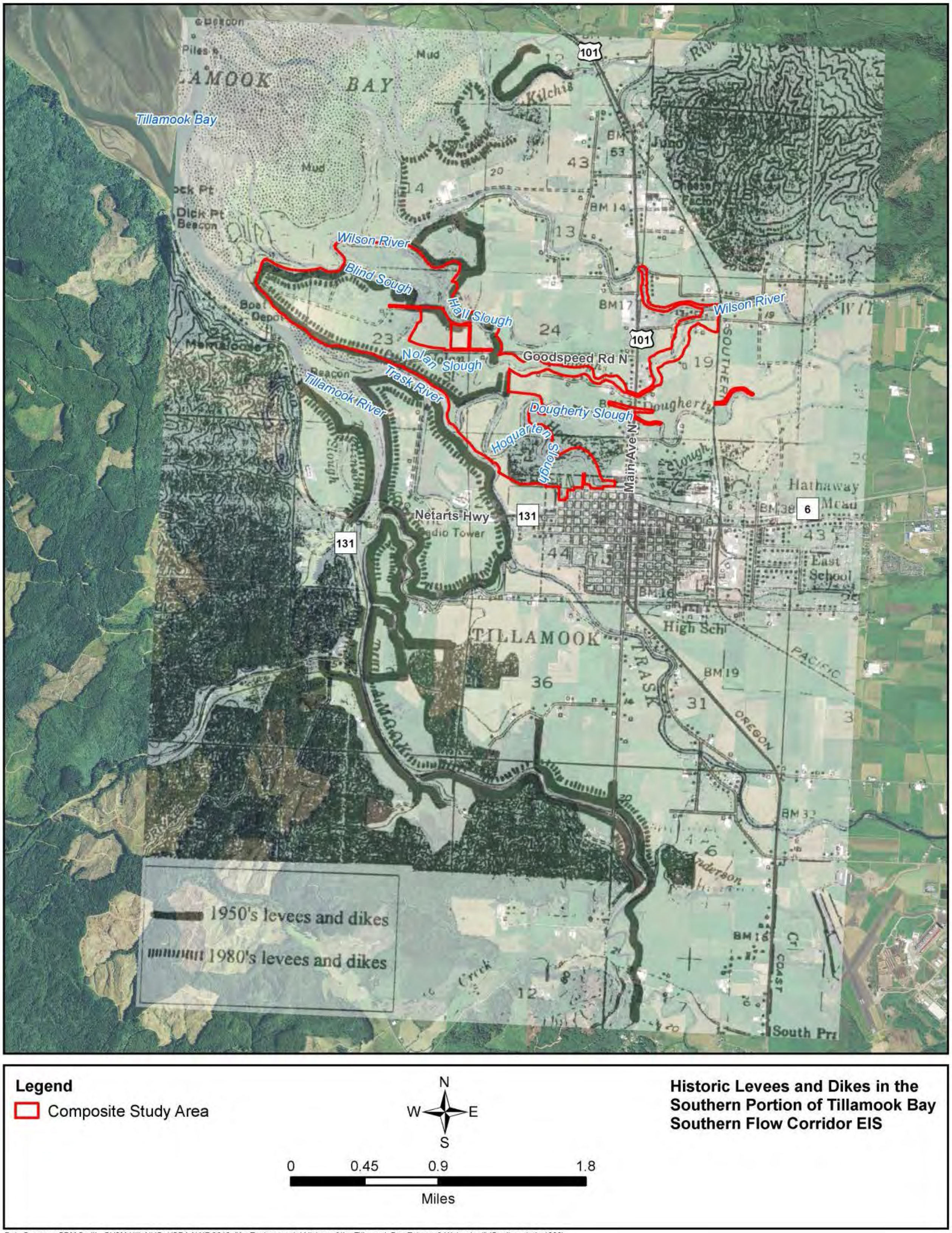


Figure 3. Historic Levees and Dikes

3.1 Vegetation

3.1.1 Overview

Vegetation cover is determined by hydrologic regime, land use, and dominant species. Human activities have greatly altered the vegetation of the study area. Historically, the Tillamook Valley floodplains were dominated by river bottom forest, which consisted of a variety of trees, including black cottonwood (*Populus balsamifera*), Sitka spruce (*Picea sitchensis*), red alder (*Alnus rubra*), western hemlock (*Tsuga heterophylla*), grand fir (*Abies grandis*), big-leaf maple (Acer macrophyllum), and western redcedar (*Thuja plicata*). Within the study area, forested bottomlands have been replaced by large open pastures and developed lands with little or no woody vegetation in the riparian areas (E&S Environmental Chemistry, Inc. [E&S] 2001). The majority of the study area is freshwater wetland (Brophy 2014a, b) with areas of tidal wetland vegetation, riparian, and upland vegetation communities. Most of these became established by diking and draining of historical tidal wetlands, rural residential development, and agricultural development.

The Tillamook Valley is an Oregon Coast Range valley bottomland (Nonaka et al. 2002). Valley bottomlands are unique ecosystems that were nearly completely forested prior to Euro-American settlement. These systems have been extensively altered as a result of agricultural use and urban development. Historically, conifer trees were more common than hardwoods in the Tillamook Valley. The predominant conifer was spruce, and bottomland areas generally supported many large spruce trees in the Tillamook area (Nonaka et al. 2002). Historical vegetation cover maps for the Tillamook Valley (Nonaka et al. 2002) suggest the eastern portion of the study area was forested at the time of early Euro-American settlement. The western portion was not tree covered (Nonaka et al. 2002). Current mapping indicates nearly all tree-covered areas in the Tillamook Valley have been lost, with most of the area converted to agriculture (Nonaka 2003).

The Tillamook Valley is located in the Sitka Spruce vegetation zone (Franklin and Dyrness 1988). It has an extensively wide valley bottom floodplain developed along major rivers that drain to the Pacific Ocean. Typical and potential natural vegetation in the study area includes Sitka spruce, western redcedar, western hemlock, Douglas-fir (*Pseudotsuga menziesii*), and grand fir in the canopy, with salal (*Galtheria shallon*), sword fern (*Polystichum munitum*), vine maple (*Acer circinatum*), and Oregon grape (*Mahonia* spp.) in the shrub layer. Riparian areas contain red alder, western redcedar, and big-leaf maple, with a salmonberry (*Rubus spectabilis*) understory. Estuaries and coastal wetlands consist of Baltic rush (*Juncus balticus*), Lyngby's sedge (*Juncus lyngbyi*), tufted hairgrass (*Deschampsia cespitosa*), Pacific silverweed (*Potentilla pacifica*), and seaside arrowgrass (*Triglochin maritime*), with shore pine (*Pinus contorta*), sweet gale (*Myrica gale*), and Hooker's willow (*Salix hookeriana*) (Franklin and Dyrness 1988). A map of vegetation communities present within the study area is presented in **Figure 4**.

Existing vegetation communities within the study area include freshwater wetland, tidal wetland, and upland (Brophy 2014b). **Table 3.1** presents a summary of vegetation communities present within the study area for each alternative. A detailed discussion of these vegetation communities follows.

Table 3.1. Summary of Existing Vegetation Communities for Each Alternative

Vegetation Community [1]	Preferred Alternative (acres)	Hall Slough Alternative (acres)	Alternative 3 (acres)	Typical Vegetation
Freshwater Wetland				
Diked emergent wetland, active pasture (2)	220.05	7.84	170.92	Pasture grasses, reed canarygrass, Pacific silverweed, soft rush
Diked emergent wetland, cropped (1)	62.69	---	62.68	Meadow foxtail, reed canarygrass
Diked emergent wetland, inactive/abandoned pasture (3)	117.49	---	115.09	Reed canarygrass, slough sedge, cat-tail, spikerush, Pacific silverweed
Diked scrub-shrub (4)	40.95	---	40.98	Hooker's willow, red elderberry
Diked forested wetland, Sitka spruce, non-tidal (6)	42.79	---	42.79	Sitka spruce, Hooker's willow, red elderberry
Diked forested wetland, red alder (7)	17.66	---	17.66	Red alder
Diked forested wetland, Sitka spruce/red alder (8)	7.81	---	---	Sitka spruce, red alder
Tidal Wetland				
Estuarine emergent (9)	2.95	---	2.95	Emergent herbaceous species include Baltic rush, Lyngby's sedge, tufted hairgrass, Pacific silverweed, seaside arrowgrass
Diked forested wetland, Sitka spruce, tidal (5)	32.93	1.34	32.93	Sitka spruce
Upland				
Riparian forested (10)	42.85	27.13	42.85	Sitka spruce/western hemlock, red alder/black cottonwood/willow
Riparian scrub-shrub (11)	1.73	1.47	---	Red alder, willow, black twinberry, Pacific crabapple, salmonberry, red elderberry, Himalayan blackberry, cutleaf blackberry, Scot's broom
Upland forested (12)	44.89	---	46.65	Sitka spruce, red alder
Upland pasture/cropped/mixed use (13)	0.03	75.96	---	Pasture grasses, hay crops, ornamental landscape vegetation

[1] *Numbers in parentheses correspond to the vegetation community numbers on* ***Figure 4.***

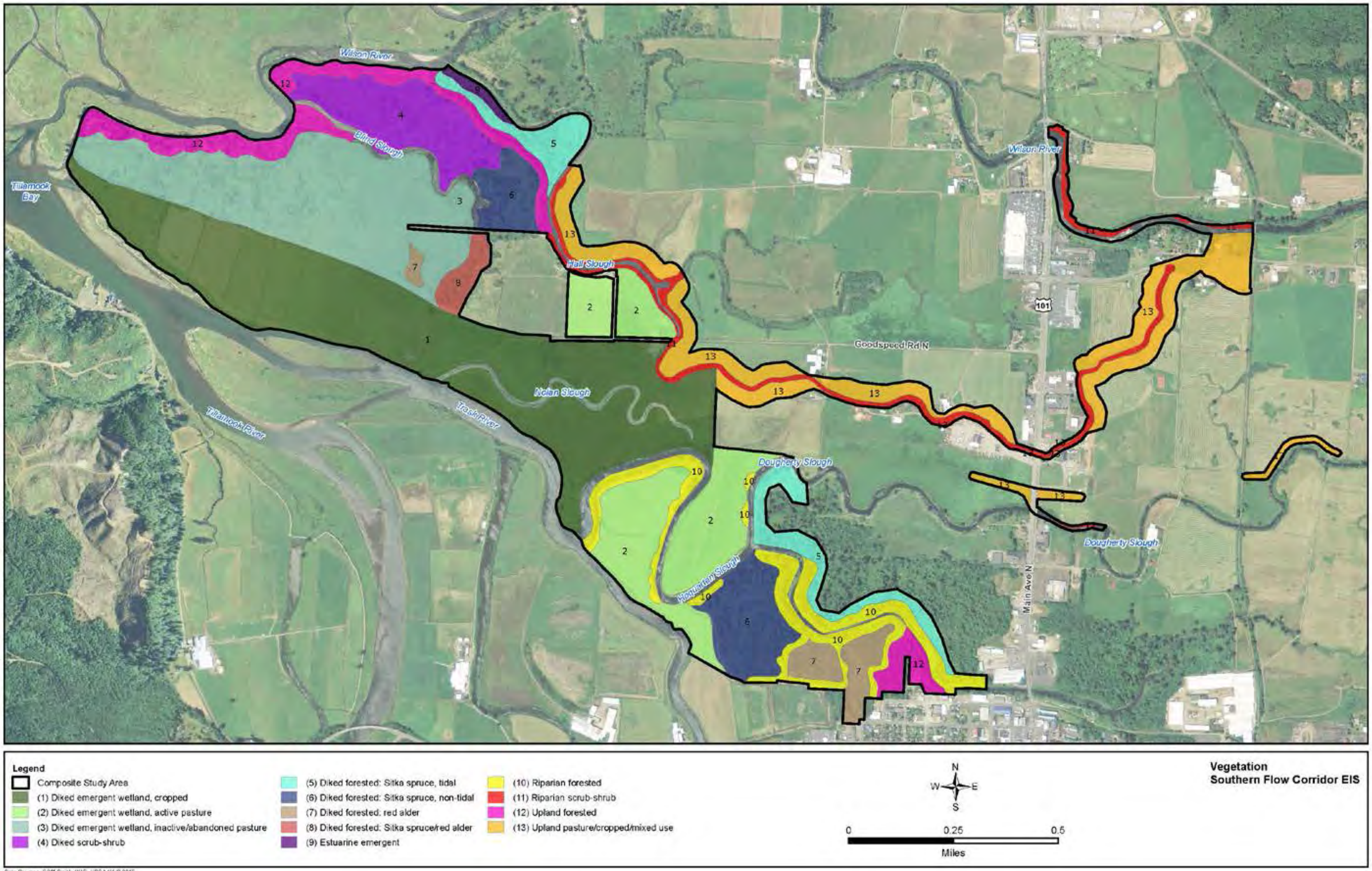


Figure 4. Vegetation Map

3.1.2 Wetland Vegetation

Wetland vegetation communities within the study area include emergent, scrub-shrub, and forested communities. Emergent wetland vegetation communities within the study area are one of two types: actively managed for agriculture as pasture or crops and inactive or abandoned pasture (Brophy 2014a). Pasture production is active in the southeast areas of the study area, and land is protected from the Trask River and Hoquarten and Dougherty sloughs by levees (Brophy and van de Wetering 2014). The area north of Blind Slough was not diked until the 1960s and appears never to have been farmed; it converted to a freshwater wetland with water levels regulated by tide gates. Brophy (2014b) describes current emergent vegetation community types as follows:

- **Diked emergent wetland, active pasture.** These include areas dominated by reed canarygrass (*Phalaris arundinacea*), Pacific silverweed, soft rush (*Juncus effusus*), or transitional wetland to upland areas dominated by tall fescue (*Schedonorus arundinacea*).
- **Diked emergent wetland, cropped.** These areas are typically dominated by meadow foxtail (*Alopecurus pratensis*) or reed canarygrass.
- **Diked emergent wetland, inactive/abandoned pasture.** These areas are dominated by reed canarygrass, slough sedge (*Carex obnupta*), common cat-tail (*Typha latifolia*), creeping spikerush (*Eleocharis palustris*), or pacific silverweed.

Scrub-shrub wetland vegetation within the study area generally consists of dense shrub communities that developed following the clearing of spruce forest. Within the study area, patches of scrub-shrub vegetation are present along fencerows and ditches. Dominant vegetation is comprised of willow, salmonberry, sword fern, red elderberry (*Sambucus racemosa*), and huckleberry (*Vaccinium* spp.), with the relative dominance varying with site condition (E&S 2001). One scrub-shrub wetland community is present within the study area. It is located in the northwestern portion of the study area in the area north of Blind Slough. In the Tillamook wetland prioritization study, it is identified as a high priority site (Ewald and Brophy 2012). Historically mapped as a tidal marsh, the area appears to have been utilized as pasture in the more recent past. Grazing currently appears to be limited or non-existent. The area is densely vegetated with predominantly woody vegetation. This vegetation community is categorized by Brophy (2014b) as:

- **Diked scrub-shrub wetlands, non-pasture.** This area is dominated by Hooker’s willow or red elderberry.

Most of the tidal forest in Oregon was probably tidal spruce swamp (also referred to as tideland spruce meadow) because the dominant tree is generally Sitka spruce (Jefferson 1975). Forested vegetation communities within the study area consist of remnant patches of historic tidal spruce swamp, a rare plant community in Oregon (Jefferson 1975), and occasional hardwood stands. Tree surveys of the study area have identified two primary tree species, Sitka spruce and red alder. Each of these species is dominant where they occur and limited in overlap. Tidal spruce swamp is currently found in very limited areas of the Tillamook lowlands. The area between Hoquarten and Dougherty sloughs in the easternmost portion of the study area contains one of the few remaining intact tidal swamps in the Tillamook Bay estuary (Ewald and Brophy 2012) and is the largest remaining tidal forested swamp in the area (Wilson et al. 1997; Brophy 1999; Tillamook Estuaries Partnership [TEP] 2010).

The northwest portion of the site along Hall Slough has naturally higher elevations and supports a Sitka spruce tidal swamp (Brophy and van de Wetering 2014; Brophy 1999). In addition to Sitka spruce, tidal spruce forest communities may include hemlock, grand fir, red alder, and vine maple , with an understory of hazelnut (*Corylus cornuta*), salmonberry, crabapple (*Malus fusca*), huckleberry, and salal (Coulton et al. 1996).

Currently, there are two forested vegetation communities within the study area, as categorized by Brophy (2014a):

- **Diked forested wetlands:** Sitka spruce, tidal. This area is dominated by Sitka spruce and is currently tidally influenced
- **Diked forested wetlands:** Sitka spruce, non-tidal. This area is dominated by Sitka spruce but is not currently tidally influenced.
- **Diked forested wetlands, non-pasture:** red alder. This area is dominated by red alder.

The *Tidal Wetland Prioritization for the Tillamook Bay Estuary* (Ewald and Brophy 2012) describes tidal wetlands present in the Tillamook Bay estuary. Ewald and Brophy prioritized wetland areas in the Tillamook Bay estuary based on size, tidal channel conditions, wetland connectivity, salmonid diversity, historical wetland type, and diversity of vegetation classes. While Ewald and Brophy prioritize sites to assist in conservation and restoration planning, the authors stress that “no tidal wetland is unimportant” and recommend conservation of all existing tidal wetlands. Restoration of tidal wetlands is considered important as well, regardless of priority ranking. The rankings indicate no regulatory significance or intent but are intended to provide a strategic approach to conservation and restoration of wetlands in the Tillamook Bay estuary.

3.1.3 Riparian

Riparian areas are the vegetated areas along a water body. Typically, they provide a natural buffer between the waterbody and adjacent uplands. Healthy riparian areas provide many benefits, including the following:

- Shade to regulate stream temperatures
- Stabilization of stream banks
- Filtration of sediments and pollutants
- Improvement of habitat and wildlife corridors
- Increased large wood recruitment to streams (TEP 2010)

Riparian vegetation throughout the study area is generally limited and in poor condition except on Hoquarten Slough (Brophy 1999). Riparian trees are largely absent as streams pass through predominantly agricultural land. However, Sitka spruce-dominated stands and groves of red alder are found in substantial quantities along Hoquarten Slough through much of the study area.

The study area contains two of the last seven remaining intact tidal swamps in the estuary (Brophy and van de Wetering 2014). Outside of the forested area along Hoquarten Slough, the composition of the riparian vegetation is primarily blackberries and non-native grasses or other brush and young hardwoods. In either case, the vegetation is generally discontinuous (TBNEP 1998a). A well-developed riparian vegetation community along Hoquarten Slough is characterized by Sitka spruce and western hemlock (TEP 2010).

Vegetation along Hall Slough is typical of that of other streams in the study area, consisting of a very narrow riparian corridor, generally less than 25 feet wide, surrounded by active pasture and farmland. Data on riparian vegetation along Hall Slough is not currently available; however, information from Brophy (2015) suggests probable vegetation in this area would include red alder, black twinberry (*Lonicera involucrata*), Pacific crabapple, salmonberry, red elderberry, and Hooker's willow, with Himalayan blackberry (*Rubus bifrons*), cutleaf blackberry (*Rubus laciniatus*), and Scotch broom (*Cytisus scoparius*) present in disturbed areas along the edges of fill along levees and roads.

3.1.4 Upland Vegetation

Upland vegetation provides a variety of important functions. Upland vegetation slows runoff and reduces soil compaction, allowing better percolation of rainfall into soils and groundwater. Leaves and branches intercept falling rain, reducing or preventing soil erosion by reducing the effect of raindrop splash. In addition, vegetative litter from dead leaves and branches builds up an organic surface on the ground that provides protection of the soil layer. Roots of trees and shrubs help to keep soil material in place. Upland vegetation can also provide habitat for a variety of wildlife (Oregon Watershed Enhancement Board 1999).

Very little upland area is present within the study area. It is generally limited to dikes, levees, dredge spoil sites, and rural residences where the vegetation consists of predominantly non-native grasses and forbs or planted ornamental species. Outside of the riparian corridor, upland pasture is the dominant vegetation type along the western half of Hall Slough. Pastures in the remaining portions of the study area appear to have been wetlands historically; however, some pastures or portions of pastures currently may function as uplands due to long-term diking and draining of these areas.

3.1.5 Trees

Limited tree surveys were conducted by the Tillamook County surveyor within the study area (Levesque 2015). The surveys generally were conducted in areas where it was expected there would be some disturbance such as along levees that would be removed or where new levees would be built. The position and species of trees greater than 12 inches diameter at breast height (dbh) were documented with a global positioning system (GPS) (**Figure 5**). Approximately 450 red alder and 200 Sitka spruce along Hoquarten Slough in the southeastern portion of the study area were documented. Spruce groves and a few habitat spruce along Hall Slough in the northwestern portion of the study area also were mapped. Sitka spruce may provide potential nesting habitat for the federally listed threatened marbled murrelet (see Section 4.6.3). Sitka spruce ranged in size from 12 to 72 inches dbh, with the majority falling between 18 and 36 inches dbh (**Figure 6**). Surveyed red alder trees ranged in size from 12 to 60 inches dbh, with the majority falling between 18 and 24 inches dbh (**Figure 6**).

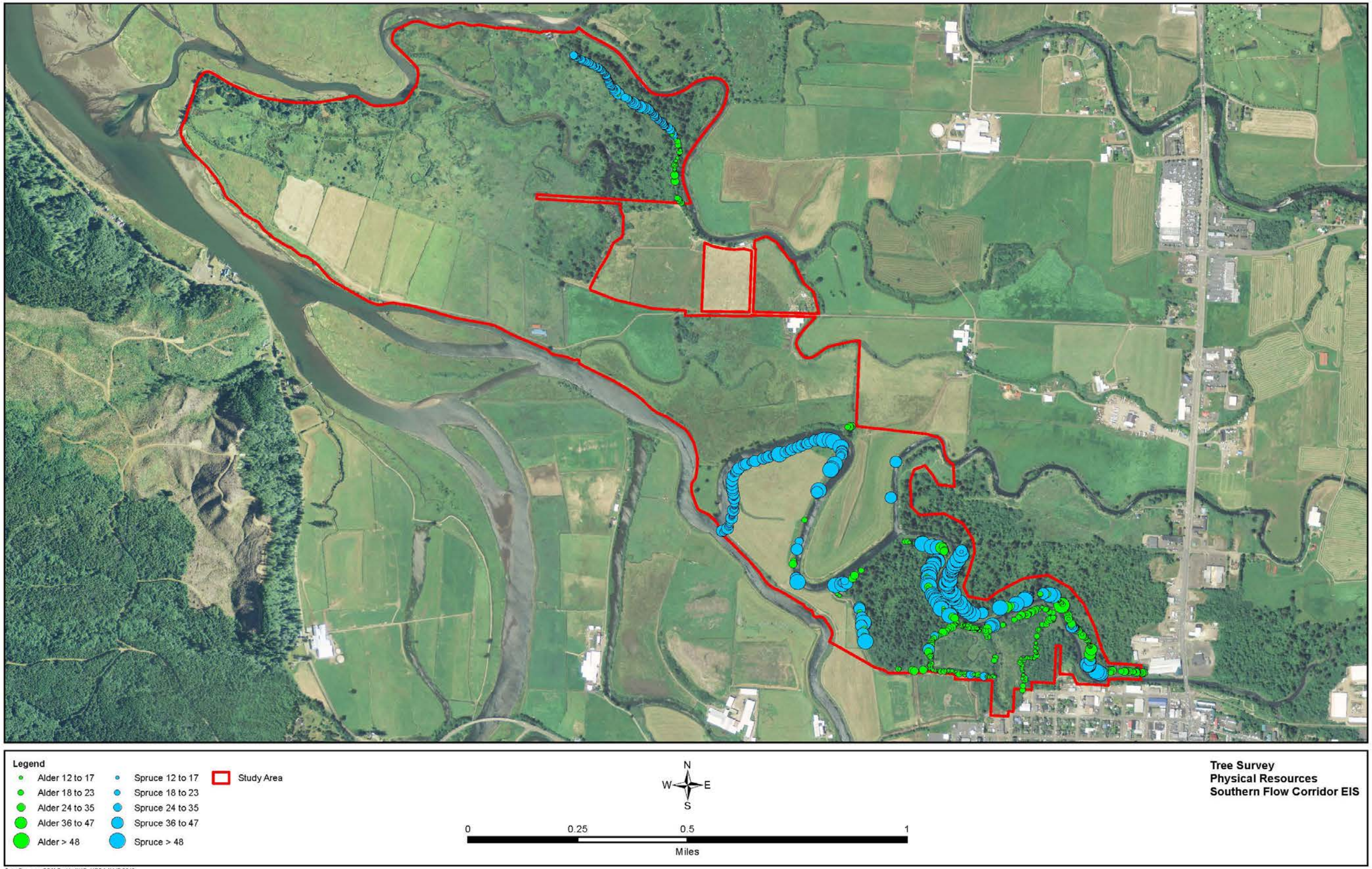


Figure 5. Tree Survey Map

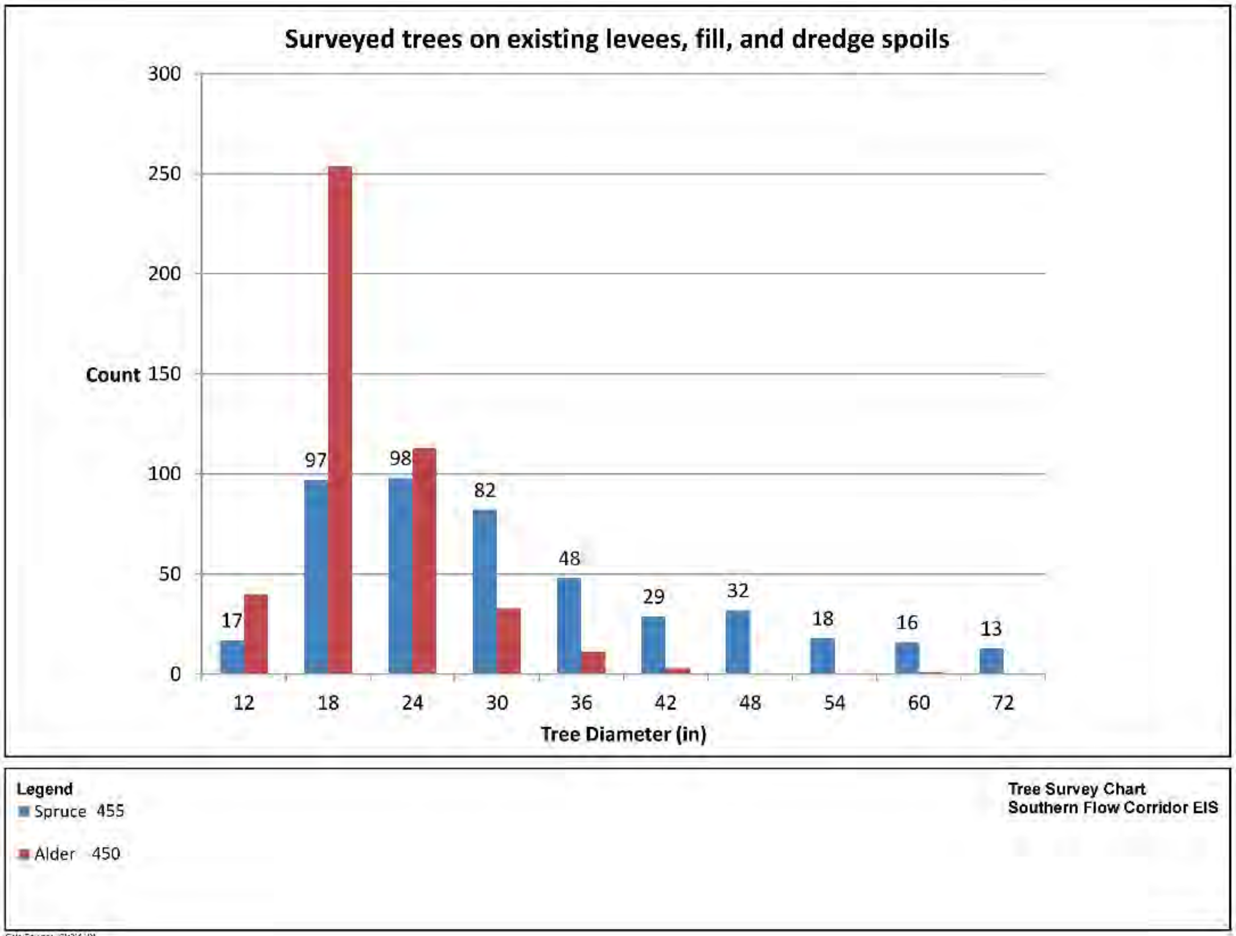


Figure 6. Surveyed Tree Diameter Distribution

3.1.6 Threatened and Endangered Plant Species

No rare or sensitive plant species are known to occur within the study area (ORBIC 2014). Nelson's checker-mallow (*Sidalcea nelsoniana*)is ESA-listed as threatened (USFWS 2014b), and while it does occur in Tillamook County, it does not naturally occur in coastal wetlands. According to USFWS, this species is not known or expected to occur within the study area (USFWS 2015a). See Section 3.4 of this report for further discussion of potentially occurring threatened and endangered species within the study area.

3.1.7 Invasive Species

One of the major goals of the Tillamook Bay Comprehensive Conservation and Management Plan (TBNEP 1999) is to control the spread of existing invasive exotic plant species and prevent the introduction of new invasive exotic plant species (TBNEP 1999). Exotic species can aggressively alter the landscape by displacing native species. **Table 3.2** presents a summary of non-native and invasive plant species currently occurring or potentially occurring within the study area (Ewald and Brophy 2012).

Table 3.2. Non-Native and Invasive Weed Species Occurring or Potentially Occurring within the Study Area

Common Name	Scientific Name	ODA Weed Classification[1]	Status in Tillamook County (present/potentially present)[2]
Bull thistle	*Cirsium vulgare*	B	Yes
Canada thistle	*Cirsium arvense*	B	Yes
Cordgrass, English Cordgrass, smooth Cordgrass, saltmeadow	*Spartina anglica,* *Spartina alterniflora* *Spartina patens*	A, T	Unknown
Eurasian watermilfoil	*Myriophyllum spicatum*	B	Yes
False brome	*Brachypodium sylvaticum*	B	Yes
Garlic mustard	*Alliaria petiolata*	B, T	Unknown
Giant hogweed	*Heracleum mantegazzianum*	A, T	Unknown
Gorse	*Ulex europaeus*	B, T	Yes
Hydrilla	*Hydrilla verticillata*	A	Unknown
Knotweed, Japanese	*Fallopia japonica*	B	Yes
Lesser celandine	*Ranunculus ficaria*	B	Yes
Parrotfeather	*Myriophyllum aquaticum*	B	Yes
Policeman's helmet	*Impatiens glandulifera*	B	Yes
Purple loosestrife	*Lythrum salicaria*	B	Yes
Reed canarygrass	*Phalaris arundinacea*		Yes
Shining geranium	*Geranium lucidum*	B	Unknown
Spurge laurel	*Euphorbia esula*	B,T	Unknown
Tansy ragwort	*Senecio jacobaea*	B	Yes
Yellow flag iris	*Iris pseudacorus*	B	Yes

[1] *ODA 2014*
[2] *TEP 2010*

Four invasive species are of particular concern in the Tillamook Bay estuary: smooth and saltmeadow cordgrass (*Spartina* spp.), purple loosestrife (*Lythrum salicaria*), and reed canarygrass. The importance of these species is attributed to the following characteristics:

- They are wetland plants that can occupy large areas of current and former tidal wetlands to the exclusion of native species.
- They are on the ODA's "T" list (ODA 2014), indicating they are to be considered economic threats to the state.

- Three of the four (cordgrasses and purple loosestrife) are tolerant of brackish water, making them threats in the estuary.
- The *Tillamook Bay Comprehensive Conservation and Management Plan* identifies prevention and/or control of cordgrasses and purple loosestrife in its “Key Habitat Action Plan” (TBNEP, 1999).

Cordgrass has not been documented in the Tillamook Bay estuary, but two species of cordgrass (smooth cordgrass [*Spartina alterniflora*] and saltmeadow cordgrass [*Spartina patens*]) have been documented in Oregon (Ewald and Brophy 2012). Both species are invasive in the Pacific Northwest and considered a serious threat to Oregon estuaries in general. Spartina can be controlled by physical means (e.g., digging, mowing, covering, and tilling) if the population size is small (Pfauth et al. 2003). Glyphosate treatment is effective in some situations. Biological control is not an eradication technique but may be effective in an integrated management strategy for large populations.

Purple loosestrife has been documented in the Tillamook Bay estuary (Ewald and Brophy 2012). It is an invasive, non-native wetland plant and a serious threat to freshwater and brackish water wetlands throughout the Pacific Northwest. The plants can be controlled manually, preferably before seed set, if infestations are small and plants are young (United States Forest Service 2015). Older plants can be controlled by mid-summer and late season spot treating with a glyphosate-type herbicide. Biological control is recommended for long-term control of large infestations.

Reed canarygrass is very widespread in the low-brackish to freshwater tidal portion of the estuary, particularly in disturbed areas and along river banks (Ewald and Brophy 2012). This species is intolerant of highly saline water but is able to persist in slightly brackish water. As a result, it is common in altered tidal wetlands where saltwater has been excluded by diking, tide gates, or restrictive culverts. Reed canarygrass forms dense single-species stands that exclude other species (Ewald and Brophy 2012). Manual controls include digging, mowing, cultivating, and flooding (Tu 2004). Prescribed fire may be combined with other treatments. Various herbicides, including glyphosate, are available for chemical treatment. There are no known biological control agents.

Several other invasive species are found in the Tillamook Bay estuary. The Oregon Weedmapper application (http://www.weedmapper.oregon.gov/) shows several populations of Himalayan, Japanese, and giant knotweed (*Polygonum polystachyum*, *P. cuspidatum*, and *P. sachalinense*, respectively) as well as yellow flag iris (*Iris pseudacorus*).

3.2 Wetlands

3.2.1 Overview

Historical wetlands in the Tillamook Bay area included tidal marshes, lower wooded tidelands, and river floodplain bottomlands (Coulton et al. 1996). Tidal marsh was found in the marine and brackish zones of the estuary and was dominated by grasses or other low growing non-woody vegetation. Lower wooded tidelands, also referred to as tidal swamps, were located farther up the estuary immediately adjacent to tidal marshes. Tidal swamps are dominated by woody vegetation (trees and shrubs) (Brophy 2009). River floodplain bottomlands were located farther upslope and extended east from the tidal swamps to the eastern end of the main valley. Two types of river floodplain bottomlands were present: those within the area of typical tidal influence, and those beyond the upper extent of tidal influence (Coulton et al. 1996). River floodplain bottomlands were dominated by saline tolerant to freshwater woody vegetation.

Ewald and Brophy (2012) describe tidal wetlands currently present in the Tillamook Bay estuary. They include mud flats, aquatic beds (eelgrass and algae beds, exposed only briefly during low tides), emergent marsh (low and high marsh), scrub-shrub wetlands, and forested wetlands. Tidal scrub-shrub and forested wetlands are collectively referred to as “tidal swamps.” Low marsh occurs near the ocean on the fringes of the bay; high marsh occurs slightly upslope of low marsh (Ewald and Brophy 2012). Tidal cycles regulate the frequency and duration of inundation in the salt marsh. As a result, the tides not only affect the salinity levels within the marsh but are also responsible for establishment of varying plant species assemblages. On the Oregon coast, high tides inundate low marshes twice a day. Flood tides might cover the surface of high marshes only a few times each year, during the largest spring tides (Oberrecht no date). Low and high marshes also tend to support unique plant communities. Typical low-marsh indicator species include seaside arrowgrass , pickleweed (*Salicornia* sp.), and Lyngbi’s sedge. Tufted hairgrass and common spike rush are typical high marsh species. Pacific silverweed, redtop (*Agrostis gigantea*), and Baltic rush typically occur in the transition zone between the high marsh and adjacent uplands (Oberrecht no date). Wetlands within the study area have been subject to varying degrees of human modification.

The National Wetlands Inventory (NWI) identifies five wetland types within the study area (**Figure 7**). NWI mapping is based on aerial photo interpretation and thus presents only a broad-level identification of wetland areas. Freshwater emergent wetlands occupy the majority of the study area. Freshwater forested/scrub-shrub, seasonally flooded wetlands are identified in the north-central and southeastern portions of the study area (USFWS 2014c). Freshwater ponds are present in the northwestern portion of the study area. Small areas of estuarine wetland are also present.

The City of Tillamook Local Wetland Inventory maps wetlands and possible wetlands within the city’s urban growth boundary (UGB). The southeastern portion of the study area lies within the UGB. The Local Wetland Inventory (LWI) also identifies wetlands in this area (Wilson et al. 1997); however, wetlands identified in the LWI are the same as those in the NWI.

A limited wetland delineation was conducted within the study area. State and federal wetland jurisdiction for each of the proposed activity types played a key role in determining the methods and resolution of the wetland delineation. Because the study area is tidally influenced, regulatory jurisdiction by the Oregon Department of State Lands (DSL) and USACE are governed by OAR 141-085-0515 and 33 CFR Part 328, respectively. Both agencies have agreed to use the “Highest Observed Tide” (HOT) as the regulatory wetland boundary for this project, which is documented as occurring at elevation 11.9 feet above mean sea level (DSL 2010). Because the extent of the HOT encompasses most of the project area (generally excepting the tops of the highest berms), all areas below the HOT elevation are essentially regulated as “wetlands” by the agencies, regardless of whether they exhibit wetland characteristics.

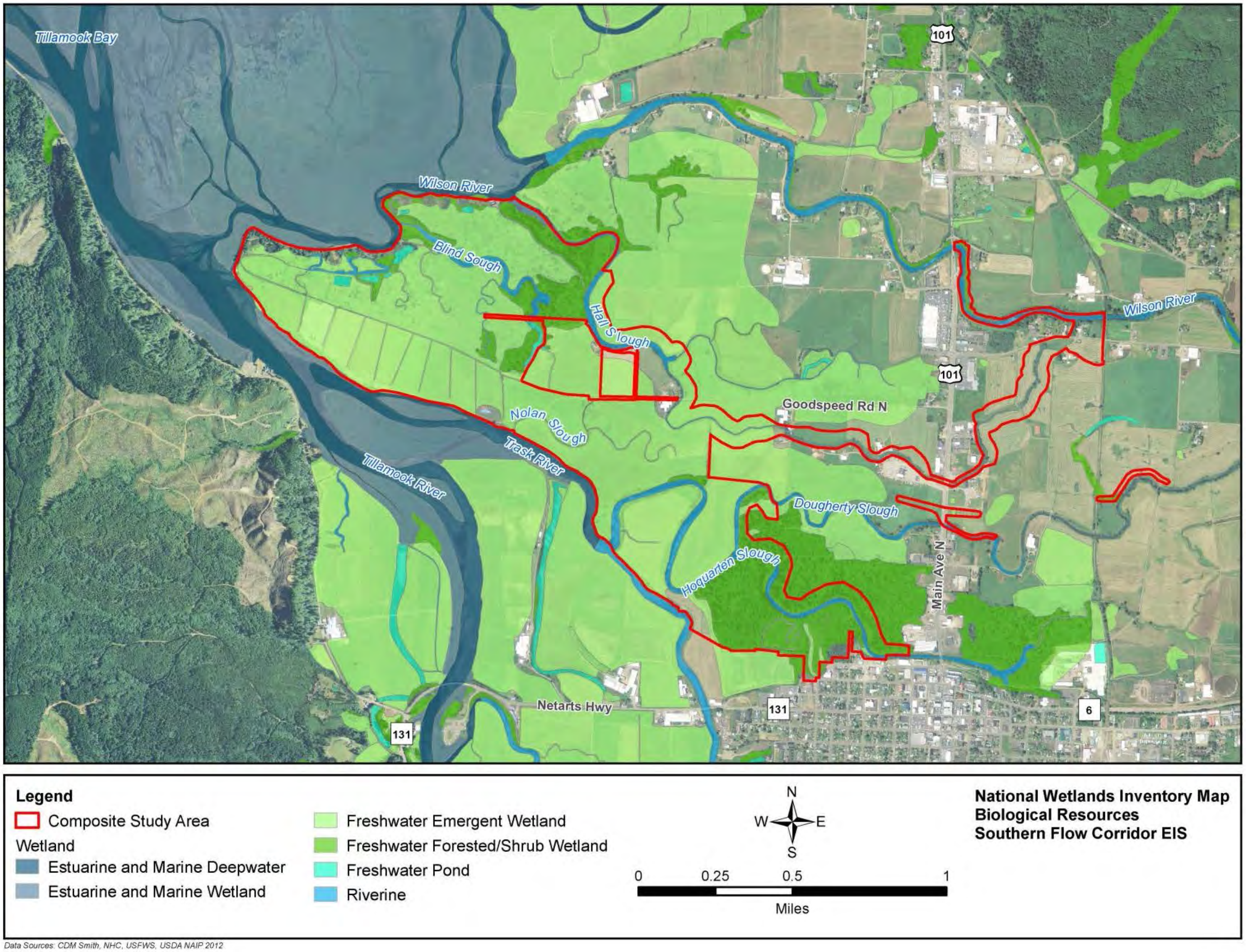


Figure 7. National Wetlands Inventory Map

Because the project mainly involves restoration of former wetlands, rather than wetland loss due to development, a high degree of delineation accuracy is less important. However, in areas where fill and removal is proposed for construction of new or improved levees and related infrastructure, a standard wetland delineation was conducted. MCS Corp and Latimer Environmental LLC staff conducted wetland delineation fieldwork on May 16, July 14 to 16, August 22, and September 15 to 17, 2014. **Table 3.3** presents a summary of wetlands identified within the study area.

Table 3.3. Existing Wetlands within the Study Area

NWI Wetland Class	Delineated Wetlands[1]	Area (acres)
Estuarine and Marine Wetland	Saltwater Wetlands	21.5
Freshwater Emergent Wetland	Farmed Herbaceous Wetland	418.9[2]
	Unfarmed Herbaceous Wetland	126.5
Freshwater Forested/Scrub-shrub	Scrub-shrub Wetland	31
	Forested Wetland	67.5
Riverine/Freshwater Pond	Other Waters	44[3]

[1] *(MCS Corp and Latimer 2015)*

[2] *The draft Wetland Delineation Report currently includes riverine habitat and waterways in the total area of freshwater emergent wetland for a total of 462.9 acres. The exact area of riverine habitat and waterways is still to be determined. For the purposes of this report, we have used the total area of NWI-mapped freshwater pond and riverine habitat, 6.5 and 37.5 acres, respectively. We subtracted those amounts from 462.9 to arrive at the total area of freshwater emergent/farmed herbaceous wetland.*

[3] *Acreages are from NWI mapping.*

The DRAFT Wetland Delineation Map is presented in **Figure 8**. **Figure 8** shows the HOT as elevation contours of 11.9 feet overlain on the study area map; closed polygons (in red) show those areas occurring above the HOT that likely would be non-jurisdictional, pending agency concurrence.

3.2.2 Wetland Classes Present within the Study Area

Ground-level studies indicate wetlands found within the study area include freshwater emergent, scrub-shrub, and forested communities as well as some remnant tidal wetland communities (Brophy 2014a, b; MCS Corp and Latimer 2015; Wilson et al. 1997). A summary of wetland types present within the project area is provided below, followed by more detailed information on selected portions of the study area.

3.2.2.1 Freshwater Emergent Wetlands

There are 545.4 acres of freshwater emergent wetlands in the study area. Emergent wetlands within the study area include 418.9 acres of actively managed agricultural areas (pastures, crops) and 125.5 acres of unfarmed herbaceous wetland including inactive or abandoned pastures (MCS Corp and Latimer 2015; Brophy 2014b). Areas where diking did not occur until the 1960s, such as the area north of Blind Slough, do not appear to have been farmed and have converted to a freshwater wetland with water levels regulated by tide gates. South of and adjacent to Blind Slough, a large area managed for waterfowl after the cessation of agricultural activities resulted in a series of excavated water features (Brophy and van de Wetering 2014).

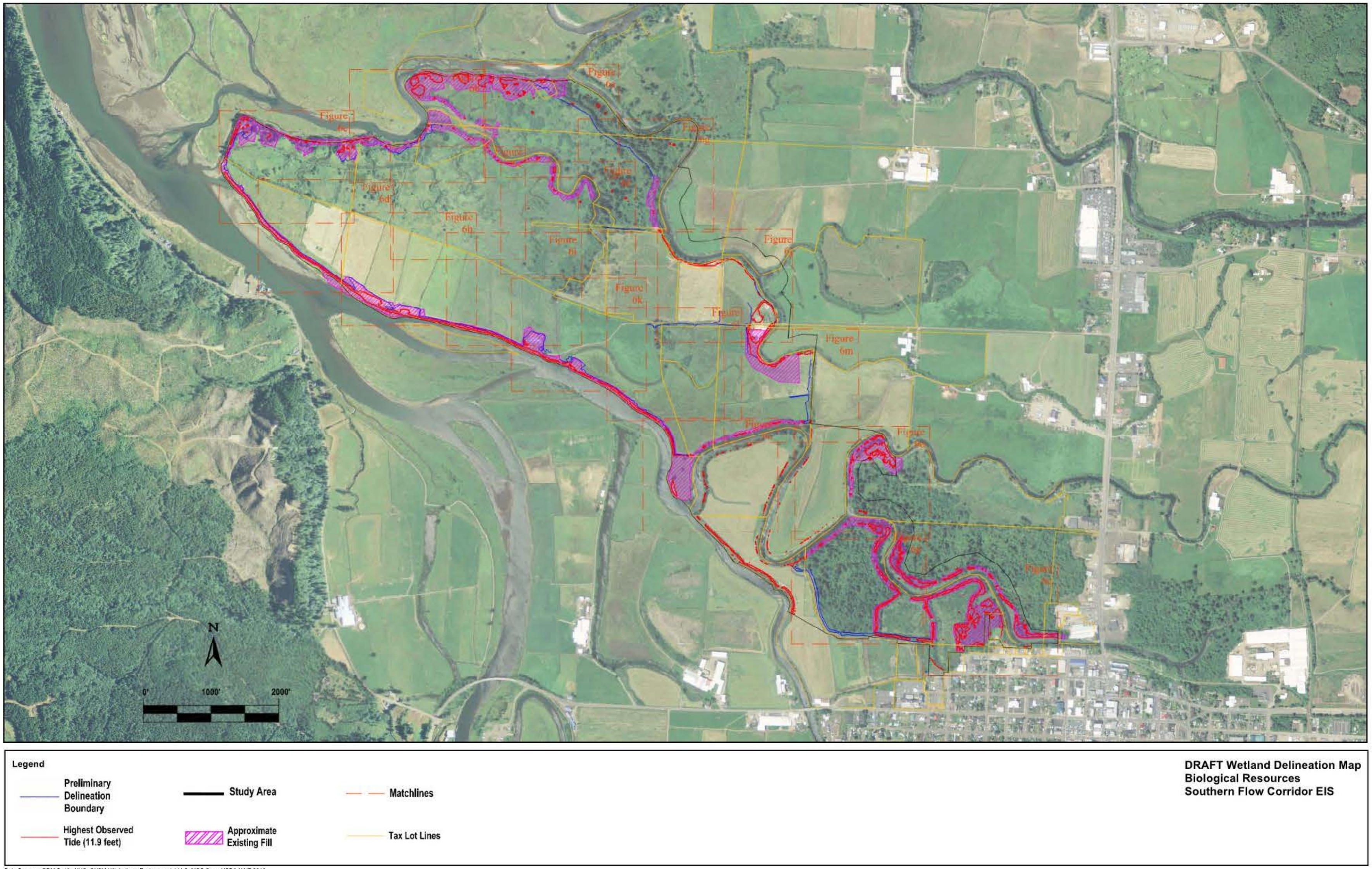


Figure 8. Draft Wetland Delineation Map

Preliminary results of vegetation monitoring (Brophy and Brown 2015) indicate the majority of freshwater emergent wetlands within the study area is dominated by non-native grasses and forbs. Non-native species account for approximately 75 percent total cover of vegetation and include reed canarygrass, spreading bentgrass, meadow foxtail, spotted touch-me-not (*Impatiens capensis*) , bird’s-foot trefoil, (*Lotus corniculatus*) and tall fescue. The dominant non- native species is reed canarygrass at approximately 50 percent cover. Total cover of native vegetation is less than 20 percent. The dominant native vegetation is slough sedge at approximately 7 percent cover. Other native vegetation present includes tufted hairgrass, soft rush, Pacific water parsley (*Oenathe sarmentosa*), and common silverweed, together accounting for approximately 10 percent of the total vegetation cover. The wetland delineation documented reed canarygrass, colonial bentgrass, soft rush, tall fescue, velvetgrass, Italian ryegrass (*Lolium perenne*) and meadow foxtail. Farmed wetland areas were dominated by reed canarygrass, colonial bentgrass, soft rush, and slough sedge in the unfarmed wetland areas (MCS Corp and Latimer 2015).

3.2.2.2 Freshwater Forested/Scrub-Shrub Wetlands

There is a total of 98.5 acres of freshwater forested/scrub-shrub wetlands in the study area: 31 acres of scrub-shrub wetland and 67.5 acres of forested wetland. Patches of scrub-shrub wetlands are present primarily along ditches, fencerows, and field edges throughout the study area. Scrub-shrub wetlands in the study area are generally characterized by one of two vegetation communities: a Hooker’s willow vegetation alliance, or a red elderberry alliance (Brophy 2014b).

Remnant patches of historic spruce wetlands are present within the study area. These are generally outside agricultural boundaries and are relatively undisturbed. The easternmost portion of the study area is dominated by historic spruce swamp with diked remnants along Hoquarten Slough (Brophy and van de Wetering 2014). This is the largest remaining tidal spruce swamp in the Tillamook area. A smaller area of tidal spruce swamp is present in the northwest portion of the site along Hall Slough (Brophy and van de Wetering 2014). Vegetation within these wetlands primarily consists of Sitka spruce, willows (*Salix* spp), salmonberry, and slough sedge in the understory (MCS Corp and Latimer 2015).

3.2.2.3 Estuarine and Marine Wetlands

A small area (2.5 acres) of NWI-mapped estuarine emergent wetland is mapped near the mouth of Hall Slough in the northwestern portion of the study area.

3.2.2.4 Riverine Wetlands

The wetland delineation documents numerous sloughs, canals, and manmade ditches within the study area; however these drainages were not delineated separately from the adjacent wetlands (MCS Corp and Latimer 2015). NWI mapping indicates 37.5 acres of riverine wetland in the study area. A riverine wetland includes all wetlands and deepwater habitats contained within a channel, with two exceptions: (1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens and (2) habitats with water containing ocean-derived salts in excess of 0.5 percent. A riverine wetland is bounded on the landward side by upland or the channel bank (including natural and manmade levees) or by wetland dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens (Cowardin et al. 1979). The NWI maps Blind, Dougherty, and Hoquarten sloughs as riverine wetlands within the study area. Typical agricultural ditches within the study area consist of steep to vertical banks vegetated by reed canarygrass, slough sedge, spreading rush (*Juncus patens*) and aquatics such as water milfoil (*Myriophyllum* sp) and duckweed (*Lemna* sp). These trapezoidal ditches are generally linear and designed to drain agricultural fields.

3.2.2.5 Freshwater Pond

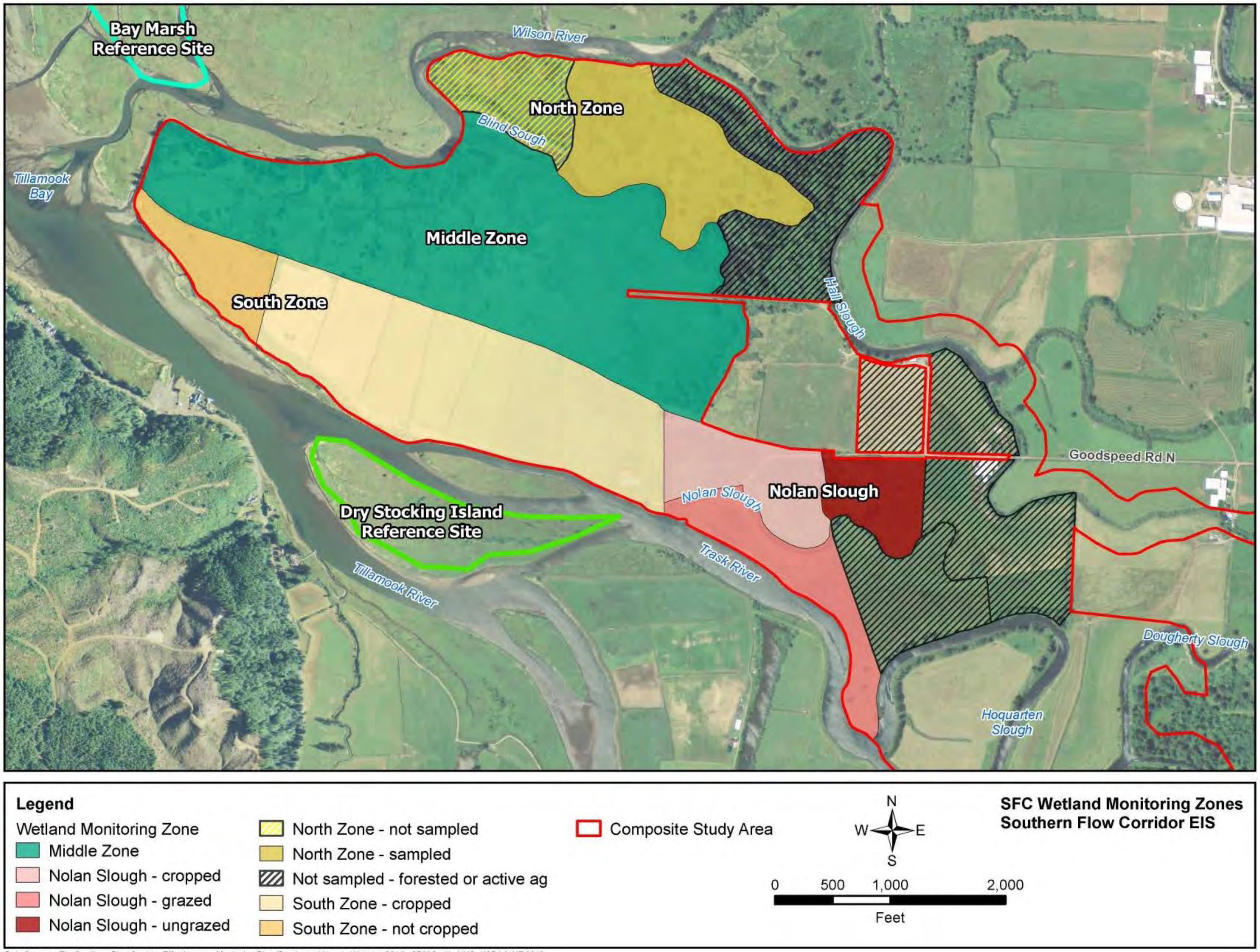
Freshwater pond wetlands were not delineated separately from the adjacent wetlands; however, the NWI maps Freshwater Pond within the study area. Freshwater Pond (6.5 acres) is mapped in the northwestern portion of the study area. South of and adjacent to Blind Slough, a large area managed for waterfowl after the cessation of agricultural activities resulted in a series of excavated water features (Brophy and van de Wetering 2014).

3.2.3 Additional Site Information

The *Southern Flow Corridor Project Effectiveness Monitoring Plan* (Brophy and van de Wetering 2014) divides the study area into four zones for monitoring purposes based on current land use (**Figure 9**) and provides baseline information on existing wetland conditions within the study area. The *Tillamook Bay Wetlands: Management Plan for the Wilson, Fuhrman, and Farris Acquisition Properties* further characterizes properties within the areas proposed for acquisition and restoration by the Tillamook County Performance Partnership (Sowers et al. 2001). Two of these properties (Farris and Fuhrman, 142 acres and 81 acres, respectively) were unsuitable for agricultural use and had previously been converted to duck hunting preserves with conservation easements in place. The Wilson property (154 acres) was a former dairy farm with land suitable for gazing and forage production (Levesque 2013).

North Wetland Zone

The northern portion of the study area (North Wetland Zone) is a relatively less intensively altered, freshwater wetland area to the north of Blind Slough. This area appears not to have been farmed (Tillamook County 2013) although it was probably grazed (Brophy and van de Wetering 2014). Blind Slough, thought to be a historical channel of the Wilson River, was disconnected for many years from the Wilson River by constructed levees. Its connection with the Wilson River recently has been partially restored with the installation of new culverts and tide gates. Sowers et al. (2001) characterize this area as freshwater wetlands with some upland areas associated with dredge spoil piles adjacent to the Wilson River. They also document a stand of mature spruce forest in the northwestern portion of this zone. Levees surrounding this zone appear to be failing in places; however, tidal exchange continues to be limited (Sowers et al. 2001)



Data Sources: The Southern Flow Corridor Effectiveness Monitoring Plan (Brophy and Van de Wetering 2014), CDM Smith, NHC, USDA NAIP 2012

Figure 9. SFC Monitoring Zones

Middle Wetland Zone

The central portion of the study area (Middle Wetland Zone) is primarily abandoned pastureland to the north of Goodspeed Road and South of Blind Slough. In the past, this area was actively managed as pasture, but it retains many intact remnant channels (Brophy and van de Wetering 2014). Sowers et al. (2001) characterize this area as predominantly freshwater wetlands with isolated patches of wooded upland. Remnant tidal changes present in this area are partially or entirely blocked from tidal exchange. This area shares a common dike with the South Wetland Zone. Areas of the invasive species Scot's broom are found in this zone in association with piles of dredge spoils from a 1971-72 USACE dredging project (Sowers et al. 2001). Manmade freshwater ponds, originally created to enhance waterfowl habitat, are scattered throughout this zone.

South Wetland Zone

The southern portion of the study area (South Wetland Zone) is intensively managed, actively farmed land south of the centerline ditch and adjacent to the Trask River. Sowers et al. (2001) describe this area as farmed freshwater wetland, currently used as pasture. This area contains an extensive system of linear and manmade drainage ditches that terminate at floodgates at the western end of this zone. The Wilson River levee system borders the southern and western edges of this zone adjacent to the Trask River. Several piles of dredge spoils are located on the southern edge of the levee near the Trask River (Sowers et al. 2001)

Nolan Slough Wetland Zone

This area is also heavily ditched. The area around Nolan Slough (Nolan Slough Wetland Zone) in the eastern portion of the study area is currently active pasture, with more ditching than the Middle Wetland zone but less than the South Slough area (Brophy and van de Wetering 2014). The lower portion of Nolan Slough is an estuarine channel (Sowers et al. 2001).

The Tidal Wetland Prioritization for the Tillamook Bay Estuary (Ewald and Brophy 2012) describes tidal wetlands present in the Tillamook Bay estuary. In this study, Ewald and Brophy identified and characterized current and likely former tidal wetlands within the Tillamook Bay estuary. The study prioritized sites for conservation and restoration based on the following criteria:

- Size of site
- Tidal channel condition
- Wetland connectivity
- Salmonid diversity
- Historical wetland type
- Diversity of vegetation classes

While the Ewald and Brophy study prioritizes sites to assist in conservation and restoration planning, the authors stress that "no tidal wetland is unimportant," and recommend conservation of all existing tidal wetlands. Restoration of tidal wetlands is considered important as well, regardless of priority ranking. The rankings indicate no regulatory significance or intent but are intended to provide a strategic approach to conservation and restoration of wetlands in the Tillamook Bay estuary.

Nine sites were identified and characterized within the study area (**Figure 10**). Together these sites cover nearly all of the project areas for the Proposed Action and Alternative 3 and the western portion of the Hall Slough project area. Four of the sites were classified as “high” priority. They include sites 39, 40, 50, and 53. **Table 3.4** provides a summary of those wetland types, their acreages, and assigned rankings.

Table 3.4. Wetland Prioritization Study Sites within the Study Area

Site ID	Area (acres)	Wetland Classification[2] (> 10% cover)[3]	Percent of Site	Historical Vegetation Class[4] (> 10% cover)[3]	Percent of Site	Priority Ranking
38	143	Freshwater emergent, diked	66.5	Marsh	98	Medium-high
39	66	Freshwater emergent, diked	63.7	Marsh	64	High
		Freshwater forested, diked	17.1	Swamp	28	
40	20	Freshwater forested, diked	92.3	Swamp	75	High
				Water	16	
45	257	Freshwater emergent, diked	58.6	Swamp	100	Medium
50	73	Freshwater emergent, diked	79.3	Swamp	94	High
51	103	Freshwater emergent, diked	82.9	Swamp	96	Medium
52	65	Freshwater forested	73.2	Swamp	88	Medium-high
		Freshwater scrub-shrub	17.6			
53	103	Freshwater forested	78.8	Swamp	95	High
		Freshwater emergent	14.9			

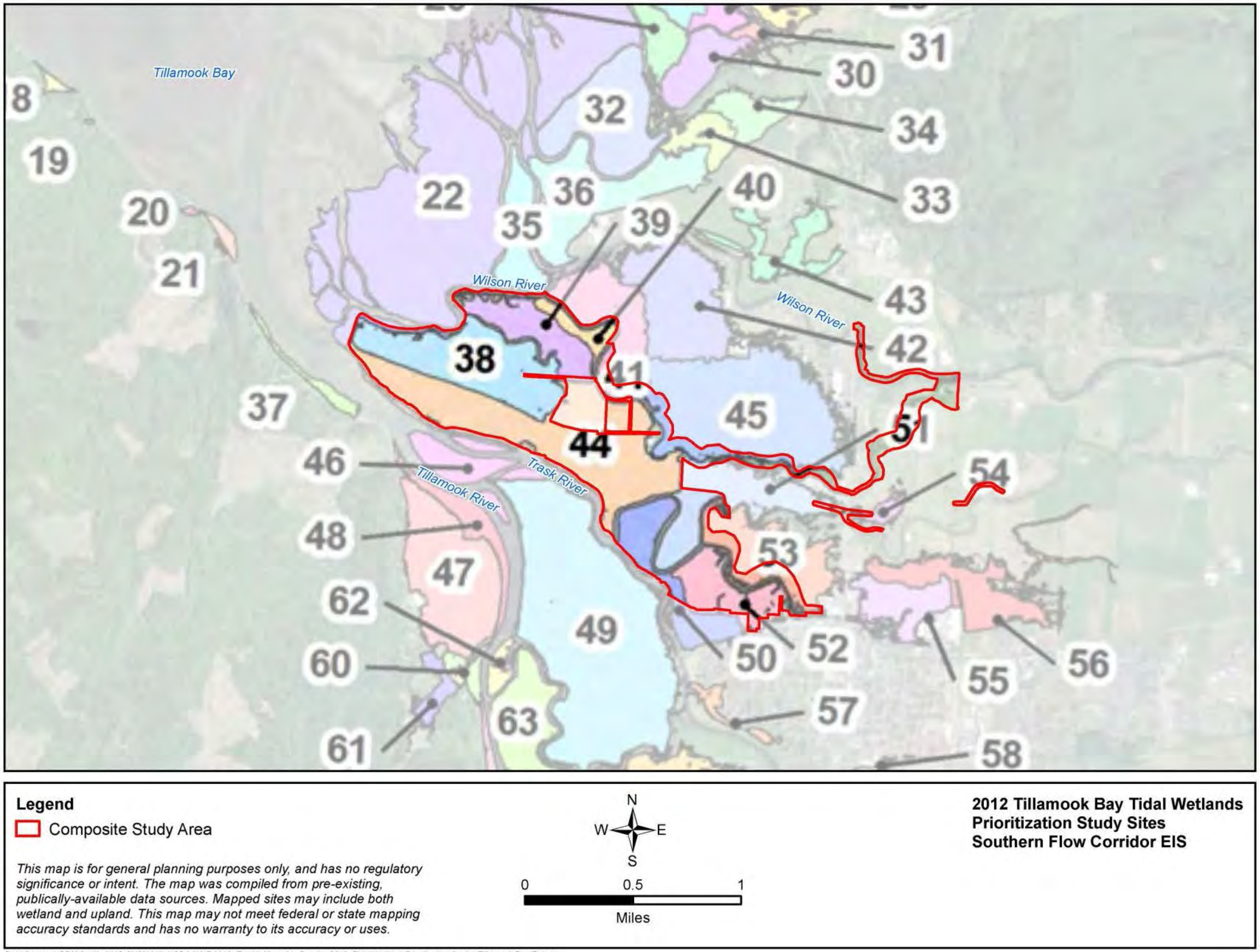
1 - Ewald and Brophy (2012)

2 - For the purpose of this evaluation, only the dominant wetland or historical vegetation classes are noted. Dominant is defined as any class with greater than 10 percent areal cover within the site.

3 - Cowardin et al. classes of wetlands within the site, from NWI mapping (USFWS 2014c)

4 - Historical vegetation classes of wetlands within the site are from Christy et al. (2008). Forested lands were assumed to have been swamp (forested wetland) because all sites are within tidal range.

Site 39 is located in the northwestern portion of the study area. It was mapped as tidal marsh in the 1800s (Hawes et al. 2008). It is thought to have served as pasture in the past, but the extensive woody vegetation cover on the site suggests that at the present time grazing is either light or non-existent (Ewald and Brophy 2012).



Data Sources: CDM Smith, NHC,CH2M-Hill, USDA NAIP 2012, Ewald, M. and L. Brophy. 2012. Tidal Wetland Prioritization for the Tillamook Bay Estuary.

Figure 10. 2012 Tillamook Bay Tidal Wetlands Prioritization Sites

Site 40 is located south of Hall Slough in the northwestern portion of the study area. It is one of seven remaining intact tidal swamps in the Tillamook Bay estuary. There appears to have been no alterations to this site from 1939 to the present (Ewald and Brophy 2012).

Site 50 is an agricultural area located in the southeastern portion of the study area between Hoquarten Slough and the Trask River[1] (Ewald and Brophy 2012). Dikes and tide gates restrict tidal flow into the northwestern corner of the site; however, the southeastern portion of this site is tidal, probably receiving flow from Hoquarten Slough through a breach in the dike (Mattison 2011).

Site 53 is located in the southeastern portion of the study area between Hoquarten and Dougherty sloughs. It is considered fully tidal and contains larger sinuous tidal channels with no apparent in-channel flow restrictions (e.g., tide gates and culverts). There is a natural levee along Dougherty Slough, but it does not appear to affect tidal inundation via Hoquarten Slough. Hoquarten Slough appears to be the main source of tidal flow (Ewald and Brophy 2012). Remnants of a dike are present along Hoquarten Slough, but it is mapped as breached, with a note that it is identified by the County for removal (Mattison 2011).

3.3 Fish and Wildlife

This section describes fish and wildlife resources and associated habitats in the study area.

3.3.1 Affected Environment

Generally, current conditions within the proposed study area include a diverse mix of terrestrial and aquatic habitat types that provide habitat for a number of fish species, aquatic invertebrates, marine mammals, and terrestrial wildlife species. Terrestrial habitats include mature spruce dominated riparian forest communities and spruce swamp (Brophy and van de Wetering 2014); managed pasture lands and farms, shrub-scrub; and blackberry (*Rubus armeniacus*) hedgerows; and other communities as described in Sections 3.1.1 and 4.4.1. Aquatic habitats include marine and brackish tidal creeks, tidally influenced rivers and sloughs, seasonal standing water areas, emergent wetlands, shrub-scrub wetlands, and spruce dominated forest and swamp (Brophy and van de Wetering 2014). Perennial waterways in the study area are altered with dikes, revetments, riprap, tide gates, and dredge spoils that limit floodplain connectivity. Many of the water bodies are channelized. Existing agricultural lands are crisscrossed with numerous drainage ditches, and some of these are linked to intermittent tidal waterways, including tributaries to Blind Slough, Hall Slough, and the Trask and Wilson rivers. Of the various habitats, four are Priority Habitats as identified in the Oregon Conservation Strategy: wetlands, estuarine habitats, riparian habitats, and freshwater aquatic habitats (ODFW 2006).

The existing saline and freshwater interface is complex and affected by tides, rainfall, and season. Downstream portions of the study area may contain salinity levels ranging from 0.1 to 30.1 parts per thousand during the spring to summer period (Ellis 1999). The highest salinity and the largest extent of saline waters within the study area are expected when incoming river flows from the Wilson and Trask rivers are at their lowest (August and September) and when

[1] Note that the reference document (Ewald and Brophy 2012) says “Wilson River,” but judging from the mapping, that is incorrect and should be Trask River.

these flows correspond with extreme tidal changes. Water chemistry is important to fish and other regional wildlife in the project vicinity, and the project occurs at this interface.

Current conditions provide habitat for a variety of terrestrial and aquatic animal species within the study area. These include birds, reptiles, amphibians, mammals, invertebrates, and fish. Additionally, the greater Tillamook Bay ecosystem is a significant aquatic area that provides habitat for commercially and recreationally important shellfish, myriad invertebrates, game and non-game fish, migratory and resident birds, and marine mammals.

Recent summer site reconnaissance by biologists[2] noted a number of migratory and resident bird species utilizing a variety of the habitats. These species included Western wood peewee (*Contopus sordidulus*), Tree swallow (*Tachycineta bicolor*), Red-tailed hawk (*Buteo jamaicensis*), Great blue heron (*Ardea herodias*), American robin (*Turdus migratorius*), Swainson's thrush (*Catharus ustulatus*), Cedar waxwing (*Bombycilla cedrorum*), Turkey vulture (*Cathartes aura*), and Purple martin (*Progne subis*). Although not exhaustive, the list indicates a rich diversity of birds. The study area and Tillamook Bay, in general, are important stop-over and wintering areas for migratory shorebirds, waterfowl, and wide ranging sea birds as well as summer habitat for neotropical passerines and other migratory species (Audubon Society of Portland 2014; Oregon Tourism Commission 2014).

Bald eagles have the potential to forage throughout the study area. No Bald eagle nests were positively confirmed in the study area from initial field reconnaissance, ORBIC records, or state documentation (ORBIC 2014), but Bald eagles have been observed within the study area and subsequent local investigations have located one active nest on Hoquarten Slough near the Sadri property. The nest is in a large spruce that is on a portion of the levee within the proposed project area. Open water habitats, wetlands, pastures, and estuarine areas within the study area provide suitable foraging opportunities for Bald eagle.

North coastal lowlands, such as those that occur in the project area, are expected to provide habitat to a number of mammals. A formal analysis and survey of mammals in the study area has not been completed to date, but some common species anticipated to occur within the study area include black-tailed deer (*Odocoileus hemionus columbianus*), Roosevelt elk (*Cervus canadensis*), and a variety of ground and tree-dwelling mammals, including raccoon (*Proycon lotor*), Pacific jumping mouse (*Zapus trinotatus*), coyote (*Canis latrans*), common gray fox (*Urocon cinereoargenteus*), red fox (*Vulpes vulpes*), bobcat (*Lynx rufus*), Douglas squirrel (*Tamiasciurus douglasii*), northern flying squirrel (*Glaucomys sabrinus*), voles (*Microtus* spp.), shrews (*Sorex* spp.), Townsend's mole (*Scapanus townsendii*), western pocket gopher (*Thomomys mazama*), Townsend's chipmunk (*Neotamias townsendii*), striped skunk (*Mephitis mephitis*), western spotted skunk (*Spilogale gracilis*), mink (*Neovision vision*), long-tailed weasel (*Mustela frenata*), beaver (*Castor canadensis*), muskrat (*Odontra zibethicus*), nutria (*Myocastor coypos*), and river otter (*Lutra canadensis*) (Maser et al. 1981; Eder 2002; ODFW 2014b; Oregon Forest Resources Institute 2013).

Fish species utilizing the study area are varied and seasonal. Ellis (1999) collected a diverse assemblage of marine, freshwater, and estuarine species in the project vicinity, including

[2] *June 30, 2014 by Jay Lorenz (CCPRS), Peggy O'Neill (CCPRS), and Casey Storey (WHPacific, Inc.)*

anadromous species. Additionally, directed sampling of the study area by Brophy and van de Wetering (2014) identified both anadromous salmonids and resident estuarine species. The Trask, Tillamook and Wilson rivers contain important salmonid game species, including three species of salmon (*Oncorhyncus* spp.), two species of anadromous trout (*Oncorhyncus* spp.), nongame species such as large-scale sucker (*Catostomus macrocheilus*), three-spine stickleback (*Gasterosteus aculeatus*), lamprey (*Lampetra tridentata* and *Lampetra richardsonii*), multiple species of sculpin (*Cottus* spp.), and resident non-migratory trout (*Oncorhyncus* spp.) (Ellis 1999; NMFS 2008a; StreamNet 2014; TEP 2010, van de Wetering et al. 2014).

The list of fish species in Tillamook Bay, the Tillamook, Trask and Wilson rivers, and Hall and Hoquarten sloughs is provided in **Table 3.5**. Estuarine habitats within the study area are EFH for coho salmon (*Oncorhynchus kisutch*) and Chinook salmon (*Oncorhynchus tshawytscha*) (NMFS 2014). The project area is also EFH for Pacific Coast groundfish (NMFS 2014). Species within this designation likely to be found in the study area include starry flounder (*Platichtyhys stellatus*) and Pacific sanddab (*Citharichthys sordidus*) (Ellis 1999). Tillamook Bay is also EFH for Coastal Pelagics, including Northern anchovy (*Engraulis mordax*) (Pacific Fishery Management Council [PFMC] 1998), which have been found in the study area (Ellis 1999).

Table 3.5. Common Fish of Upper Tillamook Bay and Tidal Portions of Rivers and Sloughs within the Study Area

Common Name	Scientific Name
Threespine stickleback	*Gasterosteu aculeatus*
Chinook salmon	*Oncorhynchus tshawytscha*
Coho salmon	*Oncorhynchus kisutch*
Chum salmon	*Oncorhynchus keta*
Steelhead trout	*Oncorhynchus mykiss*
Cutthroat trout	*Oncorhynchus clarki*
Pacific herring	*Clupea pallasii*
Shiner perch	*Cymatogaster aggregata*
Pacific staghorn sculpin	*Leptocottus armatus*
Prickly sculpin	*Cottus asper*
Pacific sanddab	*Citharichthys sordidus*
Starry flounder	*Platichthys stellatus*
English sole	*Parophrys vetulus*
Pacific lamprey	*Entosphenus tridentatus*

Sources: Ellis 1999; NMFS 2014

Macroinvertebrate distribution in the study area is not documented; however, a variety of arthropods, gastropods, ground dwelling annelids, and a great assemblage of species common to the intertidal habitats found along the estuarine edge of the project are expected (ODFW 2014c; TEP 2010). The greater Tillamook Bay is an important shellfish harvest area for both commercial and recreational fisheries. Mapped clam beds occur within the central bay and north of the study area. Common target species found in the bay include Dungeness crabs (*Metacarcinus magister*), cockles (*Clinocardium nuttallii*), gaper clams (*Tresus capax*), butter clams (*Saxidomus giganteus*), softshell clams (*Mya arenaria*), and little neck clams (*Leukoma staminea*) (ODFW 2014c; Ainsworth et al. 2014).

Tillamook Bay is also home to commercial oyster production. Various studies have identified a multitude of other aquatic invertebrates utilizing bay habitats, particularly closer to the bay mouth and in association with rocky shorelines, rip rap, and intertidal zones (Houck et al. 1997).

3.4 Threatened and Endangered Species

This section describes special-status species with potential to occur in the study area. Special-status species include federally threatened, endangered, proposed, and/or candidate plant or wildlife species (USFWS and NMFS); federal species of concern (USFWS); state threatened, endangered, and proposed wildlife species (ODFW); state sensitive animals (ODFW); and state threatened, endangered, and candidate plants (ODA). All federally listed species except the southern Distinct Population Segment (DPS) of green sturgeon (*Acipenser medirostris*) are also included on the Oregon state threatened and endangered species list although the specific designation (endangered or threatened) may differ. Not all state-listed species are federally listed or federal candidates.

USFWS indicates 10 listed plant and animal species occurring within Tillamook County as well as one candidate species and numerous unlisted species of concern (**Table 3.6, Table 3.7,** and Attachment A). Listed and candidate species include four birds, one plant, one insect, four reptiles (sea turtles), and one mammal. Additionally, the NMFS-administered and federally listed Oregon Coast coho Evolutionarily Significant Unit (ESU) is known to occur within the study area and is one of several species targeted by restoration objectives of this project (NMFS 2013). Other NMFS-administered and listed guilds, including sea turtles, cetaceans and pinnipeds, are not expected to occur within the study area and are not included in this analysis or on the lists below.

Aquatic habitats connected to the rivers, streams, sloughs, and Tillamook Bay within the study area are designated critical habitat for the Oregon Coast coho ESU (NMFS 2008a). All named waterways (Wilson River, Tillamook River, Trask River, Hall Slough, Dougherty Slough, and Hoquarten Slough) except Blind Slough are recognized as rearing and migration corridors for the species by StreamNet (2014). The study area is a transitional habitat for rearing juvenile coho salmon prior to their migration to marine habitats (Miller and Sadro 2003). The tidally influenced portion of the project may contain juvenile coho for many weeks each year given the occurrence of the project at the salt and freshwater interface (Miller and Sadro 2003). Brophy and van de Wetering (2014) found juvenile coho within the study area and adjoining aquatic sites from March through August, with the highest abundances during April, May, and June. Additionally, adult coho migrating to spawning grounds in upstream segments of the Wilson, Tillamook, and Trask rivers must pass by the study area during the fall migration (StreamNet 2014).

The southern DPS of North American green sturgeon (federally threatened) is known to occur within Tillamook Bay (NMFS 2009) and is anticipated to occur within the study area. While Critical Habitat for this species excludes Tillamook Bay (NMFS 2009), the occurrence of this species in the bay necessitates consideration of effects to this species.

Table 3.6 Potentially Occurring Special Status Plant Species in Tillamook County

Scientific Name	Common Name	Federal Status	State Status	ORBIC Record	Preferred Habitat	Elevation	Suitable Habitat Potentially Present?
Abronia umbellata ssp. *breviflora*	Pink sandverbena	SOC	E	No record	Coastal dunes and disturbed sandy areas in coastal scrub	At or near sea level	No
Anemone oregana var. *felix*	Bog anemone	SOC		No record	Sphagnum bogs and marshes	10-325 feet (ft), 2000-3000 ft	No
Cardamine pattersonii	Saddle Mt. bittercress	SOC	C	No record	Grass balds, moist cliffs, rock crevices, moss mats over bedrock; in gravel along streams in forest	2,690-3150 ft	No
Chloropyron maritimum ssp. *palustre*	Pt. Reyes bird's-beak	SOC	E	No record	Inhabits the upper end of maritime salt marshes at approximately 2.3-2.6 meters (m) (7.5-8.5 ft) above Mean Lower Low Water in sandy substrates with soil salinity 34-55 parts per thousand, and less than 30 percent bare soil in summer	0-10 ft	No
Dodecatheon austrofrigidum	Frigid shootingstar	SOC		No record	At high elevations on basalt cliffs near streams and waterfalls, sometimes on rotting wood; at low elevations basalt rock crevices in major rivers, below high water line	100-4,000 ft	No
Erythronium elegans	Coast Range fawn-lily	SOC	T	No record	Open sites on rocky slopes and cliffs; edges of sphagnum bogs; mountain bogs, meadows, and rocky balds	2,690-3,350 ft	No
Filipendula occidentalis	Queen-of-the-forest	SOC	C	Historic (1937) – location uncertain	Shady damp sites; on river banks, in rock crevices, and seeps just above high water level; damp salmonberry shrublands; on Onion Peak on rock cliffs in remnant stands of Abies and Tsuga; moist areas in full sun or partial shade	0-3,120 ft	Yes

Scientific Name	Common Name	Federal Status	State Status	ORBIC Record	Preferred Habitat	Elevation	Suitable Habitat Potentially Present?
Micranthes hitchcockiana	Saddle Mt. saxifrage	SOC	C	No record	Grassy balds, thin, rocky soils, and rock crevices	2,200-3,350 ft	No
Montia howellii	Howell's montia		C	No record	Moist lowland areas	NA	Yes
Sidalcea hendersonii	Henderson's sidalcea	SOC		No record	Coastal bog, fen, and wetland	NA	Yes
Sidalcea hirtipes	Bristly-stemmed sidalcea	SOC	C	2 miles east of project	Open meadows, grasslands, balds, coastal bluffs, and mountain peaks	0-1,800 ft, 4,800-10,900 ft	No
Sidalcea nelsoniana	Nelson's sidalcea	T	T	No record	Relatively open areas on damp soil, in meadows, wet prairie remnants, fencerows, roadsides, deciduous forest edges, and occasionally Oregon ash wetlands	150-2,000 ft	No
Silene douglasii var. *oraria*	Cascade Head catchfly	SOC	T	No record	Coastal bluffs	500-600 ft	No

Table 3.7. Potentially Occurring Special Status Fish and Wildlife Species in Tillamook County

Scientific Name	Common Name	Federal Status	State Status	ORBIC Record	Preferred Habitat	Suitable Habitat Potentially Present?
Oncorhynchus kisutch	Coho salmon	T	T	Record	Migratory between marine and freshwater; reproduction and juvenile rearing in freshwater; adult life state in marine	Yes
Acipenser medirostris	Southern DPS Green Sturgeon	T		No	Anadromous with regular use of estuarine habitats for forage	Yes

Scientific Name	Common Name	Federal Status	State Status	ORBIC Record	Preferred Habitat	Suitable Habitat Potentially Present?
Speyeria zerene	Oregon silverspot butterfly	T	T	Record outside of study area	Coastal prairie or meadow	No
Pelecanus occidentalis califronicus	California brown pelican		E	Record	Marine and estuarine waters	Yes
Charadrius alexanrinus nivosus	Western snowy plover	T	T	Record outside of study area	Beaches and ocean shore	No
Brachyranpus marmoratus	Marbled murrelet	T	T	No	Conifer-dominated forest stands that generally are 80 years old or older and/or have trees greater than or equal to 18 inches mean dbh with suitable nesting structure and within 50 miles of the Coast	Yes
Stix occidentalis caurina	Northern spotted owl	T	T	No	For nesting pairs, typically 40 to 60 percent nesting, roosting, foraging (late-successional/old-growth forest) in a home of approximately 4,000 acres	No
Phoebastria albatrus	Short-tailed albatross	E	E	No	Marine waters	No
Arorimus longicaudus	Red tree vole (Northern Oregon Coast DPS)	Candidate		No	Sitka spruce and hemlock forests	No

Potential nesting habitat also exists within the study area for the threatened Marbled murrelet (*Brachyramphus marmoratus*) (USFWS 2015a). The occurrence and frequency of use of these habitats by Marbled murrelets are unknown as no audio-visual surveys to determine species presence were conducted prior to the project review by USFWS. In the absence of two sequential years of Marbled murrelet surveys that followed approved interagency protocols for detecting murrelets, the study area is assumed to be occupied by the species based on the presence of potentially suitable habitat. USFWS wildlife biologists made site-specific determinations on the presence of potential murrelet nesting structure within the study area. Locations of 43 Sitka spruce trees, which had potential nesting habitat characteristics within the footprint of levees planned for removal, were recorded using GPS. Additional trees with potential suitable nesting habitat structure are located within the interior of the forested portions of the project site but are not subject to removal by the project actions. The forested areas are assumed to provide murrelet habitat due to presence of trees of sufficient size and structure that could potentially support nesting murrelets (USFWS 2015a). Generally, conifer trees over 107 feet tall with a diameter of at least 19.1 inches and large branch platforms at least 32.5 feet above the ground and adjacent to other trees are considered potentially suitable nesting habitat for this species (Burger 2002; Nelson and Wilson 2002; USFWS 1997, 2003, 2009, 2011, 2015a).

The Oregon silverspot butterfly prefers coastal prairie and meadow habitat. Suitable habitats in Oregon include coastal terraces and headland meadow with salt spray and montane grasslands such as occurring at Mount Hebo. Blue violets (*Viola adunca*) are required host plants for silverspot larvae. No suitable habitat is present within the study area, and there are no known sites for Oregon silverspot butterfly in the study area (USFWS 2015b).

The Western snowy plover nests along the ocean shore on sandy beaches, sand flats, and sandy dunes. Lauten and others (2014) conduct annual nesting surveys, and the study area is not recognized in annual monitoring. The study area is not along the ocean shore where sandy habitats occur, and the Western snowy plover is not anticipated in the project area.

ORBIC data indicated records for California brown pelican (*Pelecanus occidentalis californicus* – state endangered) within the study area. Open water foraging areas are available within all of the tidal waterways of the study area for California brown pelican. All open waters of Tillamook Bay downstream of the study area could also be considered suitable for California brown pelican foraging and stopover use.

The eastern stock of Steller sea lion has been delisted but is still afforded protection under the MMPA. Steller sea lion forage near shore and in pelagic waters and use terrestrial habitats as haul-out sites for periods of rest and molting and as rookeries for mating and pupping during the breeding season (Columbia River Crossing [CRC] 2010; NMFS 2008b; ODFW 2011). Haul outs and rookeries usually consist of beaches (gravel, rocky, or sand), ledges, and rocky reefs. Hundreds of Stellers breed at Three Arch Rocks near Oceanside, Oregon (Ocean Policy Advisory Council 1993). The closest designated critical habitat is at Long Brown and Seal Rocks near Port Orford, Oregon. Steller sea lion occasionally enter Tillamook Bay; however, foraging habitat, haul-out sites, and rookeries are not present (Pearson 1969), and they are not known to travel to the tributaries adjacent to the project area at the south end of the bay. Therefore, Steller sea lion are unlikely to be present in the study area during the proposed construction period. Potential impacts on Steller sea lion, if they are present, would not occur because the project would not use techniques, such as pile driving, that can cause underwater acoustical impacts.

Harbor seals also are protected under the MMPA. Harbor seals are known to seek refuge and produce pups Tillamook Bay, and haul out in large numbers in the Upper half of Tillamook Bay (Brown and Mate 1983; Ocean Policy Advisory Council 1993). There may be occasional use of nearby tributary habitats by a few harbor seals for foraging (Wright et al. 2007; Wright 2015).

SECTION 4 Environmental Consequences

This section provides analysis of potential environmental effects associated with No Action and each of the action alternatives. Alternatives range from doing nothing (No Action Alternative) to varying degrees and methods of flood reduction and wetland and floodplain restoration.

4.1 Environmental Commitments

The following environmental commitments are common to all action alternatives and consist of measures that would be taken as necessary to ensure environmental compliance and lessen impacts on biological resources. The Programmatic Restoration Opinion for Joint Ecosystem Conservation by the Services (PROJECTS) programmatic biological opinion (NMFS 2013) would be applied to the Proposed Action and Alternative 3. PROJECTS also contains many mitigation measures to protect threatened and endangered species and their habitats while conducting restoration; levee setback and removal; and tide/flood gate removal, replacement, or retrofit projects. Relevant mitigation measures from PROJECTS are summarized in Attachment B (the entire document may be found at http://www.habitat.noaa.gov/pdf/2013_12-03_PROJECTS_NWR-2013-10221.pdf). Mitigation measures proposed for the SFC project are described in Section 6 of the EIS. Natural resources agencies would determine the adequacy of proposed mitigation, and supplemental mitigation may be required. Not all measures would apply to all of the alternatives, for example, the Hall Slough Alternative would require supplemental mitigation measures due to the widening and deepening of Hall Slough and maintenance dredging.

The following environmental commitments describe typical conditions that are often applied to projects involving in-water work and that would be applied during project implementation by the applicant and operator(s). Conditions might be required through funding mechanisms, permit approvals, easement restrictions, warranties, or other legal vehicles. Environmental commitments are, in part, intended to prevent or reduce potentially important effects to negligible or minor levels.

4.1.1 General Commitments

In the course of implementing the selected action alternative, the applicant will:

- Comply with applicable federal, state, and local environmental laws and regulations.
- Balance cuts and fills during levee and drainage improvements to minimize material imports and exports and transport distances.
- Minimize drainage disturbances by retaining existing and historical drainage alignments that are serviceable and at the desired grades to reduce the lengths of new tidal channel construction.
- Sequence and schedule work to reduce the exposure of bare soil to wind or water erosion at any point in time.

Erosion Control

- Use site planning and site erosion control measures commensurate with the scope of the project to prevent erosion and sediment discharge from the project site.
- Before significant earthwork begins, install appropriate, temporary erosion controls downslope to prevent sediment deposition in the riparian area, wetlands, or water body.
- During construction, if eroded sediment appears likely to be deposited in the stream during construction, install additional sediment barriers as necessary.
- Temporary erosion control measures may include fiber wattles, silt fences, jute matting, wood fiber mulch and soil binder, or geotextiles and geosynthetic fabric.
- Soil stabilization utilizing wood fiber mulch and tackifier (hydro-applied) may be used to reduce erosion of bare soil if the materials are noxious weed free and nontoxic to aquatic and terrestrial animals, soil microorganisms, and vegetation.
- Remove sediment from erosion controls if it reaches 1/3 of the exposed height of the control.
- Whenever surface water is present, maintain a supply of sediment control materials and an oil-absorbing floating boom at the project site.
- Stabilize all disturbed soils following any break in work unless construction will resume within four days.
- Remove temporary erosion controls after construction is complete and the site is fully stabilized.

Temporary Access Roads and Paths

- Whenever reasonable, use existing access roads and paths preferentially.
- Minimize the number and length of temporary access roads and paths through riparian areas and floodplains.
- Minimize removal of riparian vegetation.
- When it is necessary to remove vegetation, cut at ground level (no grubbing).
- Do not build temporary access roads or paths where grade, soil, or other features suggest slope instability.
- Any road on a slope steeper than 30% will be designed by a civil engineer with experience in steep road design.
- After construction is complete, obliterate all temporary access roads and paths, stabilize the soil, and revegetate the area.
- Conduct timely removal of temporary fills such as gravel pads and equipment matting. Restore disturbed areas as soon as appropriate.
- Temporary roads and paths in wet areas or areas prone to flooding will be obliterated by the end of the in-water work window. Decompact road surfaces and drainage areas, pull fill material onto the running surface, and reshape to match the original contours.

Dust Abatement

- Employ dust abatement measures commensurate with soil type, equipment use, wind conditions, and the effects of other erosion control measures.
- Sequence and schedule work to reduce the exposure of bare soil to wind erosion.
- Maintain spill containment supplies on-site whenever dust abatement chemicals are applied
- Do not use petroleum-based products.
- Do not apply dust-abatement chemicals, e.g., magnesium chloride, calcium chloride salts, ligninsulfonate, within 25 feet of a water body, or in other areas where they may runoff into a wetland or water body.
- Do not apply ligninsulfonate at rates exceeding 0.5 gallons per square yard of road surface, assuming a 50:50 solution of ligninsulfonate to water.

Setback or Removal of Existing Berms, Dikes, and Levees

- Set-Back or Removal of Existing Berms, Dikes, and Levees will be conducted to reconnect historical fresh-water deltas to inundation, stream channels with floodplains, and historical estuaries to tidal influence. Such projects will take place where estuaries and floodplains have been disconnected from adjacent rivers through drain pipes and anthropogenic fill.

Floodplains and Freshwater Deltas

- Design actions to restore floodplain characteristics—elevation, width, gradient, length, and roughness—in a manner that closely mimics, to the extent possible, those that would naturally occur at that stream and valley type.
- Remove drain pipes, fences, and other capital projects to the extent possible.
- To the extent possible, remove nonnative fill material from the floodplain to an upland site.
- Where it is not possible to remove or set-back all portions of dikes and berms, or in areas where existing berms, dikes, and levees support abundant riparian vegetation, openings will be created with breaches. Breaches shall be equal to or greater than the active channel width to reduce the potential for channel avulsion during flood events. In addition to other breaches, the berm, dike, or levee shall always be breached at the downstream end of the project or at the lowest elevation of the floodplain to ensure the flows will naturally recede back into the main channel, thus minimizing fish entrapment.
- When necessary, loosen compacted soils once overburden material is removed. Overburden or fill comprised of native materials, which originated from the project area, may be used within the floodplain to create set-back dikes and fill anthropogenic holes provided that floodplain function is not impeded.

Estuary Restoration

- Project implementation shall be conducted in a sequence that will not preclude repairing or restoring estuary functions once dikes/levees are breached and the project area is flooded.

- Culverts and tide gates will be removed using the Project Design Criteria (PDC) (NMFS 2013) and conservation measures, where appropriate, as described in Work Area Isolation (PDC 27), Surface Water Withdrawals (PDC 23), Fish Capture and Release (PDC 28), and Fish Passage Restoration (PDC 33).
- Temporary roads within the project area should be removed to allow free flow of water. Material either will be placed in a stable area above the ordinary high water line or highest measured tide or be used to restore topographic variation in wetlands.
- To the extent possible, remove segmented drain tiles placed to drain wetlands. Fill generated by drain tile removal will be compacted back into the ditch created by removal of the drain tile.
- Channel construction may be done to recreate channel morphology based on aerial photograph interpretation, literature, topographic surveys, and nearby undisturbed channels. Channel dimensions (width and depth) are based on measurements of similar types of channels and the drainage area. In some instances, channel construction is simply breaching the levee. For these sites, further channel development will occur through natural processes.
- Fill ditches constructed and maintained to drain wetlands. Some points in an open ditch may be over-filled, while other points may be left as low spots to enhance topography and encourage sinuosity of the developing channel.

Dredging

Dredging during construction of and maintenance for the Hall Slough Alternatives has the potential to result in adverse impacts on water quality, fish, and other aquatic organisms. The following mitigation would be implemented to reduce this potentially significant impact:

- Use of a clamshell dredge using a close-lipped bucket (also referred to as an “environmental” bucket) operated from shore or a floating crane. This bucket has flaps that close off the top of the bucket during ascent, which reduces sediment re-suspension into the water column. An open bucket will only be used on a limited basis if sediments cannot be effectively removed with a close-lipped, environmental bucket.
- Modify the bucket speed, ensure the bucket is closed before ascent, maintain the bucket flaps, fill the bucket to capacity to minimize water in the bucket, prevent overfilling the bucket, and modify the bucket size and/or type.
- Post-dredge bathymetric surveys will be conducted to verify that only the material identified to be dredged was removed to the proper, authorized depth.
- A bin-barge or flat-deck barge with tall, watertight sideboards will be used to enclose dredged material, including dredged sediment and water. No material will be allowed to leak from the bins or overtop the walls.
- The barge will be loaded so that enough of the freeboard remains to allow for safe movement of the barge and its material on its planned route to the approved placement facility.
- All equipment used for in-water work will be clean and inspected daily prior to use to ensure the equipment has no fluid leaks. Should a leak develop during use, the leaking

equipment will be removed from the project site immediately and not used again until it has been adequately repaired. At no time will fuels or oils be allowed to enter the river.

- Floating spill containment booms and absorbent booms will be maintained on board dredge and disposal equipment to facilitate the cleanup of hazardous material spills. Containment booms and/or absorbent booms will be installed in instances where there is a potential for release of petroleum or other toxic substances.
- A monitoring plan will be implemented to monitor for turbidity during each dredging event and to help ensure the water quality will be adequately protected. Monitoring will be conducted at locations upstream (background) and downstream from the point of discharge.

4.1.2 Vegetation

- Locate staging areas in previously cleared or filled areas to reduce vegetation clearing, as practicable.
- For unavoidable temporary equipment impacts on native ground, perform work when the soil surface is as dry as practicable and better able to resist compaction, such as when the ground water table is low or during low tide.
- For unavoidable equipment impacts on compactible soil, place ground protection measures to reduce ground pressure such as wattle and brush, crushed rock, geotextile, or other methods.
- Upon completion of earthwork, remove non-native materials, decompact soil, and stabilize with vegetation, rolled erosion control products, or other erosion control measures.

4.1.3 Wetlands and Non-Wetland Waters

- Clearly demarcate wetlands within 50 feet of any ground disturbance and construction-related activities, including staging areas and access roads, to prevent unnecessary impacts from construction equipment and vehicles.
- Avoid unpermitted discharges of waste soil to jurisdictional wetlands or waters.
- Implement erosion and sediment control measures and spill prevention, control, and countermeasures to prevent contamination of wetlands and other waters during construction.
- Use low ground pressure equipment, such as tracked vehicles and lighter weight equipment, or protect wetland soil surfaces from displacement during earthwork.
- Minimize the number of temporary stream crossings; use existing stream crossings whenever practicable.
- Limit use of heavy construction equipment in wetlands when soils are saturated to the surface, as practicable.
- Construct new levees prior to breaching or removing existing levees so that the ground at the new levee locations would not be tidally influenced or inundated. Temporarily retain

the lower portions of the existing perimeter levees to prevent overtopping by summer high tides, so that virtually all the levee and fill removal, and new levee construction, occur out of the water.

- Assure no net loss of wetland functions and values through wetland resource replacement. Provide wetland resource replacement for unavoidable temporary and permanent impacts on jurisdictional wetlands or other waters.
- Minimize approved herbicide use during noxious weed control.

4.1.4 Fish and Wildlife

4.1.4.1 Aquatic Species

- Use NMFS-approved juvenile fish exclusion devices (fish screens) at intakes of water withdrawal pumps (NMFS 2011).
- Provide a concrete washout during construction to prevent contamination of waterways.
- Perform work that is located below the high tide elevation in the dry or during low tide, if possible.
- Install temporary in-water work isolation measures to divert flows and dewater work areas.
- Prepare a fish passage plan for installation or replacement of over-water structures, temporary or permanent bridges, tide gates, culverts, or fishways (ODFW 2014a).
- Construct fish friendly tide gates; that is, tide gates that have a prolonged open period to increase opportunities for juvenile fish to enter favorable backwater habitats at high tide but reduce opportunities for stranding during low tide conditions.
- Comply with the MMPA, which prohibits unauthorized direct or indirect take of marine mammals. Perform avoidance measures as required (CRC 2010; NMFS 2008b; ODFW 2011). To prevent an alteration of the animal's behavior due to construction activities, use of heavy equipment on the levees will be restricted when marine mammals are within 100 yards of the work area. This would require construction crews to be able to identify harbor seals and to be alert to the potential presence of seals when work is being conducted on the perimeter levees and floodgate structures. Work that is being completed on the landward side of the levee may continue.

4.1.4.2 Migratory Birds

- Create foraging opportunities for migratory birds and wintering waterfowl through wetland restoration and floodplain reconnections.
- Create conditions for riparian vegetation re-establishment where possible to develop suitable perching and nesting habitat attributes over time.
- Protect migratory birds, including birds listed for protection under the federal Endangered Species Act, Bald and Golden eagles, and birds of concern identified in the ODFW Conservation Strategy. An avian protection plan would be developed and implemented

to minimize potential impacts on nesting native birds. The following elements would provide protection for birds:

- Ensure compliance with the MBTA. This means migratory birds would not be killed, eggs would not be destroyed, and active nests would not be disturbed without a permit during vegetation clearing or ground disturbance.
- Train personnel to recognize migratory birds and their habitats and understand regulatory requirements of the MBTA, ESA, and BGEPA.
- Conduct pre-construction surveys within 3 days of construction activities or tree removal in potential nesting habitat when such activities would occur during the nesting season (March 1 to August 31 for song birds and possibly as early as January 15 for Bald eagles). Verify no migratory birds are nesting in areas to be cleared or trimmed.
- Do not clear vegetation during the active nesting period without a permit, unless nesting birds would be effectively excluded (Oregon Department of Transportation 2009).
- If it is not possible to conduct tree clearing outside the nesting season, obtain the applicable permit or coordinate with the USDA Applied Plant and Health Inspection Service to arrange inspections, hazing, and/or nest removal. Implement measures outside of the nesting season to keep birds from nesting in vegetation to be cleared and structures to be removed. Consider methods, such as netting, blocking materials, or harassing birds, to keep them from nesting.
- For all raptors (other than eagles), remove inactive nests before nesting season begins or place deterrents in the nest platform to prevent nesting during the year of construction. (Remove all deterrents after construction disturbances cease.) Establish a work restriction buffer in concurrence with resource agencies' recommendations if an active nest is located.

4.1.4.2 Eagles

- Bald eagles and their nests may occur in the project area during construction and are protected by the BGEPA. At least one active nest has been confirmed within the project area. The BGEPA protects active and inactive nests and prohibits take or harm to eagles, eggs, or body parts. Where nests are blown from trees during storms or are otherwise destroyed by the elements, nest sites should continue to be protected because eagles might rebuild the nest and reoccupy the nest site.
- Avoid removal of trees containing active or relict eagle nests. Avoid use of heavy equipment within 660 feet of an active nest, and avoid land use alterations within 330 feet of a nest during any season without a permit. Permanent alteration of vegetation within 660 feet of a nest would require a permit from USFWS. Obtain a BGEPA permit from USFWS to cover potential disturbances of eagles, if necessary. The permit would not authorize injury or collection of live or dead eagles, merely permission for disturbance to eagles and permanent land use alterations.

- Use pesticides, herbicides, fertilizers, and other chemicals only in accordance with federal and state laws.
- Monitor and minimize dispersal of contaminants associated with hazardous waste removal, permitted releases, and runoff where bio-accumulating contaminants have been documented.

4.1.5 Threatened and Endangered Species

- Comply with the federal Endangered Species Act, and other applicable laws protecting special-status species.
- Avoid or reduce the potential for take or harm of special-status species by incorporating biological resources awareness training, protocol-level plant and wildlife surveys, and exclusion measures for special-status fish and wildlife.
- Implement conservation measures for Pacific salmon, steelhead, and other ESA-listed aquatic species, as established in PROJECTS (NMFS #NWR-2013-10221; NMFS 2013), including the following:

Fish Passage

- Provide fish passage for any adult or juvenile ESA-listed fish likely to be present in the action area during construction, unless passage did not exist before construction, stream isolation and dewatering is required during project implementation, or the stream is naturally impassable at the time of construction.
- After construction, provide fish passage that meets NMFS' fish passage criteria for any adult or juvenile ESA-listed fish (NMFS 2011a) for the life of the action.

Fish Salvage

- If practicable, allow listed fish species to migrate out of the work area or remove fish before dewatering; otherwise, remove fish from an exclusion area as it is slowly dewatered with methods such as hand or dip-nets, seining, or trapping with minnow traps (or gee-minnow traps).
- Fish capture will be supervised by a qualified fisheries biologist with experience in work area isolation and competent to ensure the safe handling of fish.
- Conduct fish capture activities during periods of the day with the coolest air and water temperatures possible, normally early in the morning, to minimize stress and injury of species present.
- Monitor the nets frequently enough to ensure they stay secured to the banks and free of organic accumulation.
- Electrofishing will be used during the coolest time of day, and only after other means of fish capture are determined to be not feasible or ineffective.
    - Follow the most recent version of NMFS (2000) electrofishing guidelines.
    - Do not electrofish when the water appears turbid, e.g., when objects are not visible at depth of 12 inches.
    - Do not intentionally contact fish with the anode.

- Use direct current or pulsed direct current within the following ranges:
    1. If conductivity is less than 100 microsiemens (μs), use 900 to 1100 volts.
    2. If conductivity is between 100 and 300 μs, use 500 to 800 volts.
    3. If conductivity is greater than 300 μs, use less than 400 volts.
- Begin electrofishing with a minimum pulse width and recommended voltage then gradually increase to the point where fish are immobilized.
- Immediately discontinue electrofishing if fish are killed or injured, i.e., dark bands visible on the body, spinal deformations, significant de-scaling, torpid, or inability to maintain upright attitude after sufficient recovery time. Recheck machine settings, water temperature and conductivity, and adjust or postpone procedures as necessary to reduce injuries.

- If buckets are used to transport fish:
    - Minimize the time fish are in a transport bucket.
    - Keep buckets in shaded areas or, if no shade is available, covered by a canopy.
    - Limit the number of fish within a bucket; fish will be of relatively comparable size to minimize predation.
    - Use aerators or replace the water in the buckets at least every 15 minutes with cold clear water.
    - Release fish in an area upstream with adequate cover and flow refuge; downstream is acceptable provided the release site is below the influence of construction.
    - Be careful to avoid mortality counting errors.
- Monitor and record fish presence, handling, and injury during all phases of fish capture, and submit a fish salvage report (Appendix A, NMFS 2013) to NMFS within 60 days of capture, documenting date, time of day, fish handling procedures, air and water temperatures, and total numbers of each salmon, steelhead, and eulachon handled and ESA-listed fish injured or killed.

Additional Measures

- Take all necessary and appropriate actions to minimize take of listed species: perform in-water work during July 1 to September 15 and within temporary isolation measures to minimize aquatic disturbances. Salvage listed species trapped in isolation measures prior to construction. Seek approval from ODFW and NMFS for alternate in-water work windows, if needed. Approval of a variance will be required for in-water work in 2016 from July 1 to October 31 and in 2017 from July 1 to September 30.
- Do not conduct pile driving.
- Contain or remove all food waste and garbage daily to minimize the risk of attracting predators to construction activity areas.

- Implement conservation measures for Marbled murrelet as established in the Southern Flow Corridor Biological Opinion (to be determined). The measures described below are proposed in the biological assessment for the Proposed Action (USFWS 2015a); however, it may not be possible to follow the standard seasonal and daily timing restrictions on the use of heavy equipment in proximity to potential murrelet usage areas. USFWS is considering the benefit of allowing the construction to be completed over one nesting season with increased potential disturbance for that one year as compared to requiring construction to be conducted over several nesting seasons. Through the ESA consultation process, additional or alternate mitigation and minimization provisions may be required in the biological opinion that would need to be incorporated into the project design and implementation.
  - All work crews, project managers, and monitoring crews will ensure all food waste and garbage is cleaned up and properly contained to avoid attraction of predators, such as corvids.
  - Individual tree removal will not include the loss of occupied or unsurveyed nesting structure during the breeding period. If a tree with nesting structure in an occupied or unsurveyed stand will be removed to achieve tidal wetland habitat restoration goals, it will be done prior to April 1 or after September 15.
  - Activities associated with use of heavy equipment to complete the project actions (including site preparation, clearing, levee removal, channel creation, and ditch filling) will be avoided within the disruption distance of known occupied or unsurveyed suitable murrelet habitat or unsurveyed nesting structure from April 1 to June 15. Use of Goodspeed Road within unsurveyed suitable murrelet habitat for equipment transport and haul will be allowed during the period April 1 to June 15 subject to the following restriction:
    - Road use shall be limited to 2 hours after sunrise to 2 hours before sunset. After June 15, activities in these areas would have no daily timing restriction due to the difficulty of implementing a multi-phase habitat restoration construction project in tidally influenced areas and to increase the potential for completion of all project phases in one construction season to lessen overall temporal impact of the project.
  - Use of helicopters within the disruption distance of occupied murrelet habitat, unsurveyed suitable murrelet habitat, and unsurveyed murrelet nesting structure during the entire breeding period (April 1-September 15) will not be allowed.

4.2 Vegetation

Vegetation is important for wildlife habitat, wetland and floodplain functions, and for protecting water and air quality. Changes in vegetation can affect these other resources. The regulatory framework for these related resources is described in Section 2.1. There are a few regulations specifically related to vegetation. The Noxious Weed Act (7 U.S.C. 2801 et seq.) and EO 13112, Invasive Species, require agencies to control noxious weeds and invasive plants. Similarly, the Oregon Noxious Weed Control Law (Oregon Revised Statutes [ORS] 561) authorizes the Oregon Department of Agriculture (ODA) to protect Oregon’s natural resources from the invasion and proliferation of exotic noxious weeds. The county and city comprehensive plans both identify protection of natural resources, which include vegetated areas, as important goals.

Effects of each alternative were evaluated based on the type and extent of project activities and included consideration of measures proposed to avoid adverse effects. Comparisons were made among the alternatives to evaluate relative levels of significance. For each action alternative, the impact analysis includes summaries of short-term (effects occurring during construction; a period of 1 to 2 years), transitional (2 to 10 years, depending on the resource; the period when plants, fish, and wildlife establish and adapt to new physical site and habitat conditions), and long-term (ten to fifty years), the time frame for reaching and sustaining a new dynamic equilibrium or restoration goal) effects.

The potential impacts of each alternative on vegetation communities are described in this section. Impacts on vegetation would be significant if implementation of the project would result in the permanent loss, degradation, disturbance or fragmentation of existing natural vegetation communities.

4.2.1 No Action Alternative

Under the No Action Alternative, the existing mix of vegetation communities, including emergent wetlands (pasture and non-pasture), shrub/scrub wetlands, and mature Sitka spruce riparian/tidal forested wetlands would largely remain. However, agricultural uses on the County-owned land would phase out over time, and land that is currently pasture and hayfields would be expected to convert to freshwater wetlands supporting emergent plants with patches of scrub/shrub and forest. Seasonal high water from recurrent flood events would result in continued periodic inundation of low-lying areas. Vegetation communities, including emergent wetlands (pasture and non-pasture), shrub/scrub wetlands, and mature Sitka spruce riparian/tidal forested wetlands, would continue to experience ecosystem disturbances. Over the long term, non-native and invasive plant species currently in the wetlands likely would increase as a result of seed transported by floodwaters and by continued agricultural practices.

Additionally, the development and succession of plant communities would continue to occur. Some expansion of willow dominated shrub/scrub wetlands would occur in current emergent wetlands without grazing pressure, and some sedimentation and closure of waterways would occur over time. The County-owned area (152 acres) that is currently in pasture and hayfields likely would transition to a similar shrub-dominated system with cessation of grazing. The Sitka spruce stands in the eastern and north-central portions of the project area would remain, as no substantial change in the hydrologic regime would be expected. Some large diameter Sitka spruce trees could be lost through winter storms, flood inundation, and senescence although this vegetation type could potentially expand.

4.2.2 Alternative 1: SFC – Landowner Preferred Alternative

In contrast to the No Action Alternative, the Proposed Action, would result in modifications of existing vegetation, including direct removal of some vegetation and changes to hydrologic regime and water salinity level and ultimately would result in a major shift in vegetation community types within the study area. Approximately 522 acres of tidally-influenced wetlands would be restored to pre-disturbance tidal wetland conditions in the areas re-opened to tidal influences. The majority of the existing wetlands would be converted from freshwater emergent wetlands to estuarine tidal wetlands with a saline or brackish water regime. Most of the existing freshwater wetland vegetation consists of pasture and other non-native vegetation which would not tolerate the saline waters that would enter the site, and would die off (NHC 2010). Salinity levels would vary across the restoration area, with higher salinity levels west, decreasing inland, resulting in potentially less impact to vegetation communities farther inland.

Construction impacts would include removal of vegetation in areas where levees would be removed, modified, or constructed. Blind Slough would be lengthened to connect to Hall Slough, which would cause removal of some existing wetland vegetation or establishment of brackish water or saline tolerant tidal wetland vegetation communities adjacent to the new channel. Other new channels would be constructed on the downstream ends of the new flood control structures in the new levees and at the upstream end of Nolan Slough. At approximately 20 locations, existing riprap would be removed to help reestablish channel connections with the bordering rivers and sloughs and encourage the historic side channels to reform on the interior. As these side channels re-form, the vegetation communities would be expected to diversify as different elevations and permanent watercourses develop.

To the extent practicable, spruce trees would be preserved in place and protected, in particular those spruce trees that were identified as having appropriate physical structure to support potential marbled murrelet nesting. Approximately 100 to 150 spruce trees and all the red alder trees along Hoquarten Slough in the southeastern portion of the study area would be removed; approximately 40-50 trees would be retained. Several hundred more spruce would be removed along Hall Slough as a result of the berm removal along Hall Slough in the northwestern portion of the study area. Approximately 5-10 trees would be retained in this area. The size range and number of surveyed trees within the project area are shown on **Figure 6**. **Figure 11** shows trees that would be retained.

Some of the spruce trees that are removed would be reused on site to provide large woody debris and habitat structures within the restoration area. A habitat log typically consists of the root wad and the first 30 feet of the spruce trunk. The log ends of placed habitat trees would be keyed into the ground for anchoring. They would be placed in the floodplain areas, but not in the active channels. Permanent anchoring by piling or other engineered means would not be used and trees will be free to move during flood events. Some trees would be reserved for use in offsite restoration projects; approximately 40 trees would be used by ODFW at a proposed restoration site along Beaver Creek in 2016 (Levesque 2015). Additional trees suitable for reuse in other restoration projects may be stockpiled for up to 2 years for reuse as habitat structures in other restoration projects. Branches and other vegetative debris would be chipped on site and used for hog fuel on access roads and as brush berms or other temporary erosion and sediment control. Bigger limbs and tops would be used in place for temporary plank roads for construction access. These plank roads would remain post-project and would deteriorate in place. Levee sideslopes of the new setback levees and modified levees would be hydroseeded for erosion control.

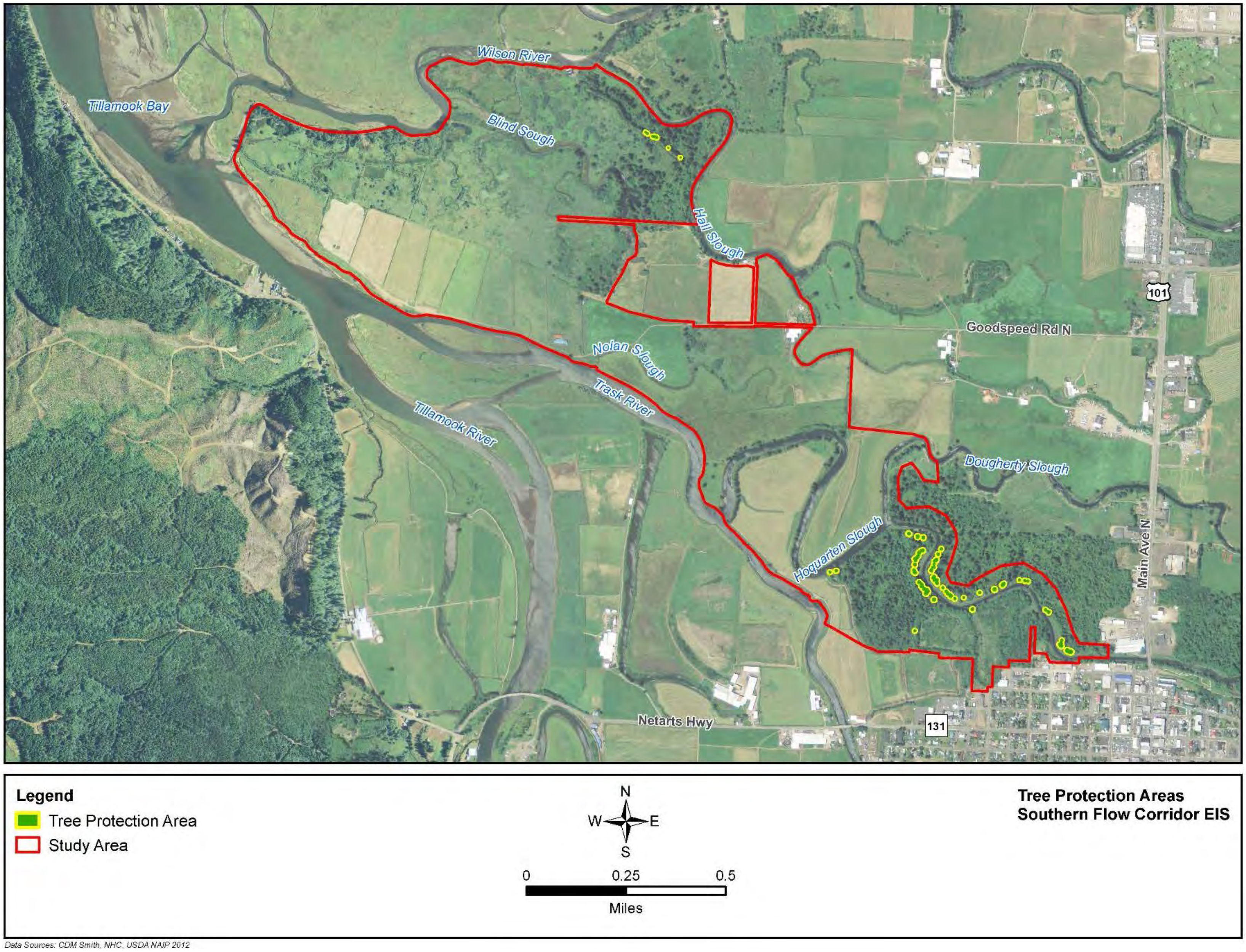


Figure 11. Tree Protection Areas

During construction, measures would be implemented to control the introduction and spread of invasive species in the project area. To ensure non-native or invasive plants or seeds are not introduced or spread in the project area, vehicle wash stations would be located at all major entrances to the construction site, with the precise locations to be determined by the construction contractor in compliance with permit conditions.

Following removal of the perimeter levees, wetland vegetation communities, wetland vegetation communities would transition to a species assemblage tolerant of saline or brackish water (Meyers 1996; Thom et al. 2002; USFWS 2014a; Warren et al. 2002). Natural tidal processes would bring in the water, salinity, sediment, and seeds that would initiate restoration (NHC 2010). Native estuarine plants would become established through natural recruitment from the soil seed bank and propagules brought by the tidewaters from nearby tidal marshes (Frenkel and Morlan 1991; Rozsa 2012). Wetlands in areas farthest from the bay may receive little or no saline or brackish water and therefore may have little change from current conditions. Reference sites with which to compare development of the proposed project have been identified in the SFC Project Effectiveness Monitoring Plan (Brophy and van de Wetering 2014).

During this transition period, the existing vegetation would be expected to change in response to changes hydrology and salinity. Because of prior land subsidence associated with removal of tidal influence due to diking (Simenstad et al. 1999), it is likely the lands would initially convert to low marsh or tidal mudflat habitats (i.e., floods and drains twice daily) (Tiner 2013). Over time and through sediment accretion, low marsh may convert to high marsh (i.e., slightly higher elevations and less frequent flooding) (Jefferson 1975). Lower portions of the spruce forest in the northwest corner likely would die off, either through salinity or simply higher water levels (NHC 2011). Some trees in the forested wetlands along the southern study area near the City of Tillamook may also die off due to higher water levels after dike removal; however, mortalities likely would be fewer as impacts from changes in salinity and water levels from re-introduced tides would be less. Riparian vegetation would establish naturally along stream channels at higher elevations, providing increased habitat diversity, cooling water to benefit aquatic organisms, and streambank stabilization (TBNEP 1999). Tree species that would likely establish include willow, black cottonwood, and red alder. Under normal conditions, the growth rate for alder and cottonwood is 3 to 4 feet per year and 1 to 12 feet per year respectively (Huff, et al., 2013) indicating that these species would provide good shade and cover after approximately 10 to 15 years.

Restoration of tidal wetlands through tidal reconnection and removal of flow barriers, such as dikes and levees, produces an ecological trajectory toward relatively undisturbed conditions (Cornu and Sadro 2002). Relatively undisturbed conditions are defined as conditions typical of natural tidal wetlands, unaltered (or minimally altered) by human influence, as demonstrated in reference sites. However, in the short term, the study area may see an increase in opportunistic, non-native plant species or native colonizers not typical of the less disturbed tidal wetland vegetation community. These species may temporarily dominate during the early years after restoration but would not be expected to persist in the long term (Cornu and Sadro 2002, Woo et al. 2011a). They would be expected to die out with increasing salinity levels and eventually be replaced by saline tolerant native tidal plant species (Smith and Warren 2012).

At the Salmon Creek salt marsh restoration, pasture species rapidly died out and were initially replaced by annual native and non-native marsh colonizers. Within about 4 years, these species began to be replaced by regionally common native marsh species such as Lyngbyi's sedge , salicornia (*Salicornia virginiana*), and saltgrass (*Distichlis spicata*) (Frenkel 1995). Post-restoration monitoring at the Nisqually Delta estuarine restoration project in Puget Sound found over 75 percent cover of invasive species, primarily reed canarygrass in a pre-restoration survey of the site. One year following restoration, monitoring surveys found less than one percent cover of reed canary grass along permanent transects with saltgrass, salicornia, and Baltic rush becoming established (Woo et al. 2011a, 2011b). Temporary establishment of annuals may or may not require adaptive management to realize full potential.

While development of mature tidal wetland vegetation communities likely would not be achieved for many years, the study area would progress from an early period of rapid change to a gradual trajectory toward a fully functioning tidal wetland vegetation complex (Simenstad and Thom 1996; Thom et al. 2002). The minimum timeline for full functional replacement would be 5 to 10 years for the emergent wetland vegetation (Kidd and Yeakley 2014; Zedler and Callaway 1999), with longer time periods expected for shrub and forested systems (Zedler and Callaway 1999), probably in the neighborhood of ten to fifty years. At a salt marsh restoration project conducted at the Salmon River along the central Oregon Coast in 1978, native salt marsh vegetation was fully restored within about 8 years following dike removal, with no planting, seeding, or grading (Frenkel 1995). The Proposed Action would result in increased wetland habitat complexity and availability, providing significant ecological benefits, including development of low and high tidal marsh and forested tidal vegetation communities (Tillamook County 2013).

Reference sites for the proposed project have been identified in the *Southern Flow Corridor Project Effectiveness Monitoring Plan* (Brophy and van de Wetering 2014). Transitions in the vegetation on site would be monitored according to the monitoring plan and results compared against the reference sites. Monitoring results would allow for an evaluation of progress of the restoration project. Monitoring would track changes in biological and physical parameters, including vegetation in the project area, and would identify areas where adaptive management may be needed to achieve restoration of tidal marsh communities. Monitoring was begun in spring 2014 to establish baseline conditions and would continue following implementation of the project. In addition, Tillamook County and the Port would develop a maintenance and monitoring plan as a condition of grants and permits associate with the project. The Plan would define performance standards and include adaptive management actions that would be triggered if the performance goals are not met. The County and Port would be responsible for implementation and funding of the maintenance and monitoring activities.

The Proposed Action would have moderate to major local temporary and permanent effects on the existing vegetation, but existing vegetation communities, which are predominantly pasture or non-native vegetation, would be replaced with largely native communities better adapted to the estuary environment, providing a major benefit at the local scale. In the short term (one to two years), implementation of this alternative would result in moderate to major impacts on vegetation locally as trees are removed and a predominantly saltwater regime is established. Impacts would be moderate to major on a local scale in the period following implementation (approximately two to ten years), as the existing vegetation dies and begins to be replaced with vegetation tolerant of saline conditions. Existing vegetation that would be lost is predominantly pasture or non-native vegetation. Implementation of this alternative would result in a transition of these existing vegetation communities to predominantly native, tidal wetland vegetation communities.

Long-term (ten to fifty years) adverse effects are not anticipated because vegetation communities will be left in a natural, un-maintained condition, and the communities would transition naturally from fresh to saltwater associated vegetation. In the long term, Alternative 3 would provide significant local and regional benefits as vegetation communities typical of tidal wetlands historically present in the region are re-established. Limited areas of forested vegetation communities may develop over time in areas of the project that are higher in elevation and less tidally influenced; however, the predominant vegetation community types are anticipated to be herbaceous. Re-establishment of tidal vegetation communities would result in increased habitat complexity and availability, providing significant ecological benefits, including development of low and high tidal marsh and forested tidal wetland vegetation communities.

4.2.3 Alternative 2: Hall Slough Alternative

The Hall Slough Alternative would reestablish a connection to the Wilson River, widen and deepen approximately 1.9 miles of Hall Slough, and set back and modify approximately 6.3 miles of levees along the channel bank (NHC 2010). During construction, vegetation would be disturbed where levees would be set back or modified. The areas where new setback levees would be placed are entirely pasture; therefore, there would be a minor effect on vegetation from the new setback levees. These actions would ultimately relieve regular nuisance flooding.

Changes to vegetation communities across the larger SFC study area would be similar to the No Action Alternative because actions would be limited to a narrow, heavily disturbed corridor along Hall Slough, but the locations and extents of vegetation communities would shift in response to dredging, filling, and modifying hydrology. As with the No Action Alternative, agricultural uses on the County-owned land would phase out over time, and land that is currently pasture and hayfields would be expected to convert to freshwater wetlands, supporting emergent plants with patches of scrub/shrub and forest.

The existing levees that would be removed and the banks of Hall Slough currently support riparian vegetation. This vegetation is discontinuous but does include a variety of shrubs and trees, including species such as salmonberry, twinberry, red elderberry, Hooker’s willow, and the occasional spruce, and non-native species such as Himalayan blackberry and Scot’s broom. Some of the trees along Hall Slough upstream of Goodspeed Road are mature trees that provide habitat features in an otherwise disturbed landscape. Under this alternative, short-term impacts (one to two years) associated with the channel widening would include removal of approximately 9 acres of this woody riparian vegetation.

In the years following completion of construction activities, riparian vegetation would be expected to re-establish on the new banks. The area between the top of the new channel banks and the new setback levees would be approximately 90 acres. Potentially, all of this area could convert to wetlands and riparian vegetation. Outside of the existing levees, the vegetation is currently all pasture; therefore, this would represent an increase in habitat diversity and function.

Tidal wetland conditions may develop in the area between the setback levee and the new, widened channel, particularly in the lower reaches of the slough, producing a shift from freshwater to tidal marsh vegetation.

The long-term effects of the Hall Slough Alternative on vegetation would be minor to moderately beneficial at the local scale because there would be an increase in the area of riparian and/or wetland vegetation communities in the areas of the setback and new widened channel.

4.2.4 Alternative 3: SFC – Initial Alternative

Impacts associated with Alternative 3 would be similar to those associated with the Proposed Action. Like the Proposed Action, and in contrast to the No Action Alternative, Alternative 3 would result in modifications of existing vegetation and would ultimately result in a major shift in vegetation community types from freshwater wetland pasture and other predominantly non-native vegetation communities to predominantly native vegetation typical of the historical tidal wetland communities. Alternative 3 would re-establish historical tidal connectivity, resulting in a net increase of approximately 568 acres of restored tidal wetlands. This restoration would result from the removal of existing levees and the restoration of tidal influences, resulting in the conversion of existing drained and diked farmland and other diked uplands and freshwater wetlands. Blind Slough would be lengthened to connect to Hall Slough, which would cause removal of some existing wetland vegetation or establishment of brackish water or saline tolerant tidal wetland vegetation communities adjacent to the new channel. The same changes in vegetation would be expected to occur under this alternative as described for the Proposed Action except that a somewhat larger area would be restored to the historic tidal wetland condition (568 acres versus 522 acres).

In the short term (one to two years), implementation of this alternative would result in moderate to major impacts on vegetation locally as trees are removed and a predominantly saltwater regime is established. Trees along the existing levees would be handled in the same way as described for the Proposed Action, with some being left in place as living trees, some reused on other portions of the site for habitat structures, and others removed for reuse in offsite restoration projects or resale.

Impacts would be moderate to major on a local scale in the period following implementation (approximately two to ten years), as the existing vegetation dies and begins to be replaced with vegetation tolerant of saline conditions. Existing vegetation that would be lost is predominantly pasture or non-native vegetation. Natural tidal processes would bring in the water, salinity, sediment, and seeds that would initiate ecological restoration (NHC 2010). Native estuarine plant species would become established through natural recruitment with seeds and propagules brought by the tidewaters from nearby tidal marshes (Frenkel and Morlan 1991).

Under Alternative 3, the majority of the existing vegetation communities would be converted from a freshwater to a saline or brackish water regime. Most of the freshwater wetland and pasture vegetation would not tolerate the saline waters that would enter the study area, and that vegetation would quickly die off (NHC 2010). Because the study has subsided by several feet, the lands would initially convert to low marsh or tidal mudflat habitats. Lower portions of the spruce forest in the northwest corner also would die off, either through increased salinity or higher water surface elevations. Over time, wetland vegetation communities would transition to a species assemblage tolerant of saline or brackish water. Forested wetlands along the southern study area boundary near Tillamook would die off due to higher water levels after dikes are removed. Riparian vegetation would establish naturally along stream channels at higher elevations, providing increased habitat diversity, cooling water to benefit aquatic organisms, and providing streambank stabilization (TBNEP 1999). Vegetation communities in areas farthest from the bay may receive little or no saline or brackish water and therefore may see little change from current conditions.

While restoration of tidal wetlands through tidal reconnection and removal of flow barriers, such as dikes and levees, has been shown to produce a trajectory toward reference conditions in the short term, the study area may see an increase in opportunistic, non-native plant species or native colonizers not typical of the reference tidal wetland vegetation communities. These species may temporarily dominate during the early years after restoration but would not be expected to persist in the long term (Cornu and Sadro 2002, Woo et al. 2011a, 2011b). Such temporary conditions may or may not require adaptive weed management.

In the long term (ten to fifty years), Alternative 3 would provide significant local and regional benefits as vegetation communities typical of tidal wetlands historically present in the region are re-established. Re-establishment of tidal vegetation communities would result in increased habitat complexity and availability, providing significant ecological benefits, including development of low and high tidal marsh and forested tidal wetland vegetation communities. Monitoring of the vegetation would be conducted to allow for adaptive management as described for the Proposed Action.

4.3 Wetlands

4.3.1 Overview

This section analyzes potential wetland impacts associated with the No Action Alternative and each of the proposed action alternatives. Alternatives range from doing nothing (No Action Alternative) to varying degrees and methods of flood reduction and wetland and floodplain restoration. Project work activities, including the removal of dikes, soil, plants, and the placement of materials within channels and existing wetlands, would require a removal/fill permit from DSL, a Section 404 Permit from USACE, and a Section 401 Water Quality Certification through the Oregon Department of Environmental Quality. Alternative design components that affect reasonable navigation would require a Section 10 permit through USACE.

Wetlands contribute critical functions to watershed health, including water quality improvement, filtration, flood attenuation, groundwater recharge and discharge, and fish and wildlife habitats. Tidal saltwater wetlands are among the most productive ecosystems in the world (Mitsch and Gosselink 1993). TBNEP (1999) prioritized floodplain and lowland restoration sites within the Tillamook Bay area based on these criteria: habitat connectivity, high quality in stream or riparian habitat, riparian trees, multiple benefits for habitat, water quality, erosion, and flood protection (TBNEP 1999). Impacts would be considered significant if they would result in the loss, degradation, or destruction of wetlands, resulting in a net loss of functional values.

Table 4.1 provides a summary of anticipated wetland restoration acreages by alternative. A complete discussion of anticipated impacts follows.

Table 4.1. Potential Tidal Wetland Restoration Acreages by Alternative within the Study Area

Alternative	Alternative Name	Wetland Restoration (acres)				Total Area of Wetland Restoration (acres)
		Low Marsh	High Marsh	Tidal Spruce Forest	Freshwater or Transitional	
	No Action Alternative	0	0	0	0	0
1	Proposed Action					522
2	Hall Slough Alternative	0	0	0	0	90[1]
3	Alternative 3					568

1 - Under Alternative 2, the area between the new setback levees would be approximately 90 acres; however, not all of this area may become wetlands under the alternative.

4.3.2 No Action Alternative

Under the No Action Alternative, the existing mix of wetland types, including emergent wetlands (pasture and non-pasture), shrub/scrub wetlands, and Sitka riparian/tidal forested wetlands would maintain present dynamic conditions and ecological trajectories. No Action assumes seasonal inundation from recurrent high water events would result in continued periodic flooding of low-lying areas. Agricultural uses on the County-owned land would phase out over time, and land that is currently pasture and hayfields would be expected to convert to freshwater wetlands with patches of scrub/shrub and forested wetlands. Over the long term, non-native and invasive plant species currently in the wetlands would likely increase as a result of seed transported by floodwaters and by continued agricultural practices. Also, under the No Action Alternative, the Sitka spruce stands at the eastern and north-central portions of the study area would not die off because the hydrologic regime would not change.

There would be no construction activities as part of the No Action Alternative; therefore, there would be no construction-related impacts on wetlands. Short- and long-term impacts of the No Action Alternative on wetlands would be minor as subsidence, at the estimated rate of 0.5 inch per year (see Section 4.7.1), would be expected to continue. In addition, spread of non-native and invasive species would be expected to continue with no control measures in place. The long-term reduction in tidal wetlands in the estuary would continue to be a major regional impact.

4.3.3 Alternative 1: SFC – Landowner Preferred Alternative

In contrast to the No Action Alternative, the Proposed Action would result in temporary, construction-related impacts on the existing environment during construction and tidal marsh restoration activities, including ground disturbance, vegetation removal, heavy equipment operation in wetlands and adjacent to waterways, and site stabilization. Approximately 522 acres of wetlands would be restored to tidal marsh in the areas re-opened to tidal influences.

The Proposed Action would result in temporary, construction-related impacts on the existing environment during construction and tidal marsh restoration activities, including ground disturbance, vegetation removal, heavy equipment operation in wetlands and adjacent to waterways, and site stabilization. Construction of approximately 1.4 miles of new setback levees would result in fill of approximately 10 acres of existing wetland but would also result in a shorter levee length overall. Construction of these levees would be considered a fill under state and federal regulations. This fill would be mitigated by removal of levees in other portions of the project area resulting in a net increase in total wetland area. Removal of approximately 6.9 acres of existing dikes would result in restoration of a minimum of 50 acres of previously filled wetland, resulting in a net increase in total wetlands within the study area. Under the Proposed Action, Blind Slough would be lengthened to connect to the Wilson River, which would result in removal of some existing wetlands or establishment of new wetlands adjacent to the new channel.

The transition from a freshwater to an estuarine system would result in major modification of existing terrestrial and aquatic wildlife habitats, leading to a shift in species composition in the study area (see Section 4.4). The majority of the existing wetlands would be converted from freshwater emergent wetlands to estuarine tidal wetlands with a saline or brackish water regime. A large portion of the existing wetlands that would be converted are low quality, freshwater pasture wetlands, currently providing only limited wetland functions. Most of the freshwater wetland and pasture vegetation would not be able to tolerate the saline waters that would enter the site, and that vegetation would quickly die off (NHC 2010). The land surface in the study area has subsided by several feet since diking, a common occurrence where regular tidal inundation has been eliminated or highly reduced (Simenstad et al. 1999). Therefore, it is likely the lands would initially convert to low marsh or tidal mudflat habitats (Tiner 2013).

Over time, wetland vegetation communities would transition from pasture and other non-native vegetation to an assemblage of predominantly native species tolerant of a saline or brackish water regime (Meyers 1996; Thom et al. 2002; USFWS 2014a; Warren et al. 2002). In the short term, the area could be expected to see an increase in non-native and/or invasive species (Tanner et al. 2002; Frenkel 1995), as these species are quick to establish in disturbed areas. This may include spread of currently present non-native species and/or establishment of new non-native species specifically adapted to colonize areas of disturbance. However, in the long term, implementation of proposed weed control measures along with natural recruitment of more saline-tolerant species (Smith and Warren 2012) would likely make this a negligible to minor impact. For comparison, at a salt marsh restoration project at the Salmon River along the central Oregon coast in 1978, pasture species rapidly died out and were initially replaced by annual native and non-native marsh colonizers. Within about 4 years, these species began to be replaced by regionally common native marsh species such as Lyngbyi’s sedge, salicornia, and saltgrass (Frenkel 1995).

Lower portions of the spruce forest in the northwest corner would also likely die off either through increased salinity, longer hydroperiods, or higher water levels. Forested wetlands along the southern study area boundary near Tillamook may also die off due to higher water levels after dikes would be removed. While return to fully functional tidal wetland conditions would not be achieved for several years, the study area would progress gradually from an early period of rapid change toward a fully functioning tidal wetland complex (Simenstad and Thom 1996;

Thom et al. 2002). The minimum timeline for full functional replacement would be expected to be 5 to 10 years (Kidd and Yeakley 2014; Zedler and Callaway 1999) for emergent wetlands, with longer time periods (approximately ten to fifty years) expected for shrub and forested systems (Zedler and Callaway 1999). Soil development is likely to take at least a decade or longer in the tidally re-connected wetlands (Kidd and Yeakly 2014; Short et al. 2000). The replacement wetland would be expected to be predominantly tidal marsh, characterized by herbaceous vegetation. Trees and shrubs would be expected to establish in higher elevation areas on berms and along streams and sloughs. At the Salmon Creek salt marsh restoration, while low marsh conditions were fully developed after about 8 years, full development of the presumed historical high marsh conditions could take 80 to 100 years (Frenkel 1995).

The Proposed Action would result in increased wetland habitat complexity and availability, providing significant ecological benefits, including development of areas of low and high tidal marsh and tidal forested wetlands (Tillamook County 2013). Restoration of tidal wetlands through tidal reconnection and removal of flow barriers, such as dikes and levees, has been shown to produce more naturally occurring ecological conditions. However, in the short term, the study area may see an increase in opportunistic, non-native species or native colonizers not typical of the reference wetland. Reference wetlands for the Proposed Action were identified in the *Southern Flow Corridor Project Effectiveness Monitoring Plan* (Brophy and van de Wetering 2014). This may include spread of currently present non-native species or establishment of new non-native species specifically adapted to colonize areas of disturbance. These non-native or invasive species may temporarily dominate during the early years after restoration but would not persist in the long term (Cornu and Sadro 2002). Such temporary conditions may or may not require adaptive management to maintain full function. Natural tidal processes would bring in the water, salinity, sediment, and seeds that would initiate restoration (NHC 2010). Native estuarine plants would become established through natural recruitment with propagules brought by the tidewaters from nearby tidal marshes (Frenkel and Morlan 1991; Rozsa 2012). Wetlands in areas farthest from the bay may receive little or no saline or brackish water and therefore may change little from current conditions.

No net loss of wetland functions and values would be assured through conditions of required federal and state wetland removal-fill permits. The applicant would prepare a maintenance and monitoring plan that would include performance standards and potential adaptive management measures. The applicant would be responsible for funding and implementation of the plan.

The effects of implementation of Alternative 1 on freshwater wetlands would be minor to moderate as existing wetlands currently consist of predominantly low quality pasture wetlands. During the transition period, there would be shifts in the wetland types present in project area as freshwater wetland types are replaced by estuarine wetland types. Alternative 1 would provide for the restoration of approximately 522 acres of tidal wetland. Existing wetlands would remain but would shift from freshwater to tidal wetlands. Restoration to a tidal wetland system would be a major local and regional benefit as lowland wetland and estuarine habitats have to a large degree been largely lost or degraded along the Oregon Coast. Restoration of these tidal wetlands would represent a major benefit by providing habitat for fish and wildlife species (see Section 4.6.2), including federally listed threatened or endangered species (see Section 4.6.3), and improving water quality (see Section 4.5.4) and floodplain functions (see Section 4.5.1).

4.3.4 Alternative 2: Hall Slough Alternative

The Hall Slough Alternative would reestablish a connection to the Wilson River, widen and deepen approximately 1.9 miles of the slough, set back and modify approximately 6.7 miles of levees along the channel bank, and ultimately relieve regular nuisance flooding. Widening and deepening of Hall Slough may result in removal of adjacent wetlands and associated wetland vegetation, predominantly non-native pasture grasses.

The Hall Slough alternative would result in temporary, construction-related impacts on the existing environment during construction, including ground disturbance, vegetation removal, and heavy equipment operation in wetlands and adjacent to waterways. Changes to wetlands would not differ greatly from the No Action Alternative, with the exception of the revival of the presently absent Hall Slough connection to the Wilson River and the possible formation of tidal wetlands in the area between the setback levee and the new, widened channel. As with the No Action Alternative, agricultural uses on the County-owned land would phase out over time, and land that is currently pasture and hayfields would be expected to convert to freshwater wetlands with patches of scrub/shrub and forested wetlands.

Under the Hall Slough Alternative, approximately 6.7 miles of setback levees would be constructed or existing levees modified along Hall Slough, but would result in minimal, if any, fill of existing wetland. New setback levees that would be constructed in existing wetlands would constitute fill under federal and state wetland removal-fill regulations; however, only a portion of the Hall Slough Alternative project area is within wetlands. The NWI mapping shows the downstream portions to be likely wetlands (**Figure 7**), but the vegetation mapping based on information from Brophy (2014a, b) shows the majority of the project area is upland pasture or hayfield (**Figure 4**).

In the long term, the Hall Slough Alternative would allow for the restoration of up to 90 acres of riparian flow-through and tidal wetlands between the new setback levees along the Hall Slough channel. This assumes the entire area within the new setback levees becomes wetland, but because the upper end of Hall Slough is currently not wetland, it may not become wetland with the proposed widening and deepening of the slough. Therefore, the expected acreage of restored wetland under this alternative would be expected to be less than the 90 acres within the levees. The wetlands inside the new setback levees would have improved functions as they would be reconnected to the floodplain and to tidal influences, and there would be a net beneficial effect on wetlands. It is anticipated the alternative would be self-mitigating with respect to potential impacts on wetlands because the proposed work would provide opportunities for wetland restoration on the banks of the slough.

Construction impacts of Alternative 2 on wetlands would be minor as most of the wetland areas are currently highly modified pasture areas. Transition period effects of Alternative 2 on wetlands would also be minor as wetland areas would reform in the space between the new setback levees and the channel, and these areas would be protected from agricultural disturbances. Long-term impacts of Alternative 2 on wetlands would be moderately beneficial, providing for the restoration of up to 90 acres of tidal wetland.

4.3.5 Alternative 3: SFC – Initial Alternative

Impacts associated with the Alternative 3 would be similar to those associated with the Proposed Action. Like the Proposed Action, and in contrast to No Action, Alternative 3 would result in modifications of existing wetlands, including changes to hydrologic regime and water salinity levels, and would ultimately result in a major shift in wetland types within the study area. Alternative 3 would result in temporary, construction-related impacts on the existing environment during construction and tidal marsh restoration activities, including ground disturbance, vegetation removal, heavy equipment operation in wetlands and adjacent to waterways, and site stabilization. Construction of approximately 1.6 miles of new setback levees would result in detrimental impacts on existing wetlands but would result in a shorter length of levee overall. New setback levees that would be constructed in existing wetlands would constitute fill under state and federal removal fill regulations while removal of existing dikes would restore previously filled historical wetlands. Construction-related activities, including the removal and construction of levees, movement of soil, removal of plants, and the placement of materials within ditches and existing wetlands, would require state and federal permits. Required permits would be the same as those described for the Proposed Action. This alternative would also be considered self-mitigating as it would be designed so that the wetlands on site would be restored to estuarine communities.

Similar to the Proposed Action, the transition from a predominantly freshwater to an estuarine system would result in major modification of existing wetlands, leading to a shift in species composition in the study area. While restoration of tidal wetlands through tidal reconnection and removal of flow barriers, such as dikes and levees, would trend toward less disturbed conditions, the study area may see a short-term increase in opportunistic, non-native species or native colonizers atypical of the undisturbed wetland. These species may temporarily dominate during the early years after restoration but would not persist in the long term (Cornu and Sadro 2002). Such temporary conditions may or may not require adaptive weed management. Natural tidal processes would bring in the water, salinity, sediment, and seeds that would initiate restoration (NHC 2010). Native estuarine plant species would become established through natural recruitment with seeds and propagules brought by the tidewaters from nearby tidal marshes (Frenkel and Morlan 1991). Wetlands in areas farthest from the bay may receive little or no saline or brackish water and therefore may see little change from current conditions. Overall, Alternative 3 would increase wetland habitat complexity and availability, providing important ecological benefits, including development of areas of low and high tidal marsh and forested tidal wetlands (Tillamook County 2013).

Long-term impacts associated with Alternative 3 would be similar to those associated with the Proposed Action; however, Alternative 3 would result in the restoration of more tidal wetlands, potentially restoring 568 acres of wetland, representing a net increase in total wetlands and an increase in wetland functions within the project area. Re-establishment of the historical tidal connectivity would result in a net increase of approximately 568 acres of restored tidal wetland habitat. This restoration would result from the conversion of existing drained and diked farmland and other diked uplands and freshwater wetlands. Under Alternative 3, approximately 1.6 miles of setback levees would be constructed or existing levees modified, resulting in fill of approximately 13 acres of existing wetlands. Removal of approximately 8.8 miles of existing dikes would result in restoration of approximately 64 acres of previously filled wetlands, resulting in a net increase in total wetlands within the study area.

Under Alternative 3, the majority of the existing wetlands would be converted from a freshwater to a saline or brackish water regime. Most of the freshwater wetland and pasture vegetation would not be able to tolerate the saline waters that would enter the study area, and that vegetation would quickly die off (NHC 2010). Because the study area has subsided by several feet, it is likely the lands would initially transition to low marsh or tidal mudflat habitats. Lower portions of the spruce forest in the northwestern corner would die off either through increased salinity, longer hydroperiods, or higher water levels. Over time, wetland vegetation communities would transition to species assemblages tolerant of saline or brackish water. Forested wetlands along the southern study area boundary near Tillamook may also die off due to higher water levels following dike removal. Under Alternative 3, Blind Slough would be lengthened to connect to the Wilson River, which would result in removal of some existing wetlands or establishment of new wetlands adjacent to the new channel.

Overall, Alternative 3 would result in increased wetland habitat area and complexity, providing a mix of priority ecological benefits, including development of low and high tidal marsh and forested tidal wetland vegetation communities (Tillamook County 2013). Although there would be major changes in the wetland communities in the project area, no significant vegetation adverse impacts would be anticipated because vegetation communities would transition naturally from predominantly non-native freshwater pasture to historic estuarine vegetation communities.

The effects of implementation of Alternative 3 on freshwater wetlands would be minor to moderate as existing wetlands consist of predominantly low quality pasture wetlands. During the transition period, there would be major shifts in the wetland types present in the project area as freshwater wetland types are replaced by estuarine wetland types. Alternative 3 would provide for the restoration of approximately 568 acres of tidal wetland. Existing wetlands would remain but would shift from freshwater to tidal wetlands. Restoration to a tidal wetland system would be a significant local and regional benefit as lowland wetland and estuarine habitats have, to a large degree, been lost or degraded along the Oregon Coast. Restoration of these tidal wetlands would represent a significant local benefit by providing habitat for fish and wildlife species, including federally listed threatened or endangered species, and improve water quality and floodplain function.

4.4 Fish and Wildlife

This evaluation of potential effects on fish and wildlife resources under the No Action Alternative and the action alternatives considers changes in tidal hydrology and channel morphology; aquatic habitat connectivity; sedimentation; fish passage, distribution, and density; shifts in terrestrial habitat types; fish use of large wood structures; and macroinvertebrates.

4.4.1 Relevant Regulations

Project activities must comply with a variety of state, federal, and international laws pertaining to fish and wildlife resources.

4.4.1.1 Migratory Bird Treaty Act (MBTA)

The MBTA protects nesting and direct take of non-game bird species. All action alternatives that involve removal of vegetation or ground disturbance would require compliance with the MBTA. Compliance includes work timing during periods when birds are unlikely to nest and protections for nesting birds and their eggs.

4.4.1.2 Bald and Golden Eagle Protection Act

Bald eagle and their nests that may occur within the study area are protected by the Bald and Golden Eagle Protection Act. This act includes protection of active and inactive nests and prohibitions against take or harm and possession of eagles, eggs, or body parts. Bald eagles are known to utilize the study area for foraging and one active nest within the project area has been confirmed. Local observers have located a nest on Hoquarten Slough near the Sadri property. Any project activities that occur within 660 feet of an active nest would be required to adhere to the standards outlined in the act. If construction activities within the 660-foot threshold are unavoidable during the nesting season, then a permit for disturbance would be required. A permit also would be required for permanent alternation of vegetation within the 660-foot radius around a nest tree.

4.4.1.3 Magnuson-Stevens Fishery Conservation and Management Act (MSA)

All project activities that may result in impacts on estuarine or fresh waters containing coho or Chinook salmon, groundfish, and Coastal Pelagic essential fish habitat (EFH) would require compliance with the MSA as administered by NMFS. Compliance with the MSA requires consultation with NMFS and may require minimization and mitigation for impacts on these aquatic habitats, termed EFH. All action alternatives that temporarily or permanently alter or impact EFH aquatic habitats would result in necessary consultation and may trigger a need for mitigation.

4.4.1.4 Oregon Department of Fish and Wildlife Fish Passage Requirements

All new overwater structures (bridges), culverts, fishways, fish ladders and tide gates installed in waters containing resident or migratory fish must meet ODFW fish passage standards and require approval by the state agency. Action alternative components likely to require adherence to this regulatory process include installation of tide gates, major alterations of bridges, and culvert replacements.

4.4.1.5 Marine Mammal Protection Act (MMPA)

Finally, all project aquatic activities, particularly those that occur within estuarine and marine waters, must comply with the MMPA. The MMPA prohibits the take of marine mammals and mandates an incidental take permit for activities that may indirectly impact species covered under the Act. Harassment, an action that would cause injury or disturbance, would require an Incidental Harassment Authorization, most frequently associated with potential detrimental effects of underwater noise (e.g., pile driving). Action alternatives considered for this project are not expected to result in harassment of marine mammals protected under this regulation.

4.4.2 Environmental Consequences

4.4.2.1 No Action Alternative

Under the No Action Alternative, the existing mix of habitat types, including shrub/scrub uplands, emergent wetlands (pasture and non-pasture), shrub/scrub wetlands, and mature Sitka riparian/tidal forested wetlands, would continue with the exception of County-owned land where agricultural uses would phase out over time, allowing conversion to freshwater wetlands with patches of scrub/shrub and forested wetlands that would provide habitat for fish and wildlife. Along with the terrestrial and wetland habitat types, the existing tidal creeks, backwaters, and river channels would not be manipulated, meaning historical tidal floodplains would remain disconnected from daily tidal flows.

Under the No Action Alternative, estuarine habitat availability would remain constrained, and productivity would be limited to existing channels and narrow bands of intertidal habitats. Nutrient exchange between tidal floodplains and the estuary would be limited to that which occurs through tide gates. The existing conditions and species mixes would remain in place with successional changes occurring over time. The seasonal flooding from recurrent storm events would result in continued flooding of low-lying areas in the basin, including flooding of Tillamook and surrounding lands. Inundation would remain infrequent, generally occurring during 2-year storm events or greater.

No Action would result in continued aggradation of stream and river channels through the accumulation of sediments and reductions in floodplain connectivity and potential rearing habitat for anadromous and migratory fish species. Adverse effects to salmon from diking land and restricting tidal flow to historical wetlands are well documented (David et al. 2014). Under the No Action Alternative, restoration of tidal flow and historical estuarine floodplain habitat would not occur. Thus, the adverse growth conditions for juvenile salmon as a result of disconnected historical floodplains and restricted tidal flows would continue under the No Action Alternative. Adaptability and resiliency to climate change factors affecting stream flows and hydrologic regime would also limit salmon populations due to continued discontinuity with the floodplain (Ward et al. 2015). The limited availability of juvenile salmonid rearing habitat would remain a constraining factor on system productivity for this group of target species, including the federally threatened Oregon Coast coho ESU (NOAA 2013).

The No Action Alternative would allow continued agricultural use of part of the study area and sediment accumulation within channels located inside the diked portion of the study area.

The No Action Alternative would allow existing populations of terrestrial mammals to remain. Additionally, perching bird species would continue to utilize woody vegetation and forests for nesting, foraging, and cover. Aquatic habitats for wading birds, shorebirds, and waterfowl would be limited to channel fringes and wet pasture.

The No Action Alternative would not require removal or elimination of stands of large Sitka spruce trees at the eastern end of the study area. Over time, the suitability and quality of these stands as habitat for Marbled murrelets and other species may increase with forest maturity and additional forest recruitment, potentially resulting in larger areas of spruce forest. Additionally, the increased stature of all woody vegetation left undisturbed under the No Action Alternative would result in a gradual succession to species of birds and mammals that prefer older forests with late-successional attributes.

4.4.2.2 Alternative 1: SFC – Landowner Preferred Alternative

The Proposed Action would result in substantial increases in high quality estuarine habitats, improved ecosystem connectivity, and expanded opportunities for target species.

Approximately 522 acres of freshwater emergent wetlands would transition to estuarine tidal wetlands (NHC 2011) with greater connectivity to the Tillamook Bay estuarine ecosystem. Species composition of primary waterways would remain relatively unaltered, but expansion of floodplain connectivity along these waterways would provide increased aquatic cover and habitat complexity. Low-lying wetlands and upland habitats exposed to tidal influence would lose much of the existing woody plant species over time and convert to a mixture of wetland habitat types. The minimum timeline for full functional replacement would be 5 to 10 years for the emergent wetland, with longer time periods for shrub and forested systems (Zedler and Callaway 1999). Emergent plant communities would shift from freshwater tolerant to species tolerant of some salinity. Loss of woody vegetation would result in an initial increase in woody debris locally and in Tillamook Bay as die back of trees and shrubs would provide an influx of deadfall, snags, and other woody material. Increased woody material into local waterways and estuarine habitats would provide improved habitat for migratory and resident fish populations. Along with these changes would be a large expansion of tidal low marsh and mud flat habitats. As sediment accumulates within the lower elevations of the study area, the area would gradually convert to high marsh (Zedler and Callaway 1999; NHC 2011). With this variety of habitat conversions, similar alterations to the fish and wildlife species mix, inclusive of macroinvertebrates, is anticipated to follow the progression of habitat changes.

The conversion of existing uplands and freshwater wetlands to tidally influenced saline and brackish water wetlands and estuarine habitats would have a temporal component because the decomposition of existing vegetation and the colonization by saline tolerant plant species would take years (Zedler and Callaway 1999; NHC 2011). During this conversion period, the use of the habitats by freshwater and marine associated fish and wildlife species would be immediate, but the highest and most diverse use would follow complete conversion and decomposition of existing vegetative material. Fish use of the newly accessible aquatic habitats for forage, cover, and high water refuge would occur with initial inundation for some species. Conversely, some terrestrial mammals, including deer and elk, rodents, and other guilds, would be detrimentally impacted immediately following implementation of the Proposed Action through loss of habitat and elimination of upland forage. In a regional context, impacts on these generally common species would be negligible, with overall ecosystem health providing regional benefit.

The Proposed Action is expected to substantially benefit the five target salmonid fish stocks identified by ODFW, including Oregon coast chum salmon, Oregon Coast coho salmon, coastal cutthroat trout, and fall and spring stocks of Oregon Coast Chinook salmon. The benefits to these stocks include provision of additional estuarine rearing habitat where it is currently limited and additional foraging opportunities (NMFS 2008a; NOAA 2013). The alternative would have the potential to improve salmonid resiliency to climate change and climatic variability with increased floodplain connectivity (Ward et al. 2015). Additional non-salmonid stocks identified by NMFS and ODFW as receiving benefit from the Proposed Action would include winter steelhead, Pacific lamprey, staghorn sculpin, white sturgeon, top smelt, three-spine stickleback, shiner perch, English sole, and starry flounder (NOAA 2013). These species would benefit from an improved food chain, a net increase in aquatic habitats, and improved water quality and ecological function.

Tidal creek restoration through natural processes and reconnection of relict channels to tidal influence would offer improved aquatic refuge from existing conditions for juvenile salmonids, forage fish, juvenile marine fish, and bay residents. David and others (2014) evaluated habitat-specific growth potential to juvenile Chinook salmon at a large-scale restoration project in the Nisqually River delta, Washington. Foraging performance and growth of juvenile salmon were similar between restored habitat and reference sites in tidal channels that were not previously diked. Their study is analogous to the SFC project, demonstrating that juvenile salmon use restored tidal habitat and that such habitat is comparable to native tidal channels in supporting growth of juvenile salmon. Restoring tidal channels and habitat under the Proposed Action would have beneficial effects to growth of juvenile salmon that would not be realized in the No Action Alternative (Tillamook County 2013).

Shorebird and wading bird use of the habitats within the study area would increase over time, and foraging opportunities for migratory and wintering waterfowl would be abundant. Use of some areas by upland associated passerines and other upland species would decline as vegetation and forage opportunities shift to a more marine and tidally influenced system. Raptors, such as Bald eagles and osprey, likely would have additional foraging opportunities for fish with an increase in aquatic habitat, and increases in waterfowl use would provide additional prey sources for Bald eagles and other raptors. Nesting opportunities for both Bald eagle and osprey may increase with newly created snags and establishment of additional swamp forests over time.

Productivity in the Tillamook Bay ecosystem as a whole would increase with an expansion in estuarine habitat as a result of the Proposed Action (Tillamook County 2013). Increasing estuarine habitat would lead to increased fish, bird, and invertebrate abundance and increases in habitat and foraging opportunities for the entire suite of species in this ecosystem (Tillamook County 2013). Ecological benefits of the Proposed Action include the following: increased habitat complexity and availability, increased target species use, water quality enhancement, and increased climate change resilience (Tillamook County 2013). Important shellfish populations would benefit from improved water quality and increased ecosystem productivity.

Seals may use the sloughs and rivers in the study area to pursue fish prey, but seal and sea lion occurrences are rare at the south end of the Bay (Wright 2015). Environmental commitments would assure that no take of marine mammals would occur during construction. The Proposed Action is not likely to change the frequency or abundance of marine mammals, as the mainstem channels and sloughs that might be habitable by marine mammals would remain unchanged relative to the No Action Alternative. Overall, prey availability and forage quality may increase for these species over time as bay productivity improves and ecosystem health increases.

Comparatively, the loss of freshwater habitats, including the filling of seasonally wet ditches within currently diked areas, would result in a species shift from freshwater species of macroinvertebrates and fish to saline or brackish water-tolerant species but would produce a substantial gain in productive aquatic habitats overall. While the ultimate area of habitat conversion is difficult to quantify on a temporal scale, the overall habitat complexity and availability to fish, birds, and macroinvertebrate use would greatly increase compared to the No Action Alternative.

To comply with the MBTA, all project activities that have the potential to disturb or remove woody vegetation or include substantial removal of herbaceous vegetation during grubbing and clearing should be conducted outside of active nesting periods for migratory birds. Vegetation removal is expected to be a minor impact on the study area and available habitats because it would be replaced by more desirable plant communities. Minimization of this impact includes recommendations for timing of removal based on species and specific regions in Oregon, but possible vegetation removal periods with a low likelihood of encountering nesting birds is September 1 to March 1. In compliance with the BGEPA, removal of any trees containing active or relict eagle nests should be avoided and a permit would be required for vegetation removal and construction activities within 660 feet of an active nest. USFWS would review and approve a permit application for work near a Bald eagle nest. Construction mitigation for listed Marbled murrelet is included in Section 5.4 (Endangered Species Mitigation) of this document.

Project development impacts include removal or replacement of tide gates, in-water work with any equipment, channel development, installation of sheet pile, or other permanent or temporary in-water structures. These actions could disrupt, displace, or alter important aquatic habitats; however, the effects would be minimized through adherence to environmental commitments and compliance with temporary and long-term natural resources permit requirements. Installation of work area isolation devices or structures may require fish salvage as a result of placement activities and other stranding events (flooding, entrapment, high tides). Fish salvage activities are regulated by NMFS and ODFW, and a fish salvage permit would be required. In addition, all activities that include installation or replacement of over water structures, including temporary or permanent bridges, tide gates, culverts, or fishways, would require the approval of a fish passage plan by ODFW (ODFW 2014b). Fish passage plans must meet certain standards and design guidelines and require review by an ODFW fish passage biologist and must meet approval by a NMFS fish passage engineer. To comply with certain design requirements established by programmatic biological opinion(s) utilized in permitting this project, new tide gates may be required to be "fish friendly." Fish friendly tide gates have a prolonged open period that increases opportunities for juvenile fish to enter favorable backwater habitats at high tide but reduces opportunities for stranding during low tide conditions.

Effects of construction activities, such as tree removal, clearing and grubbing, dike removal and replacement, grading, temporary road development and use, and installation of in-water structures, would be avoided or minimized by the environmental commitments.

Impacts associated with construction activities supporting the implementation of the Proposed Action would temporarily disrupt resident and migratory birds, temporarily disturb and displace aquatic organisms, and temporarily degrade water quality in rivers and other waterways in the study area. Tree and shrub removal and grading have the potential to impact nesting birds and would require adherence to impact avoidance timing to prevent detrimental effects. Removal and creation of dikes and dike segments as well as the installation of tide gates would require installation of work area isolation and/or construction of these project components in a dry or dewatered condition. Construction activities are proposed to occur during the summer of 2016 with in-water work activities primarily limited to the ODFW approved in-water work window for the riverine portions of the Wilson, Trask and Tillamook Rivers (July 1 to September 15). A variance to the in-water work windows would be requested to extend the allowable construction period through October 31, 2016 and September 30, 2017. Work area isolation measures often have the potential to temporarily strand fish and other aquatic organisms and could lead to mortality and exposure to temporary construction-generated sediment, equipment working in-water, and potential discharge of fuel and hydraulic fluids from this equipment. Adherence to environmental commitments reduces the likelihood of these detrimental impacts. Additionally, potential fish stranding would require fish salvage that may result in unintended mortalities, but these impacts are also considered through implementation of environmental commitments for avoidance and minimization.

4.4.2.3 Alternative 2: Hall Slough Alternative

The Hall Slough Alternative would reestablish a connection to the Wilson River and ultimately would relieve regular nuisance flooding. Anticipated changes to fish and wildlife habitat and species mixes would not differ much from the No Action Alternative, with the exception of reconnecting Hall Slough and the possible formation of riverine flow-through wetlands along the banks of Hall Slough.

Alterations to wetlands or forested habitats in the downstream portion of the study area would not be implemented under the Hall Slough Alternative. As with the No Action Alternative, agricultural use of County-owned land would be phased out, allowing conversion to freshwater wetlands with patches of scrub/shrub and forested wetlands that would provide habitat for fish and wildlife. Seasonal flooding of the agricultural lands near the mouths of the Trask and Wilson rivers may be reduced under this alternative, and the potential use of this area as a flood refuge by fish would be reduced with elimination of this inundation as well.

Deepening of the Hall Slough channel would remove existing in-stream habitat and alter riparian vegetation with potential dropping of the average surface water elevation and summer time intrusion of more saline waters farther upstream than under the No Action Alternative. The Hall Slough Alternative would not substantially improve the availability of estuarine or aquatic habitats in contrast to the No Action Alternative. The availability of tidally influenced lands would remain constrained by existing dikes and other barriers to tidal influence downstream of the Hall Slough construction area.

Construction activities associated with alteration of Hall Slough levees would create temporary impacts on local waterways and could detrimentally affect local and migratory fish populations using associated waterways with temporary reductions in water quality from disturbance of soil and potential sedimentation. The Hall Slough Alternative would result in temporary impacts on EFH during construction and permanent impacts on EFH from dredging and periodic channel maintenance. Substantial dredging and channel maintenance would require sediment monitoring and pollution prevention planning to prevent substantial water quality impacts. In-water work would need to be conducted during recommended in-water work periods, and fish passage would need to be maintained through the work area during construction. Vegetation removal and grading could result in local impacts on nesting birds and harassment of terrestrial and aquatic species, and all vegetation removal would need to occur outside of the nesting period. Fish and wildlife impact avoidance and minimization measures would be similar to those described under the Proposed Action.

The Hall Slough Alternative would result in temporary impacts on local waterways, temporary moderate impacts on local and migratory fish populations, temporary minor impacts on local terrestrial biota, and minor impacts on EFH.

4.4.2.4 Alternative 3: SFC – Initial Alternative

Alternative 3 would restore approximately 568 acres of wetland habitat. This restoration area would result from the conversion of existing drained and diked farmland and other diked uplands and freshwater wetlands. The restoration of wetlands would greatly increase the aquatic habitat present in the affected area because much of the area would receive tidal inundation and additional flooding. In contrast to the No Action Alternative, Alternative 3 would ultimately shift the aquatic and terrestrial species mixes of fish and wildlife and their food sources from freshwater associates to saline and brackish tolerant species. Under Alternative 3, Blind Slough would be lengthened to connect to the Wilson River, and other tidal creeks and sloughs would form or reestablish, providing an increase in in-stream and tidally influenced refuge, shelter, and foraging opportunities for a diverse range of estuarine, anadromous, and marine fish species on a seasonal and tidally dependent basis.

Alternative 3 would eliminate freshwater ditches and other primarily freshwater habitats. It would also ultimately eliminate upland spruce and alder forest as a result of dike removal, increased flood inundation, and tidal influence. Wildlife species favoring upland meadows, agricultural lands, and forest ultimately would be supplanted by those that favor tidally influenced habitats, including mud flats, low marsh, high marsh, and tidal creeks. An increase in use by shorebirds, wading birds, and some waterfowl would be anticipated. Use and presence by most mammals probably would decrease at much of the converted habitats. Creation of mud flats and low tidal marsh likely would accompany colonization by some bay-associated invertebrates, depending on salinity and sediment dynamics. Colonization and species mixes likely would be temporally dynamic, as sediment accumulation and decomposition of existing vegetation and organic material progresses and shifts over time. Additionally, the forage quality and type for all levels of biota would change throughout the conversion caused by the action but result in improved ecological function and increased local and regional productivity in Tillamook Bay.

Woody debris and other in-stream habitat complexity components would increase with implementation of Alternative 3 with connection to existing uplands. Trees in the newly inundated zones would eventually die and enter the riverine and tidal system during storms or through gradual introduction from deadfall, erosion, and decomposition.

Tillamook Bay productivity and aquatic habitats would increase under Alternative 3. The increase in aquatic habitats and the expansion of forage, cover, and rearing areas for bay inhabitants, including fish, birds, and macroinvertebrates, would benefit the food web and ecosystem.

Construction activities associated with the implementation of Alternative 3 would result in short-term displacement of terrestrial wildlife and may result in impacts on nesting birds. The removal of vegetation, heavy equipment operation, and in-water work would have the potential to temporarily impact water quality in waters adjoining the work area and could be temporarily detrimental to aquatic organisms in this area. In-water work and the installation of new in-water structures during project construction and development could require work area isolation, fish salvage, and potential inadvertent losses and temporary displacement to local and migratory fish. Project completion would be expected to result in a net gain to MSA – EFH, with temporary impacts on EFH from construction-generated sediment and localized temporary disturbance from removal of in-water structures and dikes. Therefore, fish and wildlife impact avoidance and minimization measures would be similar to those described under the Proposed Action.

Alternative 3 would result in minor impacts on local and migratory fish populations. It would have minor temporary impacts on EFH and migratory birds. Alternative 3 would result in moderate beneficial impacts on terrestrial biota and would substantially improve aquatic habitat resources and increase the availability of currently limited estuarine habitats.

4.5 Threatened and Endangered Species

This section analyzes potential impacts on federal- and state-listed species associated with each of the proposed alternatives. Alternatives range from doing nothing (No Action Alternative) to varying degrees and methods of flood reduction and wetland and floodplain restoration. All project activities associated with the action alternatives must comply with the ESA. Compliance requires evaluation of direct and indirect project impacts on protected animal and plant species and may require formal consultation with USFWS and NMFS. Consultation with NMFS under the federal ESA may also include consultation under the MSA and MMPA. Project activities that may impact or take plant species protected under the Oregon Endangered Species Act require consultation with the Oregon Department of Agriculture and compliance with the no net loss policy for impact mitigation. Based on the review of literature, database searches, habitat evaluations, and analysis, three federally listed species are included in the discussion of environmental consequences: Marbled murrelet, Oregon Coast coho salmon ESU, and the southern DPS of North American green sturgeon. These three species have been deemed as likely to occur within the project area and likely to be affected by project activities.

4.5.1 No Action Alternative

Under the No Action Alternative, there would be no construction or construction-related impacts on special status species. Habitats currently containing federally listed species, primarily Marbled murrelet and Oregon Coast coho salmon, would be unaltered by project activities. This includes designated Critical Habitat for Oregon Coast coho salmon currently mapped for the waterways in the study area. Habitats utilized by green sturgeon would remain unchanged, and the prey base would follow similar ecological trajectories.

Large diameter Sitka spruce trees would remain intact, and potential nesting habitat for Marbled murrelet may improve, but trees could be lost naturally through winter storms, flood inundation, and death.. In addition, potential freshwater rearing habitats for Oregon Coast coho and estuarine and riverine migration and rearing corridors for coho would remain unchanged.

General habitat degradation by aggradation and the effects of revetment and channelization previously described would continue. Additionally, the development and succession of plant communities would continue to occur. Some expansion of willow-dominated shrub/scrub wetlands would occur at current emergent wetlands without grazing pressure, and some closure of waterways through sedimentation would occur over time. Some large diameter Sitka spruce trees could be lost naturally through winter storms, flood inundation, and death although this habitat type could potentially expand.

4.5.2 Alternative 1: SFC – Landowner Preferred Alternative

The Proposed Action would result in a net increase in aquatic habitats and increased productivity of Oregon Coast coho salmon. Increased foraging and refuge habitat for juvenile coho salmon would lead to additional productivity of juvenile coho salmon and subsequent production of adult salmon returning to the Tillamook Bay system (Nickelson 2011). As with the temporal considerations on habitat conversion and succession described in prior sections, the acreages of viable aquatic habitat for juvenile or adult coho would vary during the transition phase and stabilize over the long term after initial restoration. Implementation of the Proposed Action would create and support for four of the six Primary Constituent Elements (PCE) established in the designation of Critical Habitat for the Oregon Coast coho salmon ESU (NMFS 2008a). These PCEs categories include freshwater rearing sites (2), freshwater migration corridors (3), estuarine areas (4), and nearshore marine areas (5) (NMFS 2008a). The Proposed Action would support these PCEs with expansion and improvement of habitat connectivity, availability and quality. It would increase forage potential in fresh and marine environments for the juveniles of the species and improve cover and access for adults.

The Proposed Action would result in a net increase in suitable cover and forage (prey) base for the southern DPS of North American green sturgeon. Short-term impacts on this species would be minor and limited to localized construction disturbances and potential water quality impacts. During project transition and in the long-term moderate improvements in Tillamook Bay, health and ecosystem function would result in a larger prey base and improved water quality conditions for this species.

Project actions would include substantial earthwork in proximity to waterways potentially containing listed salmon and may be detrimental to the species in the short term. Inadvertent discharge of sediment, equipment fluids, and other construction-related waste could result in temporary detrimental impacts on water quality and aquatic habitats, but environmental commitments, including work area isolation, erosion control best management practices (BMPs), and in-water work timing, would be implemented to reduce this short-term impact. Incidents of stranding or the likelihood of stranding are likely to decline over time as new channels are formed, drainage improves, and vegetation decomposes.

All project activities that have the potential to impact aquatic habitats would adhere to design criteria and minimization standards to limit impacts on listed coho, critical habitat, green sturgeon, and EFH as outlined in PROJECTS (NMFS 2013) and the environmental commitments previously outlined. These guidelines apply to the use and operation of heavy equipment, erosion control, general project design, invasive species control, fish passage, fish capture and removal (salvage), and work area isolation. See Section 4.1 for environmental commitments.

The Proposed Action would cause the loss of trees, including some potentially suitable for nesting by Marbled murrelet (USFWS 2015a; NHC 2011). Forty-three potentially suitable nesting trees occur on levee segments planned for removal. Thirty-four of these trees would be retained in tree protection buffers, and nine would be removed. While the current use of trees and forested areas within the study area by Marbled murrelet has not been documented by audio-visual surveys, the area is assumed occupied (USFWS 2015a). Potential nesting trees would be removed outside of the critical nesting season, which is from April 1 to September 15. As such, the potential for use and the suitability of the trees means that their removal could result in major detrimental impacts on localized habitat use by the species.

In the absence of protocol surveys, Marbled murrelets are presumed present because there are trees that could provide suitable nesting habitat. Project construction activities, including the operation of heavy equipment, disturbances related to earth moving activities, and tree removal, may have the potential to disrupt or disturb nesting Marbled murrelets and nest success. In addition, project construction activities may temporarily disturb foraging behavior of murrelets in adjoining estuary waters. It may not be possible to follow the standard seasonal and daily timing restrictions on the use of heavy equipment in proximity to potential murrelet usage areas. USFWS would consider the benefit of allowing the construction to be completed over one nesting season with increased potential disturbance for that one year as compared to requiring construction to be conducted over several nesting seasons. A biological opinion would be issued that would include additional mitigation and minimization provisions that would need to be incorporated into the project design and implementation (USFWS 2015a). Effects on foraging behavior by murrelets within the project vicinity would be of limited duration and with limited negative consequences given the availability of other forage opportunities.

The temporal loss of habitat from the removal of suitable (nest trees) or recruitment (trees greater than 60 years without suitable nesting structure) habitat would be an indirect effect of long duration (up to 5 decades or more). Moderate impacts on this species in the short term would include loss of potential nesting habitat and disruption of local foraging opportunities. Impacts on the species in the transitional period would be moderate with continued absence of suitable nesting sites, but some benefit from increased ecological function locally, and expanded foraging opportunities within the project area. Long-term effects would be beneficial because the project would result in a net increase in foraging and nesting habitat.

The Proposed Action could result in minor impacts through temporary disruption of California brown pelican due to construction activities. For example, the noise and activity associated with construction could cause pelicans to feed farther away during the construction period. Potential disruption to this species during the transitional phase of the project would not be anticipated. Over the long-term, foraging opportunities for California brown pelican likely would increase as restored salt marsh habitats result in increased productivity of Tillamook Bay.

The study area is not within designated critical habitat for Marbled murrelets (USFWS 2011). There would be no impacts on critical habitat from the project actions.

4.5.3 Alternative 2: Hall Slough Alternative

The Hall Slough Alternative would result in a moderate, short term impact to fish species, including the listed Oregon Coast coho and green sturgeon, with in-water work and periodic dredging. As with the Proposed Action, in-water work for the Hall Slough Alternative, including periodic maintenance dredging, would only occur with the ODFW in-water work window. The Hall Slough Alternative would benefit Oregon Coast coho and green sturgeon by reestablishing a connection to the Wilson River at the upper end of Hall Slough and by creating better aquatic connectivity along its length. The alternative would also restore approximately 90 acres of riverine flow-through wetlands along the banks of Hall Slough that would improve conditions within the Slough. It is anticipated there would be limited increased fish use of Hall Slough for migration, rearing, and foraging as a result of the improved connectivity. This improved habitat condition would result in moderate benefits to designated critical habitat and EFH in the long-term timeframe.

The Hall Slough Alternative would have no effect on marine mammals because they are unlikely to use the slough. The improvements in fish habitat and corresponding fish populations would result in moderate benefits to the prey base for marine mammals.

The Hall Slough Alternative would have no effect on Marbled murrelet as it would not affect the potential murrelet nesting trees in the SFC area. There would be only minor improvements to the populations of fish prey species used by California brown pelican. There would be no effect on listed plant species under the Hall Slough Alternative.

The Hall Slough Alternative could result in adverse effects to listed species and critical habitat during construction and periodic dredging activities. Potential direct effects to listed fish species and their habitats from dredging activities may include behavioral changes associated with short-term and localized increases in turbidity and short-term reductions in benthic invertebrate production. These short-term and localized effects, however, are not likely to result in adverse effects to feeding behavior, use of preferred habitat, or migration behavior of any listed or proposed aquatic species. Implementation of mitigation measures and BMPs described in Section 6 for the Proposed Action would also be required under the Hall Slough Alternative to avoid or reduce impacts on coho salmon and critical habitat. With implementation of the BMPs and mitigation measures, the Hall Slough Alternative would result in minor beneficial effects on special status species.

4.5.4 Alternative 3: SFC – Initial Alternative

Alternative 3 would increase potential rearing habitat, migration corridors and refuge, and foraging potential for juvenile coho salmon. Additionally, Alternative 3 would provide additional migration corridors, cover from predators, and high flow refuge for adult coho salmon. The additional area of aquatic habitats would increase coho salmon productivity in the Tillamook Bay system relative to the No Action Alternative.

Construction activities of Alternative 3, including heavy equipment operation in wetlands and aquatic habitats, potential sedimentation of streams and wetlands, and any work area isolation measures would include short-term, moderately adverse effects from in-water work, fish handling procedures, and temporal loss of aquatic habitats. The duration of construction and ecological responses would depend upon the periods for site stabilization, revegetation efforts, and natural conversion of habitat types. Detrimental effects from project development on the listed Oregon Coast coho ESU would be limited due to adherence to environmental commitments and BMPs as outlined by the programmatic biological opinion (NMFS 2013). Additionally, all temporary impacts would be outweighed by substantial increases in available habitat once habitat conversion commences. Much like the Proposed Action, implementation of Alternative 3 would create and support four of the six PCEs established in the designation of critical habitat for the Oregon Coast coho salmon ESU (NMFS 2008a). These PCE categories include freshwater rearing sites (2), freshwater migration corridors (3), estuarine areas (4), and nearshore marine areas (5) (NMFS 2008a). Alternative 3 would support these PCEs with expansion and improvement of habitat connectivity, availability, and quality. It would increase forage potential in fresh and marine environments for the juveniles of the species and improve cover and access for adults.

Alternative 3 would increase suitable green sturgeon habitat during project transition and long-term timelines. It would benefit green sturgeon with an improved prey base, increase in aquatic habitat and cover, and improved water quality conditions.

Alternative 3 likely would result in the removal of large diameter Sitka spruce trees during grading activities and the mortality of up to 9 spruce trees potentially suitable for nesting Marbled murrelets due to increased salinity (USFWS 20115b; NHC 2011). Alternative 3 would create additional foraging opportunities for the bird, increase prey base, and increase suitable forest habitats for nesting over time.

Although construction activities could cause temporary detrimental disturbances to nesting murrelets during nesting periods, construction activities would follow environmental commitments, such as work timing and noise distance standards, for avoidance and minimization to potential nesting birds (USFWS 2003). Alternative 3 would create minor beneficial effects to special status species and designated critical habitat in the transition period with improved ecosystem connectivity and in the long-term effects to these resources would be moderate and beneficial. Therefore, threatened and endangered species impact avoidance and minimization measures would be similar to those described under the Proposed Action.

SECTION 5 Conservation Measures

This section considers the mitigation measures required during implementation of any of the action alternatives (Alternative 1 – Proposed Action, Alternative 2 – Hall Slough Alternative, and Alternative 3) to avoid and/or reduce the potential impacts described in this EIS such that they would not be significant. If the regulatory framework and environmental commitments would not avoid or reduce detrimental impacts to a negligible or minor level, additional mitigation measures would be proposed. Proposed mitigation recognizes laws, regulations, executive orders, and environmental commitments (best management practices) would be implemented for all action alternatives, largely to avoid impacts or reduce impacts below significance thresholds or to further reduce non-significant impacts. See Section 2.1 (Regulatory Framework) and Section 4.1 (Environmental Commitments) for discussions of impact avoidance and minimization measures for project actions. See Section 2.2 for discussion on thresholds of significance.

Mitigation measures to be implemented for potentially significant impacts are described below. Note the mitigation measures recommended in this section would be above and beyond the environmental commitments for all action alternatives, which are listed in Section 4.1 (Environmental Commitments). However, no biological resources mitigation measures were determined to be required for any action alternative, beyond those that might be imposed by provisions of federal and state natural resources permits and approvals or obligated by the environmental commitments, because important impacts are largely beneficial, and detrimental impacts are negligible to minor.

5.1 Vegetation

5.1.1 Freshwater Vegetation

The environmental commitments would limit the moderate or major short term detrimental impacts of the action alternatives on freshwater vegetation to be local, temporary, incremental, and require environmental compliance, as appropriate. Therefore, the County and Port would not propose additional mitigation for short-term impacts. The negligible or minor impacts on transitional freshwater vegetation would not warrant additional mitigation. For the Proposed Action and Alternative 3, the long-term impacts would be major and beneficial and would compensate for short term detrimental impacts. For the Hall Slough, the long-term impacts would be detrimental but minor; therefore, the County and Port would not propose additional mitigation.

5.1.2 Trees

The environmental commitments would result in negligible or minor detrimental impacts of the action alternatives on trees in the short term, transitional period, and long term; therefore, the County and Port would not propose additional mitigation for impacts.

5.1.3 Tidal Vegetation

The environmental commitments would limit the short term detrimental impacts of the action alternatives on tidal vegetation to be minor—temporary, incremental, and requiring environmental compliance as appropriate. Therefore, the County and Port would not propose additional mitigation for short-term impacts. For the Proposed Action and Alternative 3, the transitional and long-term impacts would be moderate or major and beneficial. Therefore, additional mitigation for tidal vegetation would not be warranted. For the Hall Slough Alternative, the transitional and long-term impacts would be detrimental but negligible; therefore, the County and Port would not propose additional mitigation under this alternative.

5.2 Wetlands

5.2.1 Freshwater Wetlands

For the Proposed Action and Alternative 3, the short-term, transitional, and long-term impacts would be major and detrimental for freshwater wetland vegetation. Wetland removals and fills, as a consequence of construction activities that would remove or build levees, would require federal and state regulatory review. Reconnecting and restoring historical floodplains to tidal flows would create higher value tidal wetlands by design. Therefore, floodplain restoration likely would fulfill federal and state regulatory requirements for compensating for removals or fills in wetlands. Additional mitigation beyond the designed restoration of tidal floodplains would not be warranted. For the Hall Slough Alternative, the temporal impacts would be neutral and negligible, primarily because few wetlands would be affected. Federal and state wetland regulations would be satisfied, and the County and Port would not propose additional freshwater wetland mitigation under this alternative.

5.2.2 Tidal Wetlands

Impacts on tidal wetlands would inversely follow those to freshwater wetlands; that is, for the Proposed Action and Alternative 3, the short-term, transitional, and long-term impacts would be major but beneficial for tidal wetlands. For the Hall Slough Alternative, the temporal impacts would be neutral and negligible, primarily because few wetlands would be affected. Net ecological uplifts to wetlands in the Proposed Action and Alternative 3 would compensate for removals and fills, fulfilling federal and state agency requirements for ”no net loss.” Therefore, the County and Port would not propose additional mitigation measures.

5.3 Terrestrial Wildlife

5.3.1 Deer and Elk, Other Terrestrial Mammals, and Migratory Birds

With implementation of the environmental commitments, the Proposed Action and Alternative 3 would express moderate detrimental impacts during the short-term, transitional, and long-term phases for these species. However, the designed replacement habitats would be higher in priority for restoration. Therefore, additional mitigation for decreased habitat would not be warranted. For the Hall Slough Alternative, the temporal impacts would be neutral and minor, primarily because few grazing or perching habitats would be lost after channel improvements. Therefore, the County and Port would not propose additional habitat mitigation for deer and elk, other terrestrial mammals, or migratory perching birds under this alternative.

5.3.2 Bald Eagles

With implementation of the environmental commitments, Alternatives 1 and 3 would result in major short term detrimental impacts during construction on nesting Bald eagles. The Proposed Action would result in beneficial or neutral impacts on Bald eagles in the transitional period and the long-term. Observers have identified a Bald eagle nest on Hoquarten Slough near the Sadri property. The current Proposed Action design would not remove this nest tree, but would alter the vegetation within the 660-foot buffer around the tree. A permit for disturbance of Bald eagles and their nesting habitat under the Bald and Golden Eagle Protection Act would be required. If the nest is active when construction is proposed to occur, then there would be the potential for construction activity and noise to disturb the nest occupants, and a 660-foot buffer would be required around the nest tree where heavy equipment would not be operated during the nesting season (USFWS 2015a). Foraging use of the project area by Bald eagles is not expected to measurably change although populations of fish and waterfowl prey species are expected to increase, increasing foraging opportunities for the eagle.

5.4 Aquatic Species

5.4.1 Non-ESA-Listed Salmonids and MSA Groundfish

With implementation of the environmental commitments, the Proposed Action and Alternative 3 would have minor or major beneficial impacts over the short-term, transitional, and long-term phases for these species. No additional mitigation would be proposed because the impacts would be beneficial. For the Hall Slough Alternative, the temporal impacts would be minor and neutral, primarily because there would be relatively little change in habitat availability and quality. Therefore, the County and Port would not propose additional mitigation for changes in non-ESA-listed salmonids and MSA groundfish habitat under this alternative.

5.4.2 Resident Fish, Commercially and Recreationally Important Shellfish, Other Aquatic Invertebrates, and Seals and Sea Lions

With implementation of the environmental commitments, the Proposed Action and Alternative 3 would be have minor or moderate beneficial impacts over the short-term, transitional, and long-term phases for these aquatic species. No additional mitigation would be proposed because the impacts would be beneficial. For the Hall Slough Alternative, the short-term, transitional, and long-term impacts would be negligible or minor and either beneficial or neutral, primarily due to improved bay health and ecosystem function. Therefore, the County and Port would not propose additional mitigation for changes in habitat for these species under this alternative.

5.5 Threatened and Endangered Species

5.5.1 Marbled Murrelet, Oregon Coast Coho Salmon, and Green Sturgeon

Under the action alternatives and with implementation of the environmental commitments, there would be some impacts on these ESA-listed threatened and endangered species. Most of the adverse impacts would occur during the construction phase with long-term beneficial effects expected for all species. Environmental commitments for Marbled murrelet would be consistent with conservation requirements proposed in the Southern Flow Corridor Biological Assessment (USFWS 2015a) or as required by the biological opinion expected for the Proposed Action. Environmental commitments for coho salmon and green sturgeon are consistent with PROJECTS (NMFS 2013). Because environmental commitments are consistent with the biological assessment and biological opinion, and the long-term impacts would be beneficial or neutral, the County and Port would not propose additional mitigation for these threatened and endangered species.

SECTION 6 Conclusions

6.1 No Action Alternative

Under the No Action Alternative, the existing mix of vegetation communities, wetland classes, habitat types, and species mixes would be unaffected and follow present trends and ecological trajectories. Stream and river channels would continue to be constrained within diked and channelized pathways, resulting in reduced floodplain connectivity and reduced potential rearing habitat for fish. Current agricultural use of the area would likely remain although use on the County-owned lands likely would be phased out over time. Over the long term, non-native and invasive plant species currently present likely would increase as a result of seed transported by floodwaters and by continued agricultural practices and natural colonization. Sitka spruce stands in the eastern and north-central portions of the study area would remain, as no substantial change in hydrologic regime would be expected there. Stands of Sitka spruce would mature into suitable nesting habitat for the Marbled murrelet, a federally threatened species.

Historical tidal floodplains would remain disconnected from tidal flows. The seasonal flooding from recurrent flood events would result in continued flooding of low-lying areas. Areas upstream of the study area, including commercial, farm, and residential properties, likely would experience continued frequent and prolonged flood events. No Action likely would result in continued subsidence of diked agricultural lands and continued reduction in flood-supplemented soils to these areas indefinitely.

6.2 Proposed Action: SFC – Landowner Preferred Alternative

The Proposed Action would result in modifications of existing vegetation communities, wetlands, and terrestrial and aquatic wildlife habitat. This alternative would restore approximately 522 acres of tidal wetlands, resulting in a shift from a predominantly freshwater emergent system to an estuarine tidal wetland system with a saline or brackish water regime. Existing freshwater vegetation would be replaced by vegetation tolerant of saline or brackish water. Frequency and duration of inundation would increase behind areas that are currently protected by levees. Existing spruce forests likely would die off due to higher salinity and water levels. While transition to fully functional tidal wetland conditions would not be achieved for many years, the study area would progress gradually from a period of rapid change toward a less-dynamic but fully functioning tidal wetland complex. **Table 6.1** presents a summary of findings of significance for impacts on vegetation resources for the Proposed Action. **Table 6.2** presents a summary of findings of significance for impacts on wetland resources for this alternative.

The transition from a freshwater to an estuarine system would result in major modification of existing terrestrial and aquatic wildlife habitats, leading to a shift in species composition in the study area. The Proposed Action would produce a large initial expansion of tidal low marsh and mud flat habitats. Wildlife use of the area would transition from species favoring upland meadows, agricultural lands, and forest to those favoring tidally influenced habitats, including mud flats, low marsh, high marsh, and tidal creeks. This alternative would restore tidal influence to existing streams, reconnect relict channels, and provide increased recruitment of woody debris to stream channels. It would provide improved aquatic refuge from existing conditions for fish, and would offer increased foraging opportunities for migratory and wintering waterfowl. Use of some areas by upland associated perching birds and other upland species likely would decline as vegetation and forage opportunities shift to a more marine and tidally influenced system. **Table 6.3** presents a summary of findings of significance for impacts on terrestrial wildlife resources for the Proposed Action. **Table 6.4** presents a summary of findings of significance for impacts on aquatic wildlife resources for this alternative.

While there is no documented current use of the Sitka spruce forest areas by Marbled murrelet, loss of these trees would reduce potential available habitat for Marbled murrelet and therefore constitute a detrimental effect on this species. However, the Proposed Action likely would improve Marbled murrelet habitat by increasing foraging and nesting in the long term.

The Proposed Action would result in temporary impacts on the existing environment during construction and tidal marsh restoration activities, including ground disturbance, vegetation removal, heavy equipment operation in wetlands and adjacent to waterways, and site stabilization. However, overall, this alternative would result in increased wetland habitat area and complexity, providing a mix of priority ecological benefits, including development of low and high tidal marsh and forested tidal wetland vegetation communities. No adverse vegetation impacts would be anticipated because vegetation communities would transition naturally from fresh to saltwater vegetation communities.

Project development activities might disrupt or disturb anadromous salmonid use of adjacent aquatic habitats, but implementation of appropriate best management practices recommended in PROJECTS (NMFS 2013) would reduce the potential impacts to a minor level. Important benefits for anadromous salmonid populations and other aquatic species would result from reconnection of rivers, streams, sloughs, wetlands, and Tillamook Bay, including increasing the area of designated critical habitat for the Oregon Coast coho ESU. The Proposed Action would result in an increase and improvement of EFH habitats with the restoration of former aquatic (estuarine) habitats.

The Proposed Action would also result in improved opportunities and quality of forage for marine mammals, Bald eagles, and sensitive species (e.g. California brown pelican) identified in the study area. The alternative would create improved ecological functions benefitting all protected and target biological resources. **Table 6.5** presents a summary of findings of significance for impacts on species listed under ESA for the Proposed Action.

6.3 Alternative 2: Hall Slough

The Hall Slough Alternative would reestablish a connection to the Wilson River, widen and deepen the slough, set back and modify levees along the channel bank, and ultimately relieve regular nuisance flooding. Impacts from the widening of the channel would result in removal of adjacent wetlands and associated wetland and riparian vegetation as well as modification of existing instream habitat. Tidal wetland conditions may develop in the area between the setback levee and the new, widened channel, producing a shift from freshwater to tidal marsh vegetation that would result in minor modifications to terrestrial and aquatic wildlife habitat, including providing additional rearing areas for ESA-listed juvenile coho salmon, other juvenile salmonids, and some estuarine and juvenile groundfish. Reduced seasonal flooding of agricultural lands near the mouths of the Trask and Wilson rivers likely would occur, reducing the potential flood refuge area for fish in these areas. **Table 6.6** presents a summary of findings of significance for impacts on vegetation resources for the Hall Slough Alternative. **Table 6.7** presents a summary of findings of significance for impacts on wetland resources for this alternative.

Minor alterations to downstream wetland habitat would occur due to anticipated reduction in seasonal flooding. In some areas, vegetation may shift from predominantly wetland vegetation to species tolerant of drier conditions. The Hall Slough Alternative would result in negligible impacts on forested habitats within the study area and negligible loss of potential habitat for Marbled murrelets.

While the Hall Slough Alternative would result in removal of some existing habitat and wetlands, overall this alternative would relieve nuisance flooding, improve fish habitat, and provide additional rearing areas for juvenile fish, providing a moderate increase in priority ecological benefits. Detrimental impacts may occur to some freshwater fish and wildlife species associated with the widening and deepening of Hall Slough; however, overall widening and deepening of the slough and re-establishing historical connections with tidal waters would provide important habitat benefits to target salmonid and other aquatic species. **Table 6.8** presents a summary of findings of significance for impacts on terrestrial wildlife resources for the Hall Slough Alternative. **Table 6.9** presents a summary of findings of significance for impacts on aquatic wildlife resources for this alternative. **Table 6.10** presents a summary of findings of significance for impacts on species listed under ESA for the Hall Slough Alternative.

6.4 Alternative 3: SFC – Initial Alternative

Overall, Alternative 3 would provide important ecological benefits by increasing wetland habitat complexity and availability, including development of low and high tidal marsh and forested tidal vegetation communities. No adverse vegetation impacts would be anticipated because vegetation communities would transition naturally from fresh to saltwater vegetation communities. Impacts associated with Alternative 3 would be similar to impacts associated with the Proposed Action and would result in major modifications of existing vegetation communities, wetlands, and terrestrial and aquatic wildlife habitat. Alternative 3 would result in a large initial expansion of tidal low marsh and mud flat habitats. This alternative would restore approximately 568 acres of tidal wetlands, resulting in a major shift from a predominantly freshwater emergent system to an estuarine tidal wetland system with a saline or brackish water regime. Existing spruce forests likely would die off due to higher salinity and water levels. **Table 6.11** presents a summary of findings of significance for impacts on vegetation resources for Alternative 3. **Table 6.12** presents a summary of findings of significance for impacts on wetland resources for this alternative.

The transition from a mostly freshwater to a mostly estuarine system would result in modifications to existing terrestrial and aquatic wildlife habitats, leading to a shift in species composition in the study area. Wildlife use of the area would transition from species favoring upland meadows, agricultural lands, and forest to those favoring tidally influenced habitats, including mud flats, low marsh, high marsh, and tidal creeks. Alternative 3 would restore tidal influence to existing streams, reconnect relict channels, and provide increased recruitment of woody debris to stream channels. It would provide improved aquatic refuge from existing conditions for fish and would offer increased foraging opportunities for migratory and wintering waterfowl. Use of some areas by upland associated passerines and other upland species would decline as vegetation and forage opportunities shift to a more marine and tidally influenced system. **Table 6.13** presents a summary of findings of significance for impacts on terrestrial wildlife resources for Alternative 3. **Table 6.14** presents a summary of findings of significance for impacts on aquatic wildlife resources for Alternative 3.

Table 6.15 summarizes the findings of significance for threatened and endangered species under Alternative 3. Because Marbled murrelet use large Sitka spruce trees for nesting, the near-term loss of these trees would reduce potential available habitat for Marbled murrelet and therefore constitute a detrimental effect on this species. However, this alternative would probably improve Marbled murrelet habitat overall by increasing foraging and nesting opportunities in the long term. Project activities could disrupt or disturb nesting Marbled murrelet during construction activities if the birds are using the project area at that time; however, implementation of minimization measures to be developed through the ESA consultation process would reduce potential adverse effects. Major benefits for anadromous salmonid populations and other aquatic species would result from reconnection of rivers, streams, sloughs, wetlands, and Tillamook Bay, including increasing the area of designated critical habitat for the Oregon Coast coho ESU. Under Alternative 3, priority ecological benefits would be somewhat greater than those provided by the Proposed Action due to the larger area of tidal wetland restoration.

Table 6.1. Proposed Action – Findings of Significance: Vegetation Resources

Resource	Impacts					Primary Rationale
	Short Term	Transition	Long Term	Beneficial/ Detrimental[1]	Direct/ Indirect	
Freshwater vegetation	Moderate	Negligible	Major	Beneficial	Direct	Short term – would remove existing vegetation Transition – would increase non-native, invasive species Long term – would establish native tidal vegetation
Trees	Minor	Minor	Minor	Beneficial	Direct	Short term – would remove most trees on levees Long term – possible die back of remaining trees due to changes in water level and/or salinity; trees would regenerate and re-establish by natural recruitment at suitable sites; most forested areas would be avoided
Tidal vegetation	Minor	Moderate	Major	Beneficial	Direct	Short term – pasture would shift to tidal and levees to tidal Transition – annuals would shift to perennials; would be a temporary increase in weedy species Long term – would increase native tidal vegetation communities

[1]*Determination of beneficial or detrimental impacts apply to long-term impacts.*

Table 6.2. Proposed Action – Findings of Significance: Wetland Resources

Resource	Impacts					Primary Rationale
	Short Term	Transition	Long Term	Beneficial/ Detrimental[1]	Direct/ Indirect	
Freshwater wetlands	Major	Major	Major	Detrimental	Direct	Short term – would immediately change to tidal wetlands with higher salinity and tidal hydrology regime Transition – freshwater wetland vegetation would die off; would increase anaerobic conditions; would decrease soil fertility Long term – would shift to tidal wetland system--priority habitats, and relatively underrepresented regionally
Tidal wetlands	Major	Major	Major	Beneficial	Direct	Short term – would immediately increase tidal wetlands Transition – freshwater species would die off; native tidal species would begin to establish; would shift from mudflat to low marsh to high marsh Long term – naturally functioning tidal wetlands would greatly increase in area and quality from larger contiguity, increased functions and values, and greater diversity of tidal wetland types (mudflat, low marsh, high marsh)

[1]*Determination of beneficial or detrimental impacts apply to long-term impacts.*

Table 6.3. Proposed Action – Finding of Significance: Terrestrial Wildlife Species

Resource	Impacts					Primary Rationale
	Short Term	Transition	Long Term	Beneficial/ Detrimental[1]	Direct/ Indirect	
Deer and elk	Moderate	Moderate	Moderate	Detrimental	D	Short term – construction would disturb and disrupt use patterns Transition and long term – would decrease upland forage and cover during conversion to aquatic habitats
Other terrestrial mammals	Moderate	Moderate	Moderate	Detrimental	D	Short term, transition, and long term – would reduce upland cover, forage, and general habitat by conversion to aquatic habitats
Migratory perching birds	Moderate	Moderate	Moderate	Detrimental	D/I	Short term – would cause mechanical removal of potential nesting habitat and cover Transition and long term – would reduce woody vegetation and lead to fewer opportunities for nesting and cover as aquatic habitats replace upland habitats; impacts would be variable among species; snags created from trees that die from changes in surface hydrology would be beneficial to cavity nesting birds; would increase some foraging opportunities in the long term
Migratory birds – shorebirds, wading birds, waterfowl	Minor	Moderate	Moderate	Beneficial	D/I	Short term – would limit forage opportunities as inundation and conversion begins Transition and long term – would increase opportunities for foraging and improve bay ecosystem productivity and health; would increase nesting opportunities for some species and guilds
Bald eagles	Major	Moderate	Moderate	Detrimental and Beneficial	D/I	Short term – impacts on nesting and nest occupants. Transition and long term – would improve foraging opportunities and prey availability in project area; would improve bay ecosystem productivity; snags and perching/nesting areas would increase

[1]*Determination of beneficial or detrimental impacts apply to long-term impacts.*

Table 6.4. Proposed Action – Findings of Significance: Aquatic Species

Resource	Impacts					Primary Rationale
	Short Term	Transition	Long Term	Beneficial/ Detrimental[2]	Direct/ Indirect	
Non-ESA salmonids[1]	Major	Major	Major	Beneficial	D/I	Short term – expansion of aquatic habitat; some detrimental impacts from construction and initial conversion Transition – increasing prey base with conversion Long term –increase in aquatic habitat, foraging opportunities, and ecosystem health, benefitting all life stages
Pacific Coast groundfish EFH	Minor	Major	Major	Beneficial	D/I	Short term – limited suitable habitat in initial conversion stages Transition and long term –increase in habitat, forage opportunities, prey base, and quality, bay-wide productivity
Coastal Pelagic EFH	Moderate	Major	Major	Beneficial	D/I	Short term – expansion of aquatic habitat; some detrimental impacts from construction and initial conversion Transition and long term –increase in habitat, forage opportunities, prey base, and quality, bay-wide productivity
Resident fish (fresh and brackish)	Moderate	Moderate	Moderate	Beneficial	D/I	Short term – changes in habitat during and after construction would shift use from project area Transition and long term – suitable habitats would change with these species, benefitting from an increase in aquatic habitat and ecosystem health/bay productivity
Commercially and recreationally Important shellfish (crabs, clams, and oysters)	Minor	Moderate	Moderate	Beneficial	I	Short term – construction impacts would be managed to reduce sediment impacts on shellfish beds Transition and long term – increased bay productivity, reduced impacts from flooding contamination, improved sediment distribution and function
Other aquatic invertebrates	Minor	Moderate	Moderate	Beneficial	I	Short term – would not change in distribution or abundance Transition and long term – would increase in aquatic habitat and foraging opportunities; would improve bay health and eco-function
Marine mammals	Minor	Moderate	Moderate	Beneficial	I	Short term – little change in forage opportunities or suitable aquatic habitat Transition – would increase forage base Long term – would increase food sources by increasing aquatic habitats and bay productivity

[1] Analysis excludes federally threatened Oregon Coast coho ESU.
[2] Determination of beneficial or detrimental impacts apply to long-term impacts.

Table 6.5. Proposed Action – Findings of Significance: Threatened and Endangered Species

Resource	Impacts					Primary Rationale
	Short Term	Transition	Long Term	Beneficial/ Detrimental[1]	Direct/ Indirect	
Marbled murrelet	Moderate	Moderate	Moderate	Beneficial	I	Short term – would cause local disturbance during construction and loss of potential nest sites Transition – would increase forage opportunities and improve local habitat conditions Long term – would improve foraging opportunities and bay health and productivity; would reduce disturbance and human use near potential nesting areas and increase in potential nesting over time
Oregon Coast coho salmon	Major	Major	Major	Beneficial	D/I	Short term, transition, and long term – would increase aquatic habitat and critical habitat components for Coast coho; would improve cover and foraging opportunities; would improve bay health and benefit all life stages
Green sturgeon	Minor	Moderate	Moderate	Beneficial	I	Short term – would cause little change in prey base or habitat availability Transition and long term – would increase forage opportunities, prey base, and aquatic habitat and cover

[1]*Determination of beneficial or detrimental impacts apply to long-term impacts.*

Table 6.6. Hall Slough Alternative – Findings of Significance: Vegetation Resources

Resource	Impacts					Primary Rationale
	Short Term	Transition	Long Term	Beneficial/ Detrimental[1]	Direct/ Indirect	
Freshwater vegetation	Major	Minor	Minor	Detrimental	D	Short term – would reduce existing riparian cover by converting to temporary erosion control grass mixes Transition – would reduce riparian corridor vegetation structure temporarily Long term – would shift pasture to levee vegetation and permanently reduce riparian corridor complexity
Trees	Minor	Minor	Negligible	Detrimental	D	Short term – would remove existing trees Transition – some trees would be establishing Long term – would shift to replacement riparian corridor; willows and red alder would regenerate readily
Tidal vegetation	Minor	Negligible	Negligible	Detrimental	D	Short term – would remove tidal vegetation for channel widening Transition – vegetation would be immature and sparse Long term – would be little change in vegetation; would restore some natural tidal vegetation

[1] *Determination of beneficial or detrimental impacts apply to long-term impacts.*

Table 6.7. Hall Slough Alternative – Findings of Significance: Wetland Resources

Resource	Impacts					Primary Rationale
	Short Term	Transition	Long Term	Beneficial/ Detrimental[1]	Direct/ Indirect	
Freshwater wetlands	Negligible	Negligible	Negligible	Neutral	Direct	Short term, transition, and long term – would have little effect because there are no existing freshwater wetlands along Hall Slough (except that some consider Hall Slough itself to be riverine wetland and water of the state)
Tidal wetlands	Negligible	Negligible	Negligible	Neutral	Direct	Short term, transition, and long term – would have little effect because there are negligible existing tidal wetlands along Hall Slough (Hall Slough itself is riverine wetland and water of the state)

[1]*Determination of beneficial or detrimental impacts apply to long-term impacts.*

Table 6.8. Hall Slough Alternative – Findings of Significance: Terrestrial Wildlife Species

Resource	Impacts					Primary Rationale
	Short Term	Transition	Long Term	Beneficial/ Detrimental[1]	Direct/ Indirect	
Deer and elk	Minor	Minor	Minor	Neutral	D	Short term, transition, and long term – would not measurably change access or habitat availability
Other terrestrial mammals	Minor	Minor	Minor	Neutral	D	Short term, transition, and long term – would not measurably change access or habitat availability
Migratory perching birds	Minor	Minor	Minor	Neutral	D	Short term – would be limited and localized disturbances of habitat use and foraging Transition and long term – would not measurably reduce habitat availability
Migratory birds – shorebirds, wading birds, waterfowl	Minor	Minor	Minor	Beneficial	D	Short term, transition, and long term – would limit foraging opportunities for some species
Bald eagles	Minor	Minor	Minor	Neutral	D/I	Short term, transition, and long term – would not cause important changes in local habitats or foraging opportunities

[1]*Determination of beneficial or detrimental impacts apply to long-term impacts.*

Table 6.9. Hall Slough Alternative – Finding of Significance: Aquatic Species

Resource	Impacts					Primary Rationale
	Short Term	Transition	Long Term	Beneficial/ Detrimental [2]	Direct/ Indirect	
Non-ESA salmonids[1]	Minor	Minor	Minor	Beneficial	D/I	Short term – would have little effect on habitat availability or forage quality Transition and long term – would cause some increases in aquatic habitats, but maintenance dredging would offset some habitat improvements
Pacific Coast groundfish EFH	Minor	Minor	Minor	Neutral	D/I	Short term, transition, and long term – would have little change in the availability of estuarine habitat or forage quality
Coastal Pelagic EFH	Minor	Minor	Minor	Neutral	D/I	Short term, transition, and long term – would have little change in the availability of estuarine habitat or forage quality
Resident fish (fresh and brackish)	Minor	Minor	Minor	Beneficial	D	Short term – would trigger few changes in available local habitats Transition and long term – would cause small increases in local suitable habitats and habitat function and increase open water habitat within Hall Slough
Commercially and recreationally important shellfish (crabs, clams, and oysters)	Minor	Minor	Minor	Beneficial	I	Short term – would cause few changes to resources or associated habitats Transition and long term – would improve bay conditions and compensate for urban and agricultural inundation
Other aquatic invertebrates	Minor	Minor	Minor	Beneficial	I	Short term – would not cause many changes to resources or associated habitats Transition and long term – would improve bay conditions and somewhat increase aquatic habitat
Marine mammals	Negligible	Negligible	Negligible	Neutral	I	Short term – In-water work would cease when marine mammals are within harassment distance Transition and long term – would use the project area infrequently

1 Analysis excludes federally threatened Oregon Coast coho ESU.
2 Determination of beneficial or detrimental impacts apply to long-term impacts.

Table 6.10. Hall Slough Alternative – Findings of Significance: Threatened and Endangered Species

Resource	Impacts					Primary Rationale
	Short Term	Transition	Long Term	Beneficial/ Detrimental[1]	Direct/ Indirect	
Marbled murrelet	Negligible	Negligible	Negligible	Neutral	I	Short term, transition, and long term – would not measurably affect Marbled murrelet or their habitat
Oregon Coast coho salmon	Minor	Minor	Minor	Neutral	D	Short term – would have little effect on availability of habitat or forage quality Transition and long term – would somewhat increase aquatic habitats, but maintenance dredging would offset some habitat improvements
Green sturgeon	Minor	Minor	Minor	Beneficial	D	Short term – would have little effect on available foraging opportunities or cover Transition and long term – would cause only a small increase in deep water habitat

[1]*Determination of beneficial or detrimental impacts apply to long-term impacts.*

Table 6.11. Alternative 3 – Findings of Significance: Vegetation

Resource	Impacts					Primary Rationale
	Short Term	Transition	Long Term	Beneficial/ Detrimental[1]	Direct/ Indirect	
Freshwater vegetation	Moderate	Negligible	Major	Beneficial	Direct	Short term – would remove existing vegetation Transition – would increase in non-native, invasive species Long term – would establish native tidal vegetation
Trees	Minor	Minor	Minor	Beneficial	Direct	Short term – would remove most trees on levees Transition – might cause die back of remaining trees by changing water levels and/or water salinity Long term – would re-establish trees by natural regeneration and recruitment at suitable sites; would avoid most forested areas
Tidal vegetation	Minor	Moderate	Major	Beneficial	Direct	Short term – would shift pasture to tidal vegetation, and levee vegetation to tidal vegetation Transition – would shift from annuals to perennials; would temporarily increase weedy species Long term – would increase native tidal vegetation communities

[1]*Determination of detrimental or beneficial impacts apply to long-term impacts.*

Table 6.12. Alternative 3 – Findings of Significance: Wetlands

Resource	Impacts: Short Term	Transition	Long Term	Beneficial/ Detrimental[1]	Direct/ Indirect	Primary Rationale
Freshwater wetlands	Major	Major	Major	Adverse	Direct	Short term – would be an immediate change to tidal wetlands, increased salinity, and tidal hydrology regime Transition – freshwater wetland vegetation would die off; would increase anaerobic soil conditions and decrease soil fertility Long term – would be replaced by tidal wetlands—priority habitats and regionally underrepresented
Tidal wetlands	Major	Major	Major	Beneficial	Direct	Short term – would immediately increase area of tidal wetlands Transition – freshwater species would die off, and native tidal species would begin to establish; would be a shift from mudflat to low marsh to high marsh Long term – would greatly increase naturally functioning tidal wetlands; would increase in wetland quality by increasing contiguity and wetland functions and values; would greatly increase the diversity of tidal wetland types (mudflat, low marsh, high marsh)

[1] *Determination of detrimental or beneficial impacts apply to long-term impacts.*

Table 6.13. Alternative 3 – Findings of Significance: Terrestrial Wildlife Species

Resource	Impacts					Primary Rationale
	Short Term	Transition	Long Term	Beneficial/ Detrimental[1]	Direct/ Indirect	
Deer and elk	Moderate	Moderate	Moderate	Detrimental	D	Short term – construction would disturb and disrupt use patterns Transition and long term – conversion to aquatic habitats would reduce upland forage and cover
Other terrestrial mammals	Moderate	Moderate	Moderate	Detrimental	D	Short term, transition, and long term – conversion to aquatic habitats would reduce upland cover, forage, and habitat availability
Migratory perching birds	Moderate	Moderate	Moderate	Detrimental	D/I	Short term – would mechanically remove potential nesting habitat and cover Transition and long term – would reduce woody vegetation and lead to fewer nesting and cover opportunities as aquatic habitats replace upland habitats; impacts would vary among species; snags created from trees that die from changes in surface hydrology would benefit cavity nesting birds; would increase some foraging opportunities
Migratory birds – shorebirds, wading birds, waterfowl	Minor	Moderate	Moderate	Beneficial	D/I	Short term – would limit forage opportunities as inundation and conversion begin Transition and long term – would increase opportunities for foraging, improve bay ecosystem productivity and health, and increase nesting opportunities for some species and guilds
Bald eagles	Minor	Moderate	Moderate	Beneficial	D/I	Short term – would be little change in forage or nesting opportunities Transition and long term – would improve foraging opportunities and prey availability, increase bay ecosystem productivity, and increase snags and potential perching/nesting areas

[1]*Determination of detrimental or beneficial impacts apply to long-term impacts.*

Table 6.14. Alternative 3 – Findings of Significance: Aquatic Species

Resource	Impacts					Primary Rationale
	Short Term	Transition	Long Term	Beneficial/ Detrimental[2]	Direct/ Indirect	
Non-ESA salmonids[1]	Major	Major	Major	Beneficial	D/I	Short term – would expand aquatic habitat but cause detrimental impacts during construction and initial conversion Transition – would increasing prey base with habitat conversion Long term – would increase aquatic habitat, foraging opportunities, and ecosystem health, benefitting all life stages
Pacific Coast groundfish EFH	Minor	Major	Major	Beneficial	D/I	Short term – would limit suitable habitat during initial habitat conversion Transition and long term – would increase habitat, forage opportunities, prey base, and bay-wide quality and productivity
Coastal Pelagic EFH	Moderate	Major	Major	Beneficial	D/I	Short term – expansion of aquatic habitat; some detrimental impacts from construction and initial conversion Transition and long term – would increase habitat, forage opportunities, prey base, and quality, bay-wide productivity
Resident fish (fresh and brackish)	Moderate	Moderate	Moderate	Beneficial	D/I	Short term – changes in habitat during and after construction would shift use Transition and long term – would change suitable habitats with these species, benefitting from increased aquatic habitat and ecosystem health/bay productivity
Commercially and recreationally Important shellfish (crabs, clams, and oysters)	Minor	Moderate	Moderate	Beneficial	I	Short term – would generate managed sediment delivery to shellfish beds during construction Transition and long term – would increase bay productivity, reduce contamination from flooding, and improve sediment distribution and function
Other aquatic invertebrates	Minor	Moderate	Moderate	Beneficial	I	Short term – would cause few changes in distribution or abundances Transition and long term – would increase aquatic habitat, increase foraging opportunities, improve bay health, and improve ecosystem function

Resource	Impacts					Primary Rationale
	Short Term	Transition	Long Term	Beneficial/ Detrimental[2]	Direct/ Indirect	
Marine mammals	Minor	Moderate	Moderate	Beneficial	I	Short term – would cause little change in forage opportunities or suitable aquatic habitat Transition – would increase the forage base Long term – would increase food sources, aquatic habitats, and bay productivity

[1] Analysis excludes federally threatened Oregon Coast coho ESU.
[2] Determination of beneficial or detrimental impacts apply to long-term impacts.

Table 6.15. Alternative 3 – Finding of Significance: Threatened and Endangered Species

Resource	Impacts					Primary Rationale
	Short Term	Transition	Long Term	Beneficial/ Detrimental[1]	Direct/ Indirect	
Marbled murrelet	Moderate	Moderate	Moderate	Beneficial	I	Short term – construction would cause local disturbance and reduction of potential nest sites Transition – would increase forage opportunities and improve local habitat conditions Long term – would improve foraging opportunities and bay health and productivity; would reduce human-caused uses and disturbances near potential nesting areas; would increase potential nesting
Oregon Coast coho salmon	Major	Major	Major	Beneficial	D/I	Short term, transition, and long term – would increase aquatic habitat and critical habitat components for the species, immediately and over the long term; would improve cover and foraging opportunities; would improve bay health, benefitting all life stages
Green sturgeon	Minor	Moderate	Moderate	Beneficial	I	Short term – would not cause much change in prey base or habitat availability Transition and long term – would increase forage opportunities and increase prey base; would increase aquatic habitat and cover

[1] Determination of beneficial or detrimental impacts apply to long-term impacts.

SECTION 7 References

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Attachments

Attachment A
USFWS Species List

U.S. Fish and Wildlife Service

Trust Resources List

This resource list is to be used for planning purposes only — it is not an official species list.

Endangered Species Act species list information for your project is available online and listed below for the following FWS Field Offices:

Oregon Fish and Wildlife Office
2600 SOUTHEAST 98TH AVENUE, SUITE 100
PORTLAND, OR 97266
(503) 231-6179
http://www.fws.gov/oregonfwo/Species/Lists/RequestList.asp

Project Name:

SFC

Project Counties:

Tillamook, OR

Project Type:

Stream / Waterbody / Canals / Levees / Dikes

Endangered Species Act Species List (USFWS Endangered Species Program).

There are a total of **17** threatened, endangered, or candidate species on your species list. Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fishes may appear on the species list because a project could cause downstream effects on the species. Critical habitats listed under the **Has Critical Habitat** column may or may not lie within your project area. See the **Critical habitats within your project area** section below for critical habitat that lies within your project area. Please contact the designated FWS office if you have questions.

Species that should be considered in an effects analysis for your project:

Birds	Status		Has Critical Habitat	Contact

Trust Resources List

Marbled murrelet (*Brachyramphus marmoratus*) Population: CA, OR, WA	Threatened	species info	Final designated critical habitat	Oregon Fish And Wildlife Office
Northern Spotted owl (*Strix occidentalis caurina*) Population: Entire	Threatened	species info	Final designated critical habitat	Oregon Fish And Wildlife Office
Short-Tailed albatross (*Phoebastria (=diomedea) albatrus*) Population: Entire	Endangered	species info		Oregon Fish And Wildlife Office
western snowy plover (*Charadrius nivosus ssp. nivosus*) Population: Pacific coastal pop.	Threatened	species info	Final designated critical habitat	Oregon Fish And Wildlife Office
Xantus's Murrelet (*Synthliboramphus hypoleucus*)	Candidate	species info		Oregon Fish And Wildlife Office
Flowering Plants				
Bradshaw's desert-parsley (*Lomatium bradshawii*)	Endangered	species info		Oregon Fish And Wildlife Office
Kincaid's Lupine (*Lupinus sulphureus ssp. kincaidii*)	Threatened	species info	Final designated critical habitat	Oregon Fish And Wildlife Office
Nelson's checker-mallow (*Sidalcea nelsoniana*)	Threatened	species info		Oregon Fish And Wildlife Office
Willamette daisy (*Erigeron decumbens var. decumbens*)	Endangered	species info	Final designated critical habitat	Oregon Fish And Wildlife Office
Insects				
Fender's Blue butterfly (*Icaricia icarioides fenderi*)	Endangered	species info	Final designated critical habitat	Oregon Fish And Wildlife Office
Oregon Silverspot butterfly (*Speyeria zerene hippolyta*) Population: Entire	Threatened	species info	Final designated critical habitat	Oregon Fish And Wildlife Office
Mammals				
fisher (*Martes pennanti*) Population: West coast DPS	Proposed Threatened	species info		Oregon Fish And Wildlife Office

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red tree vole (*Arborimus longicaudus*) Population: North Oregon Coast DPS	Candidate	species info		Oregon Fish And Wildlife Office
Reptiles				
Green sea turtle (*Chelonia mydas*) Population: Except where endangered	Threatened	species info	Final designated critical habitat	Oregon Fish And Wildlife Office
Leatherback sea turtle (*Dermochelys coriacea*) Population: Entire	Endangered	species info	Final designated critical habitat	Oregon Fish And Wildlife Office
Loggerhead sea turtle (*Caretta caretta*) Population: North Pacific Ocean DPS	Endangered	species info		Oregon Fish And Wildlife Office
Olive Ridley sea turtle (*Lepidochelys olivacea*) Population: Except where endangered	Threatened	species info		Oregon Fish And Wildlife Office

Critical habitats within your project area: (View all critical habitats within your project area on one map)

The following critical habitats lie fully or partially within your project area.

Birds	Critical Habitat Type
Marbled murrelet (*Brachyramphus marmoratus*) Population: CA, OR, WA	Final designated critical habitat
Northern Spotted owl (*Strix occidentalis caurina*) Population: Entire	Final designated critical habitat
western snowy plover (*Charadrius nivosus ssp. nivosus*) Population: Pacific coastal pop.	Final designated critical habitat
Fishes	
steelhead (*Oncorhynchus (=salmo) mykiss*) Population: Upper Willamette River DPS	Final designated critical habitat

FWS National Wildlife Refuges (USFWS National Wildlife Refuges Program).

There are **4** refuges in your refuge list

Oregon Islands National Wildlife Refuge (541) 867-4550 C/O OREGON COAST NWR COMPLEX 2127 SE MARINE SCIENCE DRIVE NEWPORT, OR97365	refuge profile
Cape Meares National Wildlife Refuge (541) 867-4550 C/O OREGON COAST NWR COMPLEX 2127 SE MARINE SCIENCE DRIVE NEWPORT, OR97365	refuge profile
Three Arch Rocks National Wildlife Refuge (541) 867-4550 C/O OREGON COAST NWR COMPLEX 2127 SE MARINE SCIENCE DRIVE NEWPORT, OR97365	refuge profile
Nestucca Bay National Wildlife Refuge (541) 867-4550 C/O OREGON COAST NWR COMPLEX 2127 SE MARINE SCIENCE DRIVE NEWPORT, OR97365	refuge profile

FWS Migratory Birds (USFWS Migratory Bird Program).

The protection of birds is regulated by the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA). Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish and Wildlife Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). The MBTA has no provision for allowing take of migratory birds that may be unintentionally killed or injured by otherwise lawful activities. For more information regarding these Acts see: http://www.fws.gov/migratorybirds/RegulationsandPolicies.html.

All project proponents are responsible for complying with the appropriate regulations protecting birds when planning and developing a project. To meet these conservation obligations, proponents should identify potential or existing project-related impacts to migratory birds and their habitat and develop and implement conservation measures that avoid, minimize, or compensate for these impacts. The Service's Birds of Conservation Concern (2008) report identifies species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become listed under the Endangered Species Act as amended (16 U.S.C 1531 et seq.).

Trust Resources List

For information about Birds of Conservation Concern, go to: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Management/BCC.html.

To search and view summaries of year-round bird occurrence data within your project area, go to the Avian Knowledge Network Histogram Tool links in the Bird Conservation Tools section at: http://www.fws.gov/migratorybirds/CCMB2.htm.

For information about conservation measures that help avoid or minimize impacts to birds, please visit: http://www.fws.gov/migratorybirds/CCMB2.htm.

Migratory birds of concern that may be affected by your project:
There are **15** birds on your Migratory birds of concern list. The underlying data layers used to generate the migratory bird list of concern will continue to be updated regularly as new and better information is obtained. User feedback is one method of identifying any needed improvements. Therefore, users are encouraged to submit comments about any questions regarding species ranges (e.g., a bird on the USFWS BCC list you know does not occur in the specified location appears on the list, or a BCC species that you know does occur there is not appearing on the list). Comments should be sent to the ECOS Help Desk.

Species Name	Bird of Conservation Concern (BCC)	Species Profile	Seasonal Occurrence in Project Area
Bald eagle (*Haliaeetus leucocephalus*)	Yes	species info	Year-round
Black Oystercatcher (*Haematopus bachmani*)	Yes	species info	Year-round
Caspian Tern (*Hydroprogne caspia*)	Yes	species info	Breeding
Fox Sparrow (*Passerella liaca*)	Yes	species info	Wintering
Marbled Godwit (*Limosa fedoa*)	Yes	species info	Wintering
Olive-Sided flycatcher (*Contopus cooperi*)	Yes	species info	Breeding
Peregrine Falcon (*Falco peregrinus*)	Yes	species info	Year-round
Pink-footed Shearwater (*Puffinus creatopus*)	Yes	species info	Year-round
Purple Finch (*Carpodacus purpureus*)	Yes	species info	Year-round

Rufous hummingbird (*selasphorus rufus*)	Yes	species info	Breeding
Short-billed Dowitcher (*Limnodromus griseus*)	Yes	species info	Wintering
Short-eared Owl (*Asio flammeus*)	Yes	species info	Year-round
Vesper Sparrow (*pooecetes gramineus ssp. affinis*)	Yes	species info	Breeding
Western grebe (*aechmophorus occidentalis*)	Yes	species info	Wintering
Willow Flycatcher (*Empidonax traillii*)	Yes	species info	Breeding

NWI Wetlands (USFWS National Wetlands Inventory).

The U.S. Fish and Wildlife Service is the principal Federal agency that provides information on the extent and status of wetlands in the U.S., via the National Wetlands Inventory Program (NWI). In addition to impacts to wetlands within your immediate project area, wetlands outside of your project area may need to be considered in any evaluation of project impacts, due to the hydrologic nature of wetlands (for example, project activities may affect local hydrology within, and outside of, your immediate project area). It may be helpful to refer to the USFWS National Wetland Inventory website. The designated FWS office can also assist you. Impacts to wetlands and other aquatic habitats from your project may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal Statutes. Project Proponents should discuss the relationship of these requirements to their project with the Regulatory Program of the appropriate U.S. Army Corps of Engineers District.

Data Limitations, Exclusions and Precautions

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery and/or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Exclusions - Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Precautions - Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

The following wetland types intersect your project area in one or more locations:

Wetland Types	NWI Classification Code	Total Acres
Estuarine and Marine Deepwater	E1UBLx	0.5868
Estuarine and Marine Deepwater	E1UBL	56.5416
Estuarine and Marine Wetland	E2USP	118.9547
Estuarine and Marine Wetland	E2USN	1414.0359
Estuarine and Marine Wetland	E2USM	41.2285
Estuarine and Marine Wetland	E2ABN	3.2463
Estuarine and Marine Wetland	E2SSP	1.7413
Estuarine and Marine Wetland	E2ABM	3.0927
Estuarine and Marine Wetland	E2EMNx	0.1382
Estuarine and Marine Wetland	M2RSNr	0.2188

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Estuarine and Marine Wetland	M2ABN	4.6865
Estuarine and Marine Wetland	E2EMP	264.3389
Estuarine and Marine Wetland	E2EMN	455.7231
Estuarine and Marine Wetland	M2USN	899.2721
Estuarine and Marine Wetland	M2USP	820.2685
Estuarine and Marine Wetland	E2USNx	0.1269
Estuarine and Marine Wetland	E2RSNr	7.0671
Estuarine and Marine Wetland	M2RSN	28.9673
Freshwater Emergent Wetland	PEMFx	1.9917
Freshwater Emergent Wetland	PEMCh	71.5419
Freshwater Emergent Wetland	PEMCd	51.947
Freshwater Emergent Wetland	PEMCb	8.6494
Freshwater Emergent Wetland	PEM/FOC	1.4625
Freshwater Emergent Wetland	PEMFb	4.0574
Freshwater Emergent Wetland	PEMBd	0.2809
Freshwater Emergent Wetland	PEMFh	3.9225
Freshwater Emergent Wetland	PEM/SSR	1.0951
Freshwater Emergent Wetland	PEMF	50.283
Freshwater Emergent Wetland	PEMA	144.6284
Freshwater Emergent Wetland	PEMCdh	100.8465
Freshwater Emergent Wetland	PEMC	255.0107
Freshwater Emergent Wetland	PEMB	16.3754
Freshwater Emergent Wetland	PEMAd	842.7749
Freshwater Emergent Wetland	PEM/SSA	5.4803
Freshwater Emergent Wetland	PEMH	3.2526
Freshwater Emergent Wetland	PEMAh	3.0804

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Freshwater Emergent Wetland	PEM/SSC	81.9869
Freshwater Emergent Wetland	PEMT	4.2953
Freshwater Emergent Wetland	PEMR	71.2813
Freshwater Emergent Wetland	PEMS	0.7587
Freshwater Emergent Wetland	PEMCx	20.5798
Freshwater Emergent Wetland	PEMAdh	740.7299
Freshwater Emergent Wetland	PEMHb	1.0662
Freshwater Forested/Shrub Wetland	PFOB	2.1617
Freshwater Forested/Shrub Wetland	PFOA	252.3931
Freshwater Forested/Shrub Wetland	PFOC	371.7079
Freshwater Forested/Shrub Wetland	PFOCh	1.0425
Freshwater Forested/Shrub Wetland	PSSCb	15.4693
Freshwater Forested/Shrub Wetland	PFOR	38.5201
Freshwater Forested/Shrub Wetland	PFOS	15.7409
Freshwater Forested/Shrub Wetland	PSSR	65.299
Freshwater Forested/Shrub Wetland	PSSFb	4.1935
Freshwater Forested/Shrub Wetland	PSS/EMA	4.5995
Freshwater Forested/Shrub Wetland	PSSA	11.6721
Freshwater Forested/Shrub Wetland	PSSB	0.8154
Freshwater Forested/Shrub Wetland	PSSC	268.7603
Freshwater Forested/Shrub Wetland	PFOAd	9.9328
Freshwater Forested/Shrub Wetland	PFOAb	1.5321
Freshwater Forested/Shrub Wetland	PSSCx	1.0517
Freshwater Forested/Shrub Wetland	PFO/SSC	1.605
Freshwater Forested/Shrub Wetland	PFOAh	1.7727
Freshwater Pond	PUBFx	1.5436

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Freshwater Pond	PABH	3.2106
Freshwater Pond	PABF	1.665
Freshwater Pond	PUBHh	8.0266
Freshwater Pond	PUBVhx	0.186
Freshwater Pond	PUBHb	0.5921
Freshwater Pond	PUBKx	2.7753
Freshwater Pond	PUBHx	8.6317
Freshwater Pond	PABHh	6.3422
Freshwater Pond	PUBKrx	17.3083
Freshwater Pond	PUBH	22.6403
Freshwater Pond	PUBF	2.5985
Freshwater Pond	PUBFhx	0.5522
Freshwater Pond	PABHx	0.4384
Freshwater Pond	PUBFb	0.1432
Freshwater Pond	PUBFh	1.9346
Lake	L2ABH	20.3721
Lake	L1UBH	37.6093
Other	PUSCh	4.4229
Riverine	R2USC	13.0469
Riverine	R4USC	9.4158
Riverine	R3UBH	33.3755
Riverine	R1USR	0.7195
Riverine	R2UBH	45.1731
Riverine	R2UBHx	8.315
Riverine	R1UBV	106.0883

Attachment B
Project Design Criteria from PROJECTS

General Construction Measures

1. Project Design

a. Use the best available scientific information regarding the likely effects of climate change on resources in the project area, including projections of local stream flow and water temperature, to ensure that the project will be adaptable to those changes.
b. Obtain all applicable regulatory permits and official project authorizations before beginning construction.
c. Minimize the extent and duration of earthwork, *e.g.*, compacting, dredging, drilling, excavation, and filling.
    i. Avoid use of heavy equipment, vehicles or power tools below bankfull elevation unless project specialists determine such work is necessary, or will result in less risk of sedimentation or other ecological damage than work above that elevation.
    ii. Complete earthwork in wetlands, riparian areas, and stream channels as quickly as possible.
d. Cease project operations when high flows may inundate the project area, except for efforts to avoid or minimize resource damage.

2. Site Contamination Assessment

a. The level of detail and resources committed to such an assessment will be commensurate with the level and type of past or current development at the site. Assessments may include the following:
    i. Review available records, such as former site use, building plans, and records of any prior contamination events.
    ii. If the project site was used for industrial processes (*i.e.*, mining or manufacturing with chemicals), inspect to determine the environmental condition of the property.
    iii. Interview people who are knowledgeable about the site, *e.g.*, site owners, operators, and occupants, neighbors, or local government officials.
b. Retain contaminant survey information in the project file. Consult with NMFS if ground disturbance to accomplish the proposed project will potentially release contaminants to aquatic habitat that supports listed fish species.

3. Site Layout and Flagging

a. Before any significant ground disturbance or entry of mechanized equipment or vehicles into the construction area, clearly mark with flagging or survey marking paint the following areas:
    i. Sensitive areas, *e.g.*, wetlands, water bodies, ordinary high water, spawning areas
    ii. Equipment entry and exit points
    iii. Road and stream crossing alignments
    iv. Staging, storage, and stockpile areas
b. Before the use of herbicides, clearly flag no-application buffer zones.

4. **Staging, Storage, and Stockpile Areas**

a. Designate and use staging areas to store hazardous materials, or to store, fuel, or service heavy equipment, vehicles and other power equipment with tanks larger than 5 gallons, that are at least 150 feet from any natural water body or wetland, or on an established paved area, such that sediment and other contaminants from the staging area cannot be deposited in the floodplain or stream.
b. Natural materials that are displaced by construction and reserved for restoration, *e.g.*, LW, gravel, and boulders, may be stockpiled within the 100-year floodplain.
c. Dispose of any material not used in restoration and not native to the floodplain outside of the functional floodplain.
d. After construction is complete, obliterate all staging, storage, or stockpile areas, stabilize the soil, and revegetate the area.[1]

5. **Erosion Control**

a. Use site planning and site erosion control measures commensurate with the scope of the project to prevent erosion and sediment discharge from the project site.
b. Before significant earthwork begins, install appropriate, temporary erosion controls downslope to prevent sediment deposition in the riparian area, wetlands, or water body.
c. During construction, if eroded sediment appears likely to be deposited in the stream during construction, install additional sediment barriers as necessary.
d. Temporary erosion control measures may include fiber wattles, silt fences, jute matting, wood fiber mulch and soil binder, or geotextiles and geosynthetic fabric.
e. Soil stabilization utilizing wood fiber mulch and tackifier (hydro-applied) may be used to reduce erosion of bare soil if the materials are noxious weed free and nontoxic to aquatic and terrestrial animals, soil microorganisms, and vegetation.
f. Remove sediment from erosion controls if it reaches 1/3 of the exposed height of the control.
g. Whenever surface water is present, maintain a supply of sediment control materials and an oil-absorbing floating boom at the project site.
h. Stabilize all disturbed soils following any break in work unless construction will resume within four days.
i. Remove temporary erosion controls after construction is complete and the site is fully stabilized.
j. For projects involving near- and in-water construction, complete and record the following water quality observations to ensure that any increases in suspended sediment do not exceed background levels:
    i. Take a turbidity sample using an appropriately and regularly calibrated turbidimeter, or a visual turbidity observation, every 4 hours when work is being completed, or more often as necessary to ensure that the in-water work area is not contributing visible sediment to water, at a relatively

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[1] Road and path obliteration refers to the most comprehensive degree of decommissioning and involves decompacting the surface and ditch, pulling the fill material onto the running surface, and reshaping to match the original contour.

undisturbed area approximately 100 feet upstream from the project area, or 300 feet from the project area if it is subject to tidal or coastal scour. Record the observation, location, and time before monitoring at the downstream point.

ii. Take a second visual observation, immediately after each upstream observation, approximately 50 feet downstream from the project area in streams that are 30 feet wide or less, 100 feet from the project area for streams between 30 and 100 feet wide, 200 feet from the discharge point or nonpoint source for streams greater than 100 feet wide, and 300 feet from the discharge point or nonpoint source for areas subject to tidal or coastal scour. Record the downstream observation, location, and time.

iii. Compare the upstream and downstream observations. If more turbidity or pollutants is/are observed downstream than upstream, the activity will be modified to reduce pollution. Continue to monitor every 4 hours.

iv. If the exceedance continues after the second monitoring interval (after 8 hours), the activity will stop until the levels returns to background.

v. Results of turbidity monitoring and sampling will be summarized and submitted to NMFS in the Action Implementation Form within 60 days of end of construction.

6. Hazardous Material Spill Prevention and Control

a. At the project site:

i. Post written procedures for notifying environmental response agencies, including an inventory and description of all hazardous materials present, and the storage and handling procedures for their use.

ii. Maintain a spill containment kit, with supplies and instructions for cleanup and disposal, adequate for the types and quantity of hazardous materials present.

iii. Train workers in spill containment procedures, including the location and use of the spill containment kits.

b. Temporarily contain any waste liquids generated under an impervious cover, such as a tarpaulin, in the staging area until the wastes can be properly transported to, and disposed of, at an approved receiving facility.

7. Equipment, Vehicles, and Power Tools

a. Select, operate and maintain all heavy equipment, vehicles, and power tools to minimize adverse effects on the environment, *e.g.*, low pressure tires, minimal hard-turn paths for track vehicles, use of temporary mats or plates to protect wet soils.

b. Before entering wetlands or working within 150 feet of a waterbody, replace all petroleum-based hydraulic fluids with biodegradable products.[2]

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[2] For additional information and suppliers of biodegradable hydraulic fluids, motor oil, lubricant, or grease, see Environmentally Acceptable Lubricants by the U.S. EPA (2011); *e.g.*, mineral oil, polyglycol, vegetable oil, synthetic ester; Mobil® biodegradable hydraulic oils, Total® hydraulic fluid, Terresolve Technologies Ltd.® bio-based biodegradable lubricants, Cougar Lubrication® 2XT Bio engine oil, Series 4300 Synthetic Bio-degradable

c. Invasive species prevention and control.
   i. Before entering the project site, power wash all heavy equipment, vehicles and power tools, allow them to fully dry, and inspect them to make certain no plants, soil, or other organic material is adhering to their surface.
   ii. Before entering the water, inspect any watercraft, waders, boots, or other gear to be used in or near water and remove any plants, soil, or other organic material adhering to the surface.
d. Inspect all equipment, vehicles, and power tools for fluid leaks before they leave the staging area.
e. Before operation within 150 feet of any waterbody, and as often as necessary during operation, thoroughly clean all equipment, vehicles, and power tools to keep them free of external fluids and grease and to prevent leaks and spills from entering the water.
f. Generators, cranes or other stationary heavy equipment operated within 150 feet of any waterbody will be maintained and protected as necessary to prevent leaks and spills from entering the water.

8. Temporary Access Roads and Paths

a. Whenever reasonable, use existing access roads and paths preferentially.
b. Minimize the number and length of temporary access roads and paths through riparian areas and floodplains.
c. Minimize removal of riparian vegetation.
d. When it is necessary to remove vegetation, cut at ground level (no grubbing).
e. Do not build temporary access roads or paths where grade, soil, or other features suggest slope instability.
f. Any road on a slope steeper than 30% will be designed by a civil engineer with experience in steep road design.
g. After construction is complete, obliterate all temporary access roads and paths, stabilize the soil, and revegetate the area.
h. Temporary roads and paths in wet areas or areas prone to flooding will be obliterated by the end of the in-water work window. Decompact road surfaces and drainage areas, pull fill material onto the running surface, and reshape to match the original contours.

9. Dust Abatement

a. Employ dust abatement measures commensurate with soil type, equipment use, wind conditions, and the effects of other erosion control measures.
b. Sequence and schedule work to reduce the exposure of bare soil to wind erosion.
c. Maintain spill containment supplies on-site whenever dust abatement chemicals are applied.
d. Do not use petroleum-based products.

Hydraulic Oil, 8060-2 Synthetic Bio-Degradable Grease No. 2, *etc*. The use of trade, firm, or corporation names in this opinion is for the information and convenience of the action agency and applicants and does not constitute an official endorsement or approval by the U.S. Department of Commerce or NMFS of any product or service to the exclusion of others that may be suitable.

e. Do not apply dust-abatement chemicals, *e.g.*, magnesium chloride, calcium chloride salts, ligninsulfonate, within 25 feet of a water body, or in other areas where they may runoff into a wetland or water body.
f. Do not apply ligninsulfonate at rates exceeding 0.5 gallons per square yard of road surface, assuming a 50:50 solution of ligninsulfonate to water.

10. Temporary Stream Crossings

a. No stream crossing may occur at active spawning sites, when holding adult listed fish are present, or when eggs or alevins are in the gravel.
b. Do not place temporary crossings in areas that may increase the risk of channel re-routing or avulsion, or in potential spawning habitat, *e.g.*, pools and pool tailouts.
c. Minimize the number of temporary stream crossings; use existing stream crossings whenever reasonable.
d. Install temporary bridges and culverts to allow for equipment and vehicle crossing over perennial streams to access construction areas.
e. Wherever possible, vehicles and machinery will cross streams at right angles to the main channel.
f. Equipment and vehicles may cross the stream in the wet only where the streambed is bedrock where the streambed is naturally stable, or where mats or off-site logs are placed in the stream and used as a crossing.
g. Obliterate all temporary stream crossings as soon as they are no longer needed, and restore any damage to affected stream banks or channel.

11. Surface Water Withdrawal and Construction Discharge Water

a. Surface water may be diverted to meet construction needs, but only if developed sources are unavailable or inadequate.
b. Diversions may not exceed 10% of the available flow and will have a juvenile fish exclusion device that is consistent with NMFS' criteria (NMFS 2011a).[3]
c. Treat all construction discharge water using best management practices to remove debris, sediment, petroleum products, and any other pollutants likely to be present (*e.g.*, green concrete, contaminated water, silt, welding slag, sandblasting abrasive, grout cured less than 24 hours, drilling fluids), to ensure that no pollutants are discharged to any perennial or intermittent waterbody.

12. Fish Passage

a. Provide fish passage for any adult or juvenile ESA-listed fish likely to be present in the action area during construction, unless passage did not exist before construction, stream isolation and dewatering is required during project implementation, or the stream is naturally impassable at the time of construction.
b. After construction, provide fish passage that meets NMFS' fish passage criteria for any adult or juvenile ESA-listed fish (NMFS 2011a), for the life of the action.

[3] National Marine Fisheries Service. 2011. Anadromous salmonid passage facility design. Northwest Region.

13. Timing of In-Water Work

a. The inwater work window will be identified as the limit to inwater construction specified in the project notification form. The construction schedule will conform to the windows established in Oregon, Washington, and Idaho by the Oregon Department of Fish and Wildlife (ODFW 2008), Washington Department of Fish and Wildlife (WDFW 2010), and Idaho Department of Fish and Game, respectively. Any exceptions to in-water work windows recommended by ODFW, WDFW, or IDFG will be approved by NMFS. In the Willamette River below Willamette Falls, the winter work window (December 1 – January 31) is not approved for actions under this opinion.

b. Hydraulic and topographic measurements and placement of LW, boulders, or gravel may be completed anytime, provided the affected area is not occupied by adult fish congregating for spawning, or in an area where redds are occupied by eggs or pre-emergent alevins.

14. Fisheries, Hydrology, Geomorphology, Wildlife, Botany, and Cultural Surveys in Support of Aquatic Restoration include assessments and monitoring projects that are associated with planning, implementation, and monitoring of aquatic restoration projects covered by this opinion. Such support projects may include surveys to document the following aquatic and riparian attributes: fish habitat, hydrology, channel geomorphology, water quality, fish spawning, fish presence[4], macroinvertebrates, riparian vegetation, wildlife, and cultural resources (including excavating test pits less than 1 m^2 in size). This also includes effectiveness monitoring associated with projects implemented under this opinion, provided the effectiveness monitoring is limited to the same survey techniques described in this section.

a. Train personnel in survey methods to prevent or minimize disturbance of fish. Contract specifications should include these methods where appropriate.

b. Avoid impacts to fish redds. When possible, avoid sampling during spawning periods.

c. Coordinate with other local agencies to prevent redundant surveys.

d. Locate excavated material from cultural resource test pits away from stream channels. Replace all material in test pits when survey is completed and stabilize the surface.

e. Does not include research projects that have or should obtain a permit pursuant to section 10(a) of the ESA.

15. Work Area Isolation

a. Isolate any work area within the wetted channel from the active stream whenever ESA-listed fish are reasonably certain to be present, or if the work area is less than 300 feet upstream from known spawning habitats. However, work area isolation may not always be necessary or practical in certain settings; *i.e.,* dry streambeds and tidal zones, respectively.

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[4] Capture or enumeration by non-lethal techniques, *i.e.,* snorkel, minnow trapping; not hooking or electrofishing.

b. Engineering design plans for work area isolation will include all isolation elements.
c. Dewater the shortest linear extent of work area practicable, unless wetted in-stream work is deemed to be minimally harmful to fish, and is beneficial to other aquatic species.[5]
    i. Use a coffer dam and a by-pass culvert or pipe, or a lined, non-erodible diversion ditch to divert flow around the dewatered area. Dissipate flow energy to prevent damage to riparian vegetation or stream channel and provide for safe downstream reentry for fish, preferably into pool habitat with cover.
    ii. Where gravity feed is not possible, pump water from the work site to avoid rewatering. Maintain a fish screen on the pump intake to avoid juvenile fish entrainment (NMFS 2011a).
    iii. Pump seepage water to a temporary storage and treatment site, or into upland areas, to allow water to percolate through soil or to filter through vegetation before reentering the stream channel with a treatment system comprised of either a hay bale basin or other sediment control device.
    iv. Monitor below the construction site to prevent stranding of aquatic organisms.
    v. When construction is complete, re-water the construction site slowly to prevent loss of surface flow downstream, and to prevent a release of suspended sediment.
d. Whenever a pump is used to dewater the isolation area and ESA-listed fish may be present, a fish screen will be used that meets the most current version of NMFS' fish screen criteria (NMFS 2011a). NMFS approval is required for pumping that exceeds 3 cfs.

16. Fish Capture and Release

a. If practicable, allow listed fish species to migrate out of the work area or remove fish before dewatering; otherwise remove fish from an exclusion area as it is slowly dewatered with methods such as hand or dip-nets, seining, or trapping with minnow traps (or gee-minnow traps).
b. Fish capture will be supervised by a qualified fisheries biologist, with experience in work area isolation and competent to ensure the safe handling of fish.
c. Conduct fish capture activities during periods of the day with the coolest air and water temperatures possible, normally early in the morning to minimize stress and injury of species present.
d. Monitor the nets frequently enough to ensure they stay secured to the banks and free of organic accumulation.
e. Electrofishing will be used during the coolest time of day, and only after other means of fish capture are determined to be not feasible or ineffective.
    i. Follow the most recent version of NMFS (2000) electrofishing guidelines.

[5] For instructions on how to dewater areas occupied by lamprey, see *Best management practices to minimize adverse effects to Pacific lamprey* (*Entosphenus tridentatus*) (USFWS 2010).

ii. Do not electrofish when the water appears turbid, *e.g.*, when objects are not visible at depth of 12 inches.
iii. Do not intentionally contact fish with the anode.
iv. Use direct current (DC) or pulsed direct current within the following ranges:
1. If conductivity is less than 100 µs, use 900 to 1100 volts.
2. If conductivity is between 100 and 300 µs, use 500 to 800 volts.
3. If conductivity greater than 300 µs, use less than 400 volts.
v. Begin electrofishing with a minimum pulse width and recommended voltage, then gradually increase to the point where fish are immobilized.
vi. Immediately discontinue electrofishing if fish are killed or injured, *i.e.*, dark bands visible on the body, spinal deformations, significant de-scaling, torpid or inability to maintain upright attitude after sufficient recovery time. Recheck machine settings, water temperature and conductivity, and adjust or postpone procedures as necessary to reduce injuries.

f. If buckets are used to transport fish:
i. Minimize the time fish are in a transport bucket.
ii. Keep buckets in shaded areas or, if no shade is available, covered by a canopy.
iii. Limit the number of fish within a bucket; fish will be of relatively comparable size to minimize predation.
iv. Use aerators or replace the water in the buckets at least every 15 minutes with cold clear water.
v. Release fish in an area upstream with adequate cover and flow refuge; downstream is acceptable provided the release site is below the influence of construction.
vi. Be careful to avoid mortality counting errors.

g. Monitor and record fish presence, handling, and injury during all phases of fish capture and submit a fish salvage report to NMFS within 60 days of capture that documents date, time of day, fish handling procedures, air and water temperatures, and total numbers of each salmon, steelhead and eulachon handled, and numbers of ESA-listed fish injured or killed.

17. Invasive and non-native plant control

a. ***Non-herbicide methods.*** Limit vegetation removal and soil disturbance within the riparian zone by limiting the number of workers there to the minimum necessary to complete manual, mechanical, or hydro-mechanical plant control (*e.g.*, hand pulling, bending[6], clipping, stabbing, digging, brush-cutting, mulching, radiant heat, portable flame burner, super-heated steam, pressurized hot water, or hot foam (Arsenault *et al.* 2008; Donohoe *et al.* 2010))[7]. Do not allow cut, mowed, or pulled vegetation to enter waterways.
b. ***Herbicide Label.*** Herbicide applicators will comply with all label instructions.

[6] Knotweed treatment pre-treatment; See Nickelson (2013).
[7] See http://ahmct.ucdavis.edu/limtask/equipmentdetails.html

c. ***Power equipment.*** Refuel gas-powered equipment with tanks larger than 5 gallons in a vehicle staging area placed 150-feet or more from any natural waterbody, or in an isolated hazard zone such as a paved parking lot.
d. ***Maximum herbicide treatment area.*** Do not exceed treating 10% of the acres of riparian habitat within a 6^{th-}field HUC with herbicides per year.
e. ***Herbicide applicator qualifications.*** Herbicides may only be applied by an appropriately licensed applicator, or under the direct supervision of a licensed applicator, using an herbicide specifically targeted for a particular plant species that will cause the least impact. The applicator will be responsible for preparing and carrying out the herbicide transportation and safely plan, as follows.
f. ***Herbicide transportation and safety plan.*** The applicator will prepare and carry out an herbicide safety/spill response plan to reduce the likelihood of spills or misapplication, to take remedial actions in the event of spills, and to fully report the event. Most knotweed (*Polygonum cuspidatum*, *P. sachalinense*, *P. polystachyum* and hybrids) patches are expected to have overland access. However, some sites may be reached only by water travel, either by wading or inflatable raft or kayak. The following measures will be used to reduce the risk of a spill during water transport: (a) No more than 2.5 gallons of glyphosate will be transported per person or raft, and typically it will be one gallon or less; (b) glyphosate will be carried in 1 gallon or smaller plastic containers. The containers will be wrapped in plastic bags and then sealed in a dry-bag. If transported by raft, the dry-bag will be secured to the watercraft.
g. ***Herbicides.*** The only herbicides allowed for use under this opinion are (some common trade names are shown in parentheses):[8]
    i. aquatic imazapyr (*e.g.*, Habitat)
    ii. aquatic glyphosate (*e.g.*, AquaMaster, AquaPro, Rodeo)
    iii. aquatic triclopyr-TEA (*e.g.*, Renovate 3)
    iv. chlorsulfuron (*e.g.*, Telar, Glean, Corsair)
    v. clopyralid (*e.g.*, Transline)
    vi. imazapic (*e.g.*, Plateau)
    vii. imazapyr (*e.g.*, Arsenal, Chopper)
    viii. metsulfuron-methyl (*e.g.*, Escort)
    ix. picloram (*e.g.*, Tordon)
    x. sethoxydim (*e.g.*, Poast, Vantage)
    xi. sulfometuron-methyl (*e.g.*, Oust, Oust XP)
h. ***Herbicide adjuvants.*** When recommended by the label, an approved aquatic surfactant or drift retardant can be used to improve herbicidal activity or application characteristics. Adjuvants that contain alky amine etholoxylates, *i.e.*, polyethoxylated tallow amine (POEA), alkylphenol ethoxylate (including alkyl phenol ethoxylate phosphate esters), or herbicides that contain these compounds

[8] The use of trade, firm, or corporation names in this opinion is for the information and convenience of the action agency and applicants and does not constitute an official endorsement or approval by the U.S. Department of Commerce or NMFS of any product or service to the exclusion of others that may be suitable.

are **not** covered by this opinion. The following product names are covered by this opinion:

i. Agri-Dex
ii. AquaSurf
iii. Bond
iv. Bronc Max
v. Bronc Plus Dry-EDT
vi. Class Act NG
vii. Competitor
viii. Cut Rate
ix. Cygnet Plus
x. Destiny HC
xi. Exciter
xii. Fraction
xiii. InterLock
xiv. Kinetic
xv. Level 7
xvi. Liberate
xvii. Magnify
xviii. One-AP XL
xix. Pro AMS Plus
xx. Spray-Rite
xxi. Superb HC
xxii. Tactic
xxiii. Tronic

i. ***Herbicide carriers.*** Herbicide carriers (solvents) are limited to water or specifically labeled vegetable oil. Use of diesel oil as an herbicide carrier is not covered by this opinion.
j. ***Dyes.*** Use a non-hazardous indicator dye (*e.g.*, Hi-Light or Dynamark) with herbicides within 100-feet of water. The presence of dye makes it easier to see where the herbicide has been applied and where or whether it has dripped, spilled, or leaked. Dye also makes it easier to detect missed spots, avoid spraying a plant or area more than once, and minimize over-spraying (SERA 1997).
k. ***Herbicide mixing.*** Mix herbicides and adjuvants, carriers, and/or dyes more than 150-feet from any perennial or intermittent waterbody to minimize the risk of an accidental discharge.
l. ***Tank Mixtures.*** The potential interactive relationships that exist among most active ingredient combinations have not been defined and are uncertain. Therefore, combinations of herbicides in a tank mix are not covered by this opinion.
m. ***Spill Cleanup Kit.*** Provide a spill cleanup kit whenever herbicides are used, transported, or stored. At a minimum, cleanup kits will include Material Safety Data Sheets, the herbicide label, emergency phone numbers, and absorbent material such as cat litter to contain spills.
n. ***Herbicide application rates.*** Apply herbicides at the lowest effective label rates.
o. ***Herbicide application methods.*** Apply liquid or granular forms of herbicides as follows:
   i. Broadcast spraying – hand held nozzles attached to back pack tanks or vehicles, or by using vehicle mounted booms.
   ii. Spot spraying – hand held nozzles attached to back pack tanks or vehicles, hand-pumped spray, or squirt bottles to spray herbicide directly onto small patches or individual plants.
   iii. Hand/selective – wicking and wiping, basal bark, fill (“hack and squirt”), stem injection, cut-stump.

   iv. Triclopyr – will not be applied by broadcast spraying.
   v. Keep the spray nozzle within four feet of the ground when applying herbicide. If spot or patch spraying tall vegetation more than 15 feet away from the high water mark (HWM), keep the spray nozzle within 6 feet of the ground.
   vi. Apply spray in swaths parallel towards the project area, away from the creek and desirable vegetation, *i.e.*, the person applying the spray will generally have their back to the creek or other sensitive resource.
   vii. Avoid unnecessary run off during cut surface, basal bark, and hack-squirt/injection applications.

p. ***Washing spray tanks.*** Wash spray tanks 300-feet or more away from any surface water.

q. ***Minimization of herbicide drift and leaching.*** Minimize herbicide drift and leaching as follows:
   i. Do not spray when wind speeds exceed 10 miles per hour, or are less than 2 miles per hour.
   ii. Be aware of wind directions and potential for herbicides to affect aquatic habitat area downwind.
   iii. Keep boom or spray as low as possible to reduce wind effects.
   iv. Increase spray droplet size whenever possible by decreasing spray pressure, using high flow rate nozzles, using water diluents instead of oil, and adding thickening agents.
   v. Do not apply herbicides during temperature inversions, or when air temperature exceeds 80 degrees Fahrenheit.
   vi. Wind and other weather data will be monitored and reported for all broadcast applications.

r. ***Rain.*** Do not apply herbicides when the soil is saturated or when a precipitation event likely to produce direct runoff to salmon bearing waters from the treated area is forecasted by the NOAA National Weather Service or other similar forecasting service within 48 hours following application. Soil-activated herbicides may follow label instructions. Do not conduct hack-squirt/injection applications during periods of heavy rainfall.

s. ***Herbicide buffer distances.*** Observe the following no-application buffer-widths, measured in feet, as map distance perpendicular to the bankfull elevation for streams, the upland boundary for wetlands, or the upper bank for roadside ditches. Widths are based on herbicide formula, stream type, and application method, during herbicide applications (Table 4). Before herbicide application begins, flag or mark the upland boundary of each applicable herbicide buffer to ensure that all buffers are in place and functional during treatment.

Table 4. Herbicide buffer distances by herbicide formula, stream type, and application method.

Herbicide	No Application Buffer Width (feet)					
	Streams and Roadside Ditches with flowing or standing water present and Wetlands			Dry Streams, Roadside Ditches, and Wetlands		
	Broadcast Spraying	Spot Spraying	Hand Selective	Broadcast Spraying	Spot Spraying	Hand Selective
Labeled for Aquatic Use						
Aquatic Glyphosate	100	waterline	waterline	50	None	none
Aquatic Imazapyr	100	15	waterline	50	None	none
Aquatic Triclopyr-TEA	**Not Allowed**	15	waterline	**Not Allowed**	None	none
Low Risk to Aquatic Organisms						
Imazapic	100	15	bankfull elevation	50	None	none
Clopyralid	100	15	bankfull elevation	50	None	none
Metsulfuron-methyl	100	15	bankfull elevation	50	None	none
Moderate Risk to Aquatic Organisms						
Imazapyr	100	50	bankfull elevation	50	15	bankfull elevation
Sulfometuron-methyl	100	50	5	50	15	bankfull elevation
Chlorsulfuron	100	50	bankfull elevation	50	15	bankfull elevation
High Risk to Aquatic Organisms						
Picloram	100	50	50	100	50	50
Sethoxydim	100	50	50	100	50	50

18. Piling Installation

a. Pilings may be placed with concrete, or steel round pile 24 inches in diameter or smaller, steel H-pile designated as HP24 or smaller, or untreated wood.[9]
b. When possible, use a vibratory hammer for piling installation.
c. When using an impact hammer to drive or proof steel piles, one of the following sound attenuation methods will be used to effectively dampen sound pressure waves in all areas to a single strike peak threshold of 206 decibels and, for cumulative strikes, a 187 decibel sound exposure level (SEL) in areas and times where fish are larger than 2 grams and a 183 decibel SEL in areas and times when fish are smaller than 2 grams:
    i. Completely isolate the pile from flowing water by dewatering the area around the pile.

[9] An individual consultation and site-specific risk assessment are required for actions that propose the use of pilings made of treated wood, including chromated copper arsenate (CCA), ammoniacal copper zinc arsenate (ACZA), alkaline copper quaternary (ACQ-B and ACQ-D), ammoniacal copper citrate (CC), copper azole (CBA-A), copper dimethyldithiocarbamate (CDDC), borate preservatives, and oil-type wood preservatives, such as creosote, pentachlorophenol, and copper naphthenate.

ii. If water velocity is 1.6 feet per second or less, surround the piling being driven by a confined or unconfined bubble curtain that will distribute small air bubbles around 100% of the piling perimeter for the full depth of the water column, as described in NMFS and USFWS (2006).[10]
iii. If water velocity is greater than 1.6 feet per second, surround the piling being driven by a confined bubble curtain (*e.g.*, a bubble ring surrounded by a fabric or non-metallic sleeve) that will distribute air bubbles around 100% of the piling perimeter for the full depth of the water column.
iv. **NMFS fish passage review and approval.** Provide NMFS information regarding the timing of in-water work, the number of impact hammer strikes per pile and the estimated time required to drive piles, hours per day pile driving will occur, depth of water, and type of substrate, hydroacoustic assumptions, and the pile type, diameter, and spacing of the piles.

19. Site Restoration

a. Restore any significant disturbance of riparian vegetation, soils, stream banks or stream channel.
b. Remove all project related waste; *e.g.*, pick up trash, sweep roadways in the project area to avoid runoff-containing sediment, *etc*.
c. Obliterate all temporary access roads, crossings, and staging areas.
d. Loosen soil in compacted areas when necessary for revegetation or infiltration.
e. Although no single criterion is sufficient to measure restoration success, the intent is that the following features should be present in the upland parts of the project area, within reasonable limits of natural and management variation:
    i. Human and livestock disturbance, if any, are confined to small areas necessary for access or other special management situations.
    ii. Areas with signs of significant past erosion are completely stabilized and healed, bare soil spaces are small and well-dispersed.
    iii. Soil movement, such as active rills and soil deposition around plants or in small basins, is absent or slight and local.
    iv. Native woody and herbaceous vegetation, and germination microsites, are present and well distributed across the site; invasive plants are minimal or absent.
    v. Plants have normal, vigorous growth form, and a high probability of remaining vigorous, healthy and dominant over undesired competing vegetation.
    vi. Plant litter is well distributed and effective in protecting the soil with little or no litter accumulated against vegetation as a result of active sheet erosion ("litter dams").

[10] See also Wursig *et al*. (2000) and Longmuir and Lively (2001) for additional information on how to deploy an effective, economical bubble curtain.

vii. A continuous corridor of shrubs and trees appropriate to the site are present to provide shade and other habitat functions for the entire streambank/shoreline.

20. Revegetation

a. Plant and seed disturbed areas before or at the beginning of the first growing season after construction.
b. Use a diverse assemblage of vegetation species native to the action area or region, including trees, shrubs, and herbaceous species. Vegetation, such as willow, sedge and rush mats, may be gathered from abandoned floodplains, stream channels, *etc.* When feasible, use vegetation salvaged from local areas scheduled for clearing due to development.
c. Use species that will achieve shade and erosion control objectives, including forb, grass, shrub, or tree species that are appropriate for the site and native to the project area or region.
d. Short-term stabilization measures may include use of non-native sterile seed mix if native seeds are not available, weed-free certified straw, jute matting, and similar methods.
e. Do not apply surface fertilizer within 50 feet of any wetland or water body.
f. Install fencing as necessary to prevent access to revegetated sites by livestock or unauthorized persons.
g. Do not use invasive or non-native species for site restoration.
h. Conduct post-construction monitoring and treatment to remove or control invasive plants until native plant species are well-established.

Set-Back or Removal of Existing Berms, Dikes, and Levees

Set-Back or Removal of Existing Berms, Dikes, and Levees will be conducted to reconnect historical fresh-water deltas to inundation, stream channels with floodplains, and historical estuaries to tidal influence. Such projects will take place where estuaries and floodplains have been disconnected from adjacent rivers through drain pipes and anthropogenic fill.

1. **Floodplains and freshwater deltas**
    a. Design actions to restore floodplain characteristics—elevation, width, gradient, length, and roughness—in a manner that closely mimics, to the extent possible, those that would naturally occur at that stream and valley type.
    b. Remove drain pipes, fences, and other capital projects to the extent possible.
    c. To the extent possible, remove nonnative fill material from the floodplain to an upland site.
    d. Where it is not possible to remove or set-back all portions of dikes and berms, or in areas where existing berms, dikes, and levees support abundant riparian vegetation, openings will be created with breaches. Breaches shall be equal to or greater than the active channel width to reduce the potential for channel avulsion during flood events. In addition to other breaches, the berm, dike, or levee shall always be breached at the downstream end of the project or at the lowest elevation of the floodplain to ensure the flows will naturally recede back into the main channel, thus minimizing fish entrapment.
    e. When necessary, loosen compacted soils once overburden material is removed. Overburden or fill comprised of native materials, which originated from the project area, may be used within the floodplain to create set-back dikes and fill anthropogenic holes provided that floodplain function is not impeded.

2. **Estuary restoration**
    a. Project implementation shall be conducted in a sequence that will not preclude repairing or restoring estuary functions once dikes/levees are breached and the project area is flooded.
    b. Culverts and tide gates will be removed using the Projects Design Criteria and conservation measures, where appropriate, as described in Work Area Isolation, Surface Water Withdrawals, and Fish Capture and Release and Fish Passage Restoration.
    c. Temporary roads within the project area should be removed to allow free flow of water. Material either will be placed in a stable area above the ordinary high water line or highest measured tide or be used to restore topographic variation in wetlands.
    d. To the extent possible, remove segmented drain tiles placed to drain wetlands. Fill generated by drain tile removal will be compacted back into the ditch created by removal of the drain tile.
    e. Channel construction may be done to recreate channel morphology based on aerial photograph interpretation, literature, topographic surveys, and nearby undisturbed channels. Channel dimensions (width and depth) are based on

measurements of similar types of channels and the drainage area. In some instances, channel construction is simply breaching the levee. For these sites, further channel development will occur through natural processes.

f. Fill ditches constructed and maintained to drain wetlands. Some points in an open ditch may be over-filled, while other points may be left as low spots to enhance topography and encourage sinuosity of the developing channel.

Tide/Flood Gate Removal, Replacement, or Retrofit

Tide/Flood Gate Removal, Replacement, or Retrofit projects may include the removal, replacement, or the upgrade of existing tide and flood gates by modifying gate components and mechanisms in tidal stream systems where full tidal exchange is incompatible with current land use where backwater effects are of concern. Projects will be implemented to reconnect stream/slough corridors, floodplains, and estuaries, reestablish wetlands, improve aquatic organism passage, and restore more natural channel and flow conditions. Tide/flood gate replacement or retrofit may include, but is not limited to, excavation of existing channels, adjacent floodplains, flood channels, and wetlands, and may include structural elements such as streambank restoration and hydraulic roughness elements. Placement of new gates where they did not previously exist is not covered in this consultation.

1. **NMFS review and approval.** NMFS will review tide/flood gate removal, replacement, and retrofit projects for consistency with *Anadromous Salmonid Passage Facility Design* (NMFS 2011a).

2. For removal projects, if a culvert or bridge will be constructed at the location of a removed tide gate, the structure will be large enough to allow for a full tidal exchange.

3. Follow General Construction Measures for Staging, Storage, and Stockpile Areas, Hazardous Material Spill Prevention and Control, Equipment, Vehicles, and Power Tools, Surface Water Withdrawal and Construction Discharge Water, Work Area Isolation, Timing of In-Water Work, Fish Capture and Release, Site Restoration, and Revegetation. Excavation below the OHW line shall be conducted to the maximum extent possible during low tide cycles or low flow cycles in the downstream watercourse.

4. **Overall design goals.** Tide/flood gate replacement or retrofit design data will demonstrate:
    a. A clear linkage to limiting factors identified within an appropriate sub-basin plan or recovery plan, or based on recommendations by a technical oversight and steering committee within a localized region.
    b. The identification and, to the extent possible, the correction of the degraded baseline condition.
    c. The use of analytical approaches for determination of the tidal prism and exchange.
    d. Appropriate self-sustaining hydrologic design that includes climate change to reduce maintenance.

5. **General project design criteria**
    a. Site specific project design criteria will be set based on tidal restoration, fish passage, and flood protection needs as determined and set forth by the RRT.
    b. Tide/Flood Gate Replacement or Retrofit Options
        i. Dike removal
        ii. Dike breach
        iii. Dike setback

    iv. Bridge
    v. Non-gated pipe (NGP) or “bare” culvert
        a) Existing pipe minus the tide gate (removed)
        b) Installation of new pipe minus a tide gate
c. Tide Gate
    i. Fiberglass or aluminum gate
    ii. Side hinged gate
    iii. Self-regulating tide gate (SRT)
        a) Tension (cable) operated
        b) Float (cam) operated
d. Hybrid (such as SRT coupled with NGP)
e. Other design options as recommended by the RRT
f. Design actions to restore tidal exchange characteristics—elevation, cross-sectional area, timing—in a manner that closely mimics, to the greatest degree possible, those that would naturally occur at that stream type.

6. **Design report & associated documentation.** Tide/flood gate replacement and retrofit design and adaptive management documentation shall include:
    a. Background and Problem Statement
        i. Site history
        ii. Environmental baseline
        iii. Problem Description
        iv. Cause of problem
    b. Project Description
        i. Goals/objectives
        ii. Project elements
        iii. Sequencing, implementation
            a) Place cofferdam upstream of the culvert to prevent drainage water from entering the work area. A downstream cofferdam will also be installed to isolate the work area from the watercourse.
            b) The existing culvert requiring replacement is then excavated with equipment staged on the dike or shoreline above OHW.
            c) Excavated material is stockpiled upland for replacement in the dike once the new culvert is in-place.
            d) Waste water removed from within the cofferdam work area shall be discharged to a location landward of OHW line in a manner that allows removal of fine sediments prior to the discharged water returning to the watercourses.
            e) Upon completion of the tide gate/flood gate repairs and/or replacement, all material used to construct the cofferdams shall be removed from the watercourses and the project site returned to pre-project or improved conditions.
            f) Restore LW features to redeveloping tidal channels.

   g) Drainage ditches will be filled to become part of the surrounding contiguous tidal marsh or will be modified to become part of the tidal channel network.
 iv. Proposed work window
 v. Recovery trajectory: How will the new stream channel develop and evolve?

c. Design Analysis, including technical analyses, computations relating design to analysis, and references. Analyses shall be appropriate to the level of project complexity. At a minimum, analyses will include the following:
 i. Hydraulic Analysis
   a) Model conditions, duration, boundary conditions, inputs, and outputs will be collaboratively developed by RRT and modeler.
 ii. Sediment Assessment
 iii. Risk Analysis

d. Detailed construction drawings

e. Other regulatory jurisdictions for tide and floodgate repair and replacement will also be addressed: *i.e.*, ACOE, River and Harbors Act §10, Clean Water Act §404, CZMA, ODFW Fish Passage OAR; ODEQ & WDOE §401, WDFW Hydraulic Project Approval, Washington Environmental Policy Act evaluation, Washington Shoreline Management Act

f. River Restoration Tool. Review by the RRT will also include an evaluation using the River Restoration Analysis Tool (restorationreview.com), and therefore the following questions will be addressed in the project documentation:
 i. Problem Identification
   a) Is the problem identified?
   b) Are causes identified at appropriate scales?
 ii. Project Context
   a) Is the project identified as part of a plan, such as a watershed action plan or recovery plan?
   b) Does the project consider ecological, geomorphic, and socioeconomic context?
 iii. Goals & Objectives
   a) Do goals and objectives address problem, causes, and context?
   b) Are objectives measurable?
 iv. Alternatives Evaluation
   a) Were alternative considered?
   b) Are uncertainties and risk associated with selected alternative acceptable?
 v. Project Design
   a) Do project elements collectively support project objectives?
   b) Are design criteria defined for all project elements?
   c) Do project elements work with stream processes to create and maintain habitat?
   d) Is the technical basis of design sound for each project element?

vi. Implementation
   a) Are plans and specifications sufficient in scope and detail to execute the project?
   b) Does plan address potential implementation impacts and risks?

vii. Monitoring and Management
   a) Does monitoring plan address project compliance?
   b) Does monitoring plan directly measure project effectiveness?
   c) Does the maintenance plan include replacement for components that corrode over time?

7. **Monitoring and adaptive management.** Develop a monitoring and adaptive management plan that has been reviewed and approved by the RRT, that includes the following:
   a. Introduction
   b. Existing monitoring protocols
   c. Project effectiveness monitoring plan
   d. Project review team triggering conditions
   e. Monitoring frequency, timing, and duration
   f. Monitoring technique protocols
   g. Data storage and analysis
   h. Monitoring quality assurance plan
   i. Literature cited

Appendix H
Air Quality and Climate Change Methodology

Appendix H Air Quality and Climate Change Methodology[1]

H.1 Air Quality

H.1.1 Regulatory Setting

In response to concerns about air pollutants and greenhouse gases (GHGs), federal legislators have passed statutes that mandate control of ambient pollutants, and federal agencies have adopted rules and regulations to implement these laws. This section briefly discusses the federal laws, orders, and regulations that impact air quality and air pollutant emissions in Tillamook County.

H.1.1.1 National Ambient Air Quality Standards (40 CFR 51)

The federal statute that addresses criteria pollutants is the Clean Air Act (CAA) (http://www.epa.gov/air/criteria.html; and http://www.gpo.gov/fdsys/pkg/CFR-2014-title40-vol2/pdf/CFR-2014-title40-vol2-part51.pdf). The CAA was first enacted in 1955 and has been amended numerous times in subsequent years (1963, 1965, 1967, 1970, 1977, 1990, and 1997). The United States Environmental Protection Agency (EPA) implements the CAA through development and adoption of rules codified under 40 Code of Federal Regulations (CFR), Subchapter C – Air Programs. EPA has generally applied a two-pronged approach to controlling air pollution: (1) setting National Ambient Air Quality Standards (NAAQS) that define maximum pollution levels in air that are still protective of human health and welfare and (2) developing emission standards for sources of air pollutants to reduce pollutant emissions to the atmosphere.

Under the authority granted by the CAA, EPA has established NAAQS for the following criteria air pollutants: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3)[2], particulate matter 10 micrometers (μm) or less in diameter (PM_{10}), particulate matter 2.5 μm or less in diameter ($PM_{2.5}$)[3], and sulfur dioxide (SO_2). Primary NAAQS were established to protect human health while secondary NAAQS were created to protect public welfare and take into consideration such factors as damage to crops, architecture and ecosystems, and visibility in scenic areas.

Table H-1 presents the NAAQS currently in effect for criteria air pollutants.

[1] Note: The full citations for references cited in this appendix are located in Section 8, References, of the EIS.

[2] *Ozone (smog) is a secondary pollutant, meaning it is formed in the atmosphere through a reaction of precursor compounds in the presence of sunlight. The important precursors for O_3 formation are oxides of nitrogen (NOx) and volatile organic compounds (VOCs). Air quality impact analyses for O_3 typically assess the increase in emissions of NOx and VOC.*

[3] *$PM_{2.5}$ is made up of directly emitted particulate matter as well as secondary particulate matter formed through reactions of precursor compounds. The important gaseous precursors for $PM_{2.5}$ formation are NOx, VOC, sulfur oxides (SOx), and ammonia (NH_3).*

Table H-1. National Ambient Air Quality Standards (NAAQS)

Pollutant	Averaging Time	Primary NAAQS	Secondary NAAQS	Violation Criteria
CO	1 Hour	35 ppm (40 mg/m^3)	--	Not to be exceeded more than once per year
	8 Hour	9 ppm (10 mg/m^3)	--	
Pb	Rolling 3-Month Average	0.15 $\mu g/m^3$		Not to be exceeded
NO_2	1 Hour	100 ppb (188 $\mu g/m^3$)	--	98^{th} percentile, averaged over 3 years
	Annual	0.053 ppm (100 $\mu g/m^3$)	Same as Primary Standard	Annual mean
O_3	8 Hour	0.075 ppm (147 $\mu g/m^3$)	Same as Primary Standard	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
PM_{10}	24-Hour	150 $\mu g/m^3$	Same as Primary Standard	Not to be exceeded more than once per year on average over 3 years
$PM_{2.5}$	24 Hour	35 $\mu g/m^3$	Same as Primary Standard	98^{th} percentile, averaged over 3 years
	Annual	12.0 $\mu g/m^3$	15 $\mu g/m^3$	Annual mean, averaged over 3 years
SO_2	1 Hour	75 ppb (196 $\mu g/m^3$)	--	99^{th} percentile of 1-hour daily maximum concentrations, averaged over 3 years
	3 Hour	--	0.5 ppm (1,300 $\mu g/m^3$)	Not to be exceeded more than once per year
	24 Hour	0.14 ppm (366 $\mu g/m^3$)[1]	--	Not to be exceeded more than once per year
	Annual	0.030 ppm (79 $\mu g/m^3$)[1]	--	Annual mean

Source: 40 CFR 50

Notes:

1 - On June 22, 2010, the 24-hour and annual primary SO_2 NAAQS were revoked (75 Federal Register [FR] 35520). The 1971 SO_2 NAAQS (0.14 parts per million [ppm] and 0.030 ppm for 24-hour and annual averaging periods) remain in effect until one year after an area is designated for the 2010 1-hour primary standard. The State of Oregon recommended all of Oregon be designated unclassifiable for the 1-hour SO_2 NAAQS (Kitzhaber 2011). Although the EPA designated as nonattainment most areas in locations where existing monitoring data from 2009 to 2011 indicated violations of the 1-hour SO_2 NAAQS, they deferred action on all other areas. As a result, the EPA has not yet finalized area designations for Oregon (78 FR 47191).

Key:

-- = no standard

$\mu g/m^3$ = micrograms per cubic meter

mg/m^3 = milligrams per cubic meter

ppb = parts per billion

ppm = parts per million

The CAA also specifies future dates for achieving compliance with the NAAQS and mandates states submit and implement a state implementation plan for local areas not meeting these standards (nonattainment areas). These plans must include pollution control measures and demonstrate through modeling that the standards would be met by the specified attainment date. Once a nonattainment area has achieved the NAAQS for a given pollutant, it can be redesignated as an attainment/maintenance area, which is subject to maintenance plans itemizing how the area would continue to meet the NAAQS.

The local area of interest for this action is the Northwest Oregon Intrastate Air Quality Control Region, which includes Clatsop, Lincoln, and Tillamook counties. **Table H-2** presents the federal attainment status of Tillamook County for each criteria air pollutant.

Table H-2. Federal Attainment Status

Pollutant	NAAQS Attainment Status
CO	Unclassifiable/Attainment
Pb	Unclassifiable/Attainment
NO_2	Unclassifiable/Attainment
O_3	Unclassifiable/Attainment
PM_{10}	Unclassifiable[(1)]
$PM_{2.5}$	Unclassifiable/Attainment
SO_2	Attainment[(2)]

Source: 40 CFR 81.338
Notes:
1 - Treated as attainment.
2 - Designation based on the 1971 SO_2 standards because the EPA has deferred action on designating the area under the 2010 standard.

H.1.1.2 General Conformity (40 CFR 93, Subpart B)

On November 30, 1993, EPA promulgated a set of regulations, known as the general conformity rule, that included procedures and criteria for determining whether a proposed federal action would conform to the applicable state implementation plans. (http://www.epa.gov/air/genconform/; and http://www.gpo.gov/fdsys/pkg/CFR-2014-title40-vol20/pdf/CFR-2014-title40-vol20-part93-subpartB.pdf) The purpose of the general conformity rule is to ensure federal activities do not cause or contribute to new violations of the NAAQS, actions do not cause additional or worsen existing violations of or contribute to new violations of the NAAQS, and attainment of the NAAQS is not delayed.

Before any approval is given for a federal action, an applicability analysis must be conducted to see whether a conformity determination is required. According to the applicability analysis, the general conformity regulations would apply for all federal actions except those that are:

- Covered by transportation conformity
- Have emissions clearly at or below *de minimis* levels
- Classified as an exempt action in the rule

- Covered by a presumed-to-conform approved list

EPA created *de minimis* emission levels to limit the need to conduct conformity determinations for federal projects with minimal potential emission increases. EPA created *de minimis* emission levels for each criteria pollutant, and the *de minimis* levels for any project are based on the attainment status of the project area. When the total direct and indirect emissions from a proposed project are below the *de minimis* levels, the project would not be subject to a conformity determination. Because the general conformity *de minimis* thresholds are only applicable to federal actions in areas designated nonattainment or maintenance, the general conformity regulation does not apply to the proposed action because Tillamook County is designated attainment for all pollutants.

H.1.1.3 State Ambient Air Quality Standards

In addition to the NAAQS, the State of Oregon also has established ambient air quality standards. The ambient standards set forth in Oregon Administrative Rules (OAR) 340-202-0050 through 340-202-0130 were established to protect public health and public welfare (OAR, Chapter 340, Division 202) (http://arcweb.sos.state.or.us/pages/rules/oars_300/oar_340/340_202.html). **Table H-3** summarizes the Oregon standards.

Table H-3. State Ambient Air Quality Standards

Pollutant	Averaging Time	State AAQS	Violation Criteria
CO	1 Hour	35 ppm	Not to be exceeded more than once per year
	8 Hour	9 ppm	
Pb	Calendar quarter	0.15 µg/m^3	Not to be exceeded
NO_2	1 Hour	0.100 ppm	98th percentile, averaged over 3 years
	Annual	0.053 ppm	Annual mean
O_3	8 Hour	0.075 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
PM_{10}	24 Hour	150 µg/m^3	Not to be exceeded more than once per year
$PM_{2.5}$	24 Hour	35 µg/m^3	98th percentile, averaged over 3 years
	Annual	15 µg/m^3	Annual mean, averaged over 3 years
SO_2	1 Hour	0.075 ppm	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	3 Hour	0.50 ppm	Not to be exceeded more than once per year
	24 Hour	0.10 ppm	Not to be exceeded more than once per year
	Annual	0.02 ppm	Annual mean
Particle Fallout	Industrial Area	10 g/m2	Not to be exceeded
	Residential and commercial areas	5.0 g/m^2	Not to be exceeded
	Residential and commercial areas	3.5 g/m^2	Not to be exceeded

Source: OAR 340-202-0050 et seq.
Notes:

1 - Also applicable in industrial areas if visual observations show a presence of wood waste or soot and the volatile fraction of the sample exceeds 70 percent.
2 - Only applicable in residential and commercial areas if visual observations show a presence of wood waste or soot and the volatile fraction of the sample exceeds 70 percent.
Key:
AAQS = ambient air quality standard
µg/m^3 = micrograms per cubic meter
g/m^2 = grams per square meter
ppm = parts per million

H.1.1.4 Oregon Air Pollution Control (ORS 468A et seq.)

ORS 468A et seq. regulates air pollution control in Oregon (https://www.oregonlegislature.gov/bills_laws/ors/ors468A.html). The air pollution control regulations are intended to restore and maintain the quality of air resources in the state, provide for a coordinated statewide program of air quality control, and facilitate cooperation among local governments in establishing and supporting air quality control programs.

H.1.2 Methodology

This section summarizes the air quality impact analysis that was conducted and provides the action-related air emission results. The analysis was conducted following the general methodology described below. Predicted emissions of criteria pollutants are presented for the action alternatives.

Standard emission estimation models approved by the EPA were used to estimate emissions from proposed construction activities associated with the action alternatives. The majority of the potential emissions would be from nonroad equipment used during construction activities. The factors for engine exhaust and fugitive dust were used with estimated activity levels, such as number of pieces of equipment, number of days of active operation, disturbed acreage, and vehicle miles traveled, to determine total emissions of criteria air pollutants

The construction activity emissions were estimated using the appropriate emission factor models and spreadsheet calculations. The following construction sources and activities were analyzed for emissions:

- Onsite construction equipment emissions (NONROAD2008a; EPA 2009)
- Offsite haul truck engine emissions (MOVES2014-20141021; EPA 2014)
- Offsite worker vehicle trips to and from the sites (MOVES2014-20141021; EPA 2014)
- Entrained fugitive dust emissions for paved road travel (EPA 2011)
- Fugitive dust emissions from grading, bulldozing, and material handling activities (EPA 1998; EPA 2006)

H.1.2.1 On-Road Mobile Sources

The equipment- and activity-specific emission factors are presented in **Table H-4** for on-road vehicle travel. For paved and unpaved road emissions, the vehicle engine exhaust emissions from MOVES2014, Version 20141021 (EPA 2014) have been added to paved road dust emissions factors obtained from EPA's AP-42 emission factor estimates.

Table H-4. On-Road Vehicle Emission Factors

Source	Emission Factor (grams per mile)					
	VOC	NOx	CO	SO_2	PM_{10}	$PM_{2.5}$
Haul/Vendor Trucks	0.62	2.82	7.08	0.01	0.19	0.13
Construction Workers	0.47	0.64	4.70	0.01	0.04	0.01

Source: MOVES2014-20141021 (EPA 2014)
Key:
VOC = volatile organic compound
NOx = nitrogen oxides
CO = carbon monoxide
SO_2 = sulfur dioxide
PM_{10} = particulate matter less than 10 micrometers
$PM_{2.5}$ = particulate matter less than 2.5 micrometers

The paved road dust emission factors were determined using **Equation H-1** (EPA 2011):

$$E_{ext} = [k(sL)^{0.91}(W)^{1.02}](1 - P/4N) \quad \textbf{(Equation H-1)}$$

where:

E = particulate emission factor (grams per vehicle mile traveled, g/VMT)

k = particle size multiplier for particle size range of interest (1.0 for PM-10; 0.25 for PM-2.5)

sL = road surface silt loading (grams per square meter, 0.06 g/m^2 for roads with 5,000 to 10,000 average daily trips)

W = average weight (tons) of the vehicles traveling the road (2 tons for worker trips, 30 tons for all trucks)

P = number of "wet" days with at least 0.01 inch of precipitation during the averaging period

N = number of days in the averaging period (365 for annual)

It was assumed in the emission calculations that any exported material requiring disposal would be transported to Tillamook County Landfill located 10 miles from the project location. Additionally, it was assumed sand, gravel, and any other materials would be imported from vendors located within 20 miles of the project site. Because construction workers could reside in several cities surrounding the project site, the average commute distance for construction workers was also assumed to be 20 miles.

H.1.2.2 Nonroad Construction Sources

Table H-5 presents the emission factors for nonroad construction equipment engines. The emission factors were developed for Tillamook County, Oregon, and it was assumed all equipment would be diesel-fueled.

Table H-5. Nonroad Equipment Emission Factors

Equipment	Emission Factors (grams per operating hour)					
	VOC	NOx	CO	SO_2	PM_{10}	$PM_{2.5}$
Excavators	18.37	198.01	83.50	0.31	15.43	14.97
Off-road dump trucks	96.96	1,151.41	444.36	1.37	53.85	52.23
Scrapers	43.49	587.08	264.11	0.77	35.76	34.69
Front end loader	31.52	404.83	164.68	0.46	26.50	25.71
Sheepsfoot vibratory roller	12.89	149.15	78.49	0.18	12.62	12.24
Bulldozer	30.39	376.19	162.48	0.48	25.38	24.62

Source: MOVES2014-20141021 (EPA 2014)
Key:
VOC = volatile organic compound
NOx = nitrogen oxides
CO = carbon monoxide
SO_2 = sulfur dioxide
PM_{10} = particulate matter less than 10 micrometers
$PM_{2.5}$ = particulate matter less than 2.5 micrometers

To estimate the nonroad equipment emissions, NONROAD2008a (EPA 2009) was run to generate county-specific daily emissions (tons per day) in 2015 for each equipment type listed in **Table H-5**. The model requires an emissions year to be input, and 2015 would provide a conservative estimate because engine exhaust emissions generally decrease in future years as engine technology improves. Therefore, emission factors for the proposed construction schedule of 2016 and 2017 would be somewhat lower than the results for 2015 reported below.

The NONROAD Reporting Utility was then used to convert emissions to units of grams per hour for each equipment type. Assuming a 5-day per week construction schedule, construction equipment would operate an average of 22 days per month for 8 hours per day. The construction schedule provided by the project applicant was then used to estimate the number of hours each piece of equipment would operate during the project duration.

Fugitive dust emissions would also occur during grading, bulldozing, and material handling activities. The grading emission factors were determined using **Equations H-2 and H-3**.

$$EF_{PM15} = 0.051(S)^{2.0} \textit{ and } EF_{PM10} = EF_{PM15} \text{ x } F_{PM10} \qquad \textbf{(Equation H-2)}$$

$$EF_{TSP} = 0.04(S)^{2.5} \textit{ and } EF_{PM2.5} = EF_{TSP} \text{ x } F_{PM2.5} \qquad \textbf{(Equation H-3)}$$

where:

EF = particulate matter emission factor (pounds per vehicle mile traveled, lb/VMT)

S = mean vehicle speed (7.1 miles per hour)

F = scaling factor (0.6 for PM_{10}; 0.031 for $PM_{2.5}$)

The vehicle miles traveled was estimated using the number of acres each piece of equipment could be expected to grade during a day and the average blade width (12 feet) for the equipment to determine the number of equipment passes.

Bulldozing emission factors were estimated using **Equations H-4 and H-5**:

$EF_{TSP} = \frac{C_{TSP} \times s^{1.2}}{M^{1.3}}$ *and* $EF_{PM2.5} = EF_{TSP} \times F_{PM2.5}$ (**Equation H-4**)

$EF_{PM15} = \frac{C_{PM15} \times s^{1.5}}{M^{1.4}}$ *and* $EF_{PM10} = EF_{PM15} \times F_{PM10}$ (**Equation H-5**)

where:

EF = particulate matter emission factor (pounds per hour, lb/hr)

C = arbitrary coefficient used by AP-42 (5.7 for TSP; 1.0 for PM_{15})

s = material silt content (6.9 percent)

M = material moisture content (7.9 percent)

F = scaling factor (0.75 for PM_{10}; 0.105 for $PM_{2.5}$)

As with grading, bulldozing activities were assumed to occur 22 days per month for 8 hours per day. Using the expected duration of construction for the schedule provided by the project applicant, the number of bulldozing hours per dozer was estimated.

Material handling activities, from truck loading/unloading and other "drops," were estimated using **Equation H-6**.

$EF = k \times (0.0032) \times \frac{(\frac{U}{5})^{1.3}}{(\frac{M}{2})^{1.4}}$ (**Equation H-6**)

where:

EF = emission factor (pounds per ton, tpy)

k = particle size multiplier (0.35 for PM10; 0.053 for PM2.5)

U = wind speed (18.18 miles per hour, mph)

M = material moisture content (12 percent for soil, 0.7 percent for base course, 2.1 percent for demolition, and 11 percent for hog fuel)

Emissions were calculated from the quantity of material imported to or exported from the project site.

H.2 Climate Change

H.2.1 Regulatory Setting

GHG emissions and global climate change are governed by several federal and state laws and policies described below.

H.2.1.1 Executive Order 13653 – Preparing the United States for the Impacts of Climate Change

Executive Order 13653, signed by President Obama in November 2013, directs federal agencies to pursue new strategies to improve the nation's preparedness and resilience to climate change. (http://www.whitehouse.gov/the-press-office/2013/11/01/executive-order-preparing-united-states-impacts-climate-change.) The executive order formed the State, Local, and Tribal Leaders Task Force on Climate Preparedness and Resilience (Task Force) to recommend how the federal government could assist communities dealing with climate change by removing barriers to resilient investments, modernizing federal grant and loan programs, and developing the information and tools needed to assist with preparation. In November 2014, the Task Force published its Recommendations to the President that included the following key points:

- Building resilient communities
- Improving resilience in the nation's infrastructure
- Ensuring resilience of natural resources
- Preserving human health and supporting resilient populations
- Supporting climate-smart hazard mitigation and disaster preparedness and recovery
- Understanding and acting on the economics of resilience
- Building capacity for resilience

The Task Force also recommended the federal government establish a process for tracking and reporting on progress made in implementing the recommendations.

H.2.1.2 Oregon House Bill 3543

Oregon House Bill 3543 (https://olis.leg.state.or.us/liz/2007R1/Downloads/MeasureDocument/HB3543) establishes the following GHG emission reduction goals for Oregon:

- By 2010, arrest the growth of Oregon's GHG emissions and begin to reduce GHG emissions.
- By 2020, achieve GHG levels that are 10 percent below 1990 levels.
- By 2050, achieve GHG levels that are at least 75 percent below 1990 levels.

The bill also created the Oregon Global Warming Commission, which includes members representing the social, environmental, cultural, and economic diversity of the state. The Oregon Global Warming Commission is required to recommend ways to coordinate state and local efforts to reduce GHG emissions in Oregon and prepare for the effects of climate change.

H.2.2 Methodology

This section summarizes the climate change impact analysis that was conducted and provides the action-related GHG emission results. The analysis was conducted following the general methodology described below.

This analysis estimates carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) emissions that would occur during construction and demolition activities. The other pollutants commonly evaluated in various GHG reporting protocols – hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride – are not expected to be emitted in large quantities as a result of the action alternatives and are not discussed further in this section.

Each GHG contributes to climate change differently, as expressed by its global warming potential (GWP). GHG emissions are discussed in terms of CO_2 equivalent (CO_2e) emissions, which express, for a given mixture of GHG, the amount of CO_2 that would have the same GWP over a specific timescale. CO_2e is determined by multiplying the mass of each GHG by its GWP.

This analysis used the GWPs from the Intergovernmental Panel on Climate Change Fourth Assessment Report (Forster et al. 2007) for a 100-year time period to estimate CO_2e. This approach is consistent with the federal GHG Reporting Rule (40 CFR 98), as effective on January 1, 2014 (78 FR 71904). The GWPs used in this analysis are 25 for CH_4 and 298 for N_2O.

Standard emission estimation models approved by the EPA were used to estimate emissions from construction activities associated with the action alternatives. The majority of the emissions would be from nonroad equipment used during construction activities. The emission factors for engine exhaust were used with estimated activity levels, such as number of pieces of equipment, number of days of active operation, and vehicle miles traveled to determine total emissions of GHGs.

The construction activity emissions were estimated using the appropriate emission factor models and spreadsheet calculations. The following construction sources and activities were analyzed for emissions:

- Onsite construction equipment emissions (NONROAD2008a; EPA 2009)
- Offsite haul truck engine emissions (MOVES2014-20141021; EPA 2014)
- Offsite worker vehicle trips to and from the sites (MOVES2014-20141021; EPA 2014)

H.2.2.1 On-Road Mobile Sources

The equipment and activity specific emission factors are presented in **Table H-6** for on-road vehicle travel. Emission factors were derived from the EPA's MOVES2014 (Version 20141021) emission factor model for Tillamook County, Oregon.

Table H-6. On-Road Vehicle Emission Factors

Source	Emission Factors (grams per mile)		
	CO_2	CH_4	N_2O
Haul/Vendor Trucks	867	0.042	0.011
Construction Workers	376	0.016	0.012

Source: MOVES2014-20141021 (EPA 2014)
Key:
CH_4 = methane
CO_2 = carbon dioxide
N_2O = nitrous oxide

It was assumed in the emission calculations that any exported material requiring disposal would be transported to the Tillamook County Landfill located 10 miles from the project location. Additionally, it was assumed sand, gravel, and any other materials would be imported from vendors located within 20 miles of the project site. Because construction workers could reside in several cities surrounding the project site, the average commute distance for construction workers was also assumed to be 20 miles.

H.2.2.2 Nonroad Construction Sources

Table H-7 presents the emission factors for nonroad construction equipment engines. The emission factors were developed for Tillamook County, Oregon, and it was assumed all equipment would be diesel-fueled.

Table H-7. Nonroad Equipment Emission Factors

Equipment	Emission Factors (grams per hour)		
	CO_2	CH_4	N_2O
Excavators	54,692	3.11	1.39
Off-road dump trucks	247,874	14.08	6.31
Scrapers	129,526	7.36	3.30
Front end loader	77,182	4.38	1.97
Sheepsfoot vibratory roller	30,425	1.73	0.77
Bulldozer	82,669	4.70	2.11

Source: MOVES2014-20141021 (EPA 2014)
Key:
CH_4 = methane
CO_2 = carbon dioxide
N_2O = nitrous oxide

To estimate the nonroad equipment emissions, NONROAD2008a (EPA 2009) was run to generate county-specific daily emissions (tons per day) in 2015 for each equipment type listed in **Table H-7**. The year 2015 was used to provide a conservative estimate because engine exhaust emissions generally decrease in future years as engine technology improves. Therefore, emission factors for the proposed construction schedule of 2016 and 2017 would be somewhat lower than the results for 2015 reported below.

The NONROAD Reporting Utility was then used to convert emissions to units of grams per hour for each equipment type. Assuming a 5-day per week construction schedule, construction equipment would operate an average of 22 days per month for 8 hours per day. The construction schedule provided by the project applicant was then used to estimate the number of hours each piece of equipment would operate during the project duration.

Appendix I
Section 106 Consultation and Cultural Resources Survey

Technical Report

Southern Flow Corridor Project Cultural Resources Investigations Tillamook County, Oregon

Prepared for

Federal Emergency Management Agency (FEMA)

Revised

May 2015

Note: Portions of this document have been redacted in accordance with federal (Section 304, 54 U.S.C. 470w-3a NHPA) and Oregon Revised Statute [192.501 (11)] laws pertaining to confidentiality of cultural resources locations.

CCPRS

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Executive Summary

Surveys for archaeological resources and the built environment were conducted in support of the Southern Flow Corridor project proposed by the Port of Tillamook Bay. The project would be partially funded by the Federal Emergency Management Agency (FEMA); therefore, it is subject to the provisions of Section 106 of the National Historic Preservation Act. Investigations included background archaeological and historic research, field surveys, and the initiation of consultation with the Confederated Tribes of the Grand Ronde and the Confederated Tribes of the Siletz. The project area of potential effect (APE) intersects the purported ethnographic village of Tow-er-quot-ton on Hoquarten Slough. Archaeological survey, shovel probes, and analysis of geotechnical borings detected no indications of the village site. Two historic era archaeological sites associated with veneer and plywood mills was recorded (site numbers 35TI109 and 35TI110) and one historic era archaeological isolate (an abandoned horse drawn farm implement) was recorded (I-1). Four built environment sites were recorded including two residential structures and two sites related to the extensive drainage and levee/dike systems across the APE. These resources are recommended as not-eligible for listing in the National Register of Historic Places (NRHP). This report was prepared by Secretary of Interior (SOI) qualified archaeologist Julie Wilt, Cultural Resources Specialist Robin McClintock, and SOI architectural historian Lori D. Price. Field investigations were conducted under the direction of SOI qualified archaeologist Rosie Brownell and Robin McClintock.

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Acronyms and Abbreviations

APE	Area of Potential Effect
B.P.	Before Present
cm	centimeter
DLC	Donation Land Claim
EIS	environmental impact statement
FEMA	Federal Emergency Management Agency
GLO	General Land Office
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
ODOT	Oregon Department of Transportation
OWEB	Oregon Watershed Enhancement Board
PA	Public Assistance
POTB	Port of Tillamook Bay
SFC	Southern Flow Corridor
SHPO	State Historic Preservation Office
SOI	Secretary of the Interior
STU	Shovel Test Unit
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

SECTION 1 Introduction

1.1 Project Description

The Federal Emergency Management Agency (FEMA) is proposing to provide funding for the project known as the Southern Flow Corridor (SFC) project to the Port of Tillamook Bay (POTB) through FEMA's Public Assistance (PA) grant program. The project proposed by POTB and Tillamook County would also receive funding from the National Oceanic and Atmospheric Administration (NOAA) Restoration Center, U.S. Fish and Wildlife Service (USFWS), State of Oregon lottery funds, Oregon Watershed Enhancement Board (OWEB), Tillamook County, and other public and private entities. The project is intended to reduce flood damage in the Tillamook Valley and restore habitat in the Tillamook Bay estuary.

1.1.1 Project Purpose

The Tillamook Valley has a history of severe repetitive flooding with widespread damage to property, road closures, and economic losses. In addition, several fish and wildlife species that historically depended on the wetland, tidal marsh, and aquatic habitats of the estuary have been listed as threatened or endangered. The purpose of the Tillamook Bay Southern Flow Corridor project is to reduce life safety risk from floods, reduce damages to property and other economic losses from floods, while also contributing to the restoration of habitat for federally listed Oregon Coast coho, and other native fish and wildlife species. Not only are these species important for commercial and sport fishing, but are also an important cultural resource to the Confederated Tribes of the Grand Ronde and the Confederated Tribes of the Siletz.

Future unmitigated flooding in the Tillamook Valley will continue to contribute to life safety risks and physical and economic damages to the community. Continued degradation of critical fish and wildlife habitats within the estuary including blockages to fish passage, losses of aquatic and wetland habitats, and altered sediment erosion and deposition regimes may lead to listing of additional species under the Endangered Species Act and hamper recovery plans for currently listed species that use the project area.

1.1.2 Project Alternatives

Three action alternatives were developed for the project and are briefly described below. The Proposed Action (Southern Flow Corridor - Landowner Preferred Alternative) is shown in **Figure 1** and comprises the area of potential effect (APE) for this investigation. The three action alternatives as described below are illustrated together in **Figure 2**.

1.1.2.1 Proposed Action (Southern Flow Corridor - Landowner Preferred Alternative)

The primary intent of the Southern Flow Corridor - Landowner Preferred Alternative is to remove manmade impediments to flood flows to the maximum extent possible in the lower Wilson and Trask River floodplains. The project would accomplish this by removing many existing levees and fills along the edges of the sloughs and rivers that border the project area. New setback levees would be required to protect adjacent private lands. Areas outside the setback levees would be restored to tidal wetlands. The various features of the proposed action are shown on **Figure 3**. (Please note that the structures on the Trask River shown as to be removed in **Figure 3** had already been removed prior to the start of this study.)

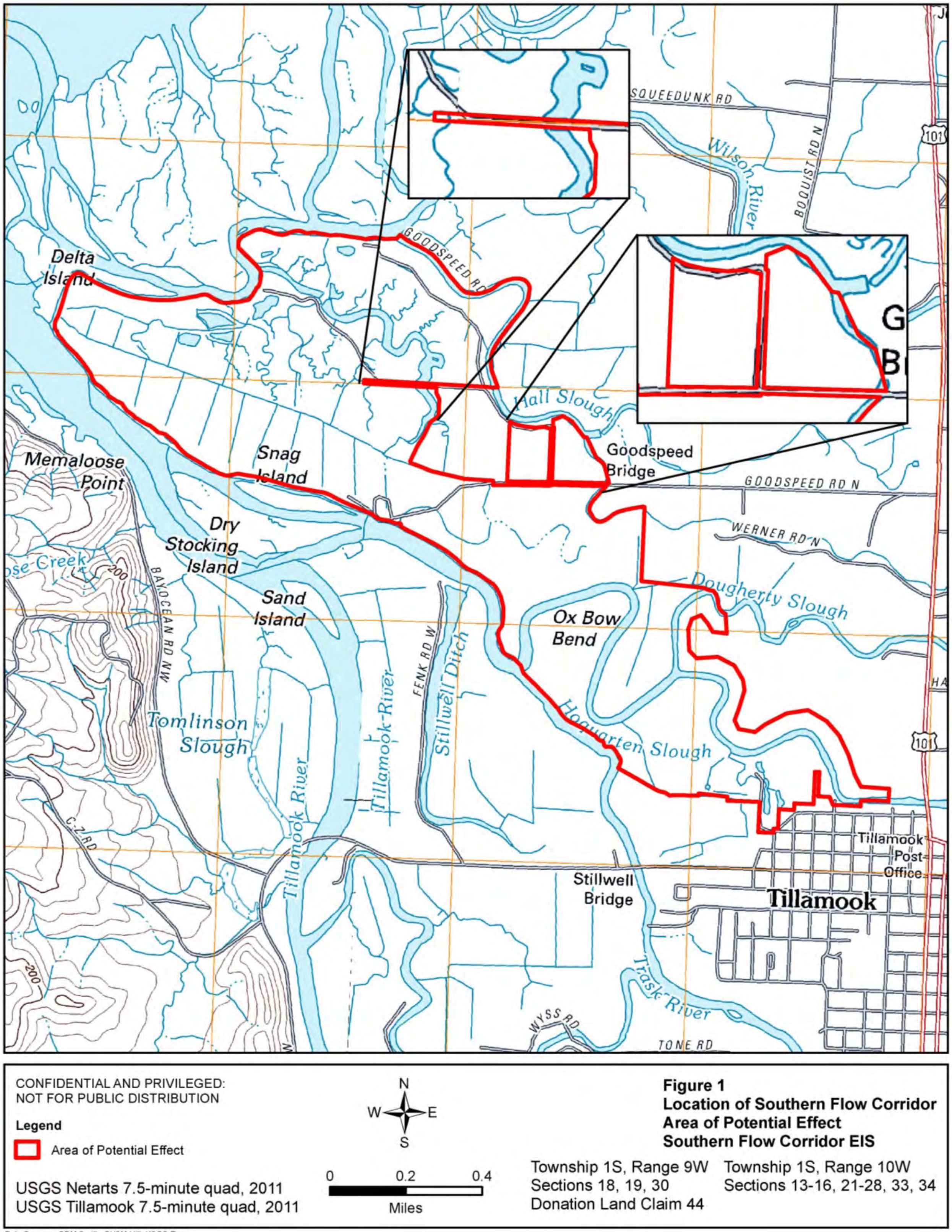
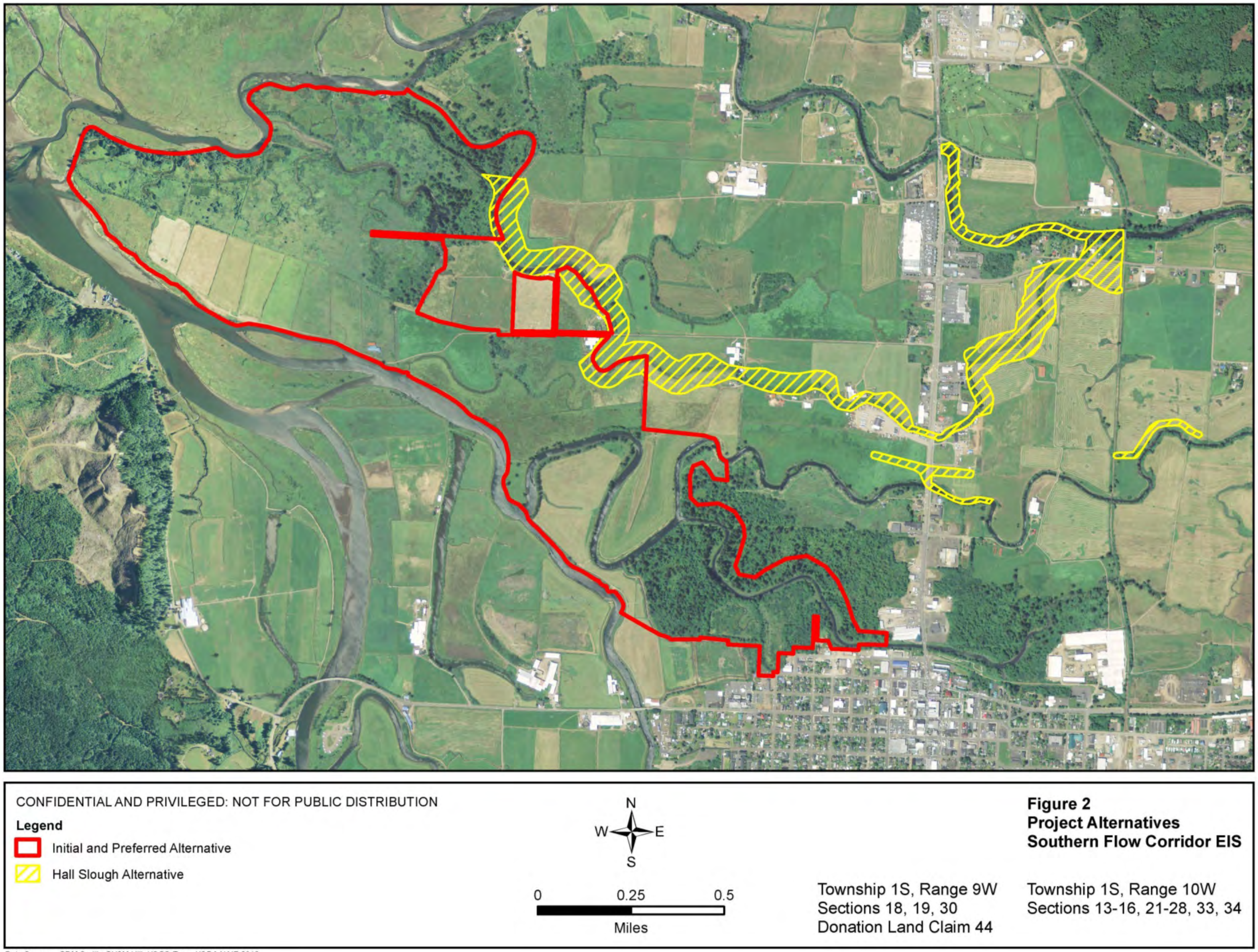


Figure 1. Southern Flow Corridor Project APE



Data Sources: CDM Smith, CH2M Hill, USGS Topo, USDA NAIP 2012

Figure 2. Southern Flow Corridor Project Alternatives

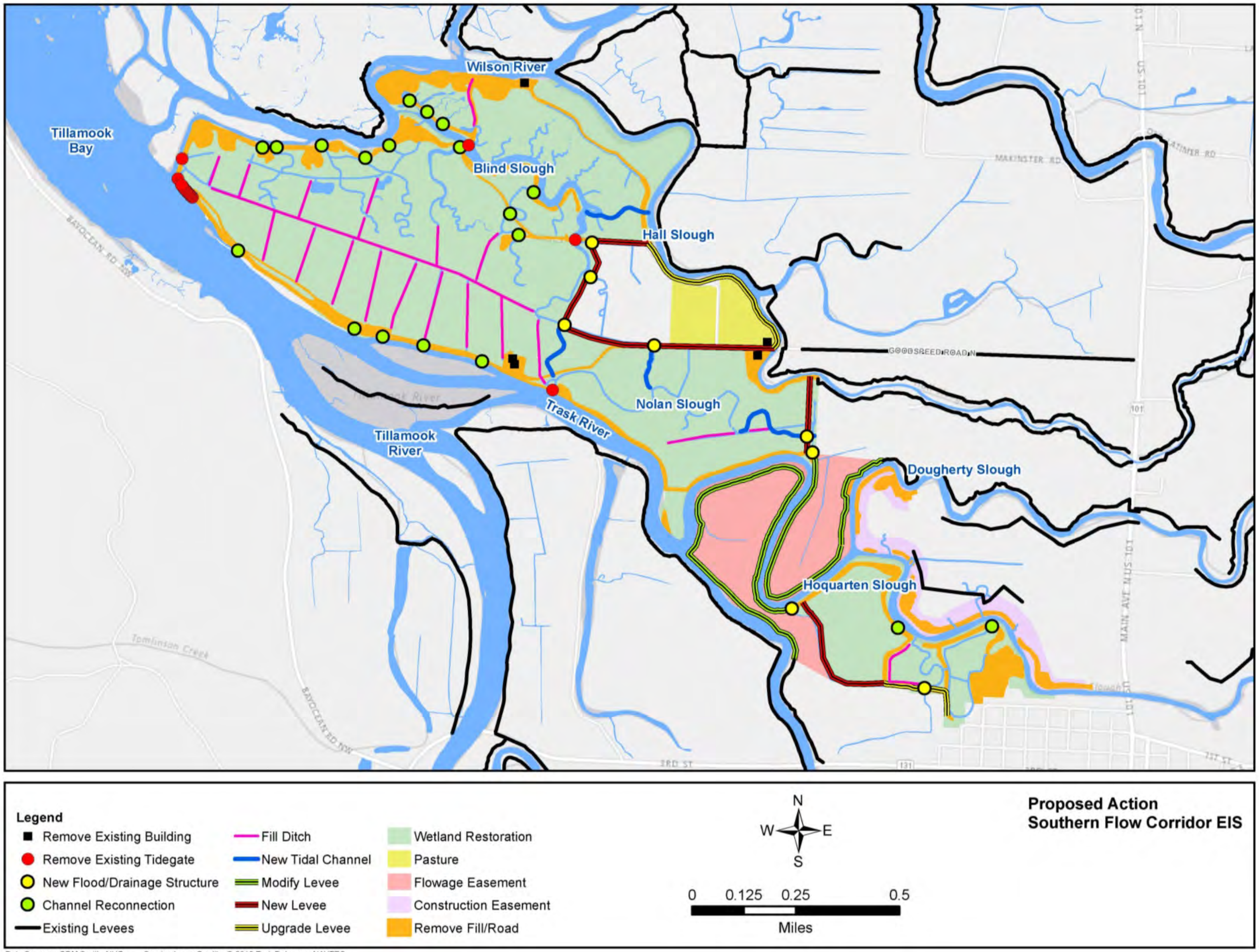


Figure 3. Proposed Action

1.1.2.2 Hall Slough Alternative

The Hall Slough Alternative would reconnect the upper end of Hall Slough to the Wilson River. Approximately 6.3 miles of levees along the channel length would be set back or modified and approximately 1.9 miles of the channel would be widened and deepened. This alternative would allow flood waters to flow down Hall Slough out to Tillamook Bay. The alternative would provide a channel for floodwaters that overtop the Wilson River in the area of the historic confluence of the river and the slough.

1.1.2.3 Southern Flow Corridor - Initial Alternative

The Southern Flow Corridor - Initial Alternative shares a number of characteristics in common with the Proposed Action, although it features somewhat different levee, floodgate, and drainage network configurations. This alternative would also function in a similar fashion to the Proposed Action in that it would also remove manmade impediments to flood flows in the lower Wilson River floodplain and restore tidal wetlands and channels.

1.2 Regulatory Framework

FEMA, in coordination with the NOAA Restoration Center, U.S. Army Corps of Engineers (USACE), and U.S. Fish and Wildlife Service, is the lead federal agency for the preparation of the environmental impact statement (EIS) supported by this technical report. Other agencies may be involved in the EIS process because they have special expertise in or knowledge of environmental issues, they have jurisdiction by law, or they must approve a portion of the proposed action (40 CFR 1501.6). FEMA is the lead agency for the National Environmental Policy Act (NEPA) and National Historic Preservation Act (NHPA) of 1966. The Oregon State Historic Preservation Office (SHPO) was notified of FEMA's lead agency status via written correspondence on February 4, 2014.

Scoping for the EIS has been completed, which included public involvement. The only comment received related to cultural resources pertained to the potential for finding artifacts in levee fill. FEMA anticipates making the draft EIS available for public comment in the late spring of 2015.

A more complete list of laws, regulations, and agency guidance applicable to cultural resources studies are listed in **Table 1**. Section 106 of the NHPA requires federal agencies to "take into account" the effect of an undertaking on historic properties and provide the Advisory Council on Historic Preservation (ACHP) an opportunity to comment on the undertaking. NRHP listing requirements are provided in 36 Code of Federal Regulations (CFR) 60 and several National Register bulletins explain how to evaluate the NRHP eligibility of individual resource types. The Section 106 compliance process is codified in 36 CFR 800. The cooperating agencies will rely on the field study and consultations conducted by FEMA under Section 106 for the SFC project.

Table 1. Applicable Laws and Guidelines for Cultural Resources Studies

Regulation (Law/Guidance)	Application
Federal	
Section 106 of the National Historic Preservation Act	Federal agency considers effect of undertaking on historic properties.
36 CFR Part 800	Details the Section 106 compliance process.

Regulation (Law/Guidance)	Application
National Environmental Policy Act	Determines whether a federal agency project will have a significant effect on the quality of the human environment.
Executive Order (EO) 13175	Consultation and Coordination with Indian Tribal Governments
Secretary of Interior's Standards and Guidelines (National Park Service 1983)	The Secretary of Interior's standards and guidelines for archaeology and historic preservation (National Park Service 1983) provide guidance for conducting archaeological investigations.
State of Oregon	
Oregon Revised Statute (ORS) 358.905 - 358.961	Archaeological Objects and Sites. Law provides definition of archaeological sites 75 years of age or older, significance, and cultural patrimony, and prohibits sale and exchange of cultural items or damage to archaeological sites on public and private lands. Items of cultural patrimony or associated with human remains are protected everywhere, unless the activity is authorized by an archaeological excavation permit.
ORS 390.235	Permit and Conditions for Excavation or Removal of Archaeological or Historical Materials.
Oregon Revised Statue (ORS) 97.740-760	Indian Graves and Protected Objects
Oregon Administrative Rule (OAR) 736-051-0080 through 0090	Administrative Rules for Archaeological Permits for Public and Private Lands.
State of Oregon Archaeological Reporting Guidelines (SHPO 2011)	Explains survey standards and expectations and provides direction for the preparation and submission of archaeological site record forms along with the accompanying survey reports.
Guidelines for Conducting Field Archaeology in Oregon (SHPO 2013a)	Guidelines for Conducting Field Archaeology in Oregon

1.3 Agency and Tribal Coordination

Consultation with Oregon State Historic Preservation Office (SHPO) and with tribes, including the Confederated Tribes of the Grand Ronde and the Confederated Tribes of the Siletz, has been initiated by FEMA. The record of communications between FEMA and SHPO including SHPO's concurrence with the Research Design and APE is provided in Appendix A. On April 16, 2015, SHPO concurred with the finding that there would be no historic properties affected by the SFC project. At the same time, SHPO also requested additional information on the historic era mill sites within the APE. This correspondence is included in Appendix A.

On August 5, 2014 Science Kilner (FEMA), Jessica Stewart (FEMA), and Robin McClintock (CCPRS) met with Grand Ronde Archaeologists Breece Edwards and Dustin Kennedy to discuss the project and address specific tribal concerns and issues.

On August 20, 2014, Grand Ronde Archaeologists Breece Edwards and Dustin Kennedy visited the CCPRS field crew and toured the APE with cultural resources specialist Robin McClintock.

SECTION 2 Natural Environment

2.1 General Landscape

Five major rivers enter the Tillamook Bay estuary, which includes the mouths of the Miami, Kilchis, Wilson, Trask, and Tillamook Rivers. The rivers originate in the Coastal Range and cut through the steep uplands to drain into the alluvial plain and estuary below. The Wilson, Trask, and Tillamook Rivers merge to form a broad alluvial plain to the east and south of the Bay on which the City of Tillamook is located. These rivers flow into the southern end of Tillamook Bay, with the exception of the Miami River, which flows into the Bay at its northern end. Flooding occurs frequently in the lower portions of the Wilson, Trask, and Tillamook Rivers, typically between October and April. High tides combine with storm surges, heavy rainfall, and snowmelt causing coastal and inland flooding.

At the end of the Pleistocene, about 12,000 years ago, melting glaciers caused previously depressed sea levels to rise significantly. Gravels and sands that had been deposited in Tillamook Bay were now inundated by the rising waters and covered by ocean-derived sands. Weathering in the upper watersheds and the transport of eroded sediments by the coastal rivers continued, and the Bay evolved its present dynamic equilibrium. These sediments are swept from the Bay on the outgoing tide (Coulton et al. 1996:8). Thus, the Bay, the APE and vicinity, are part of a hydrologically dynamic environment that is affected by ocean tides and by the erosion and deposition of sediments from the upper river valleys (Coulton et al. 1996:9).

The SFC project area is bordered to the south by the City of Tillamook and the Trask River and on the north by the Wilson River and Hall Slough. The project area contains a total of 646 acres comprised of Tillamook County lands (392), City of Tillamook lands (6), and privately held lands (248). The APE is a flat, low-lying floodplain separated by natural meandering sloughs and a network of levees and ditches that were constructed as flood control devices and to facilitate settlement and agriculture (**Photos 1 and 2**). The levees are typically linear and most are approximately 20 feet wide by 8 to 12 feet above surrounding waterways. Dredged river sediments were used to construct the levees along the Wilson and Trask Rivers (Coulton et al. 1996:19). The levees are often wider where dredged river sediments were used in construction. Other levees appear to have been constructed from local soils as there were often linear depressions (sometimes filled with water) adjacent. Imported gravel and rock were also used in their construction. Atop many of the levees are linear stands of mature fir and spruce trees as well as primitive two-track dirt roads or foot paths in some instances.

Approximately half of the project area is currently used for agricultural purposes, notably grass hay and livestock pasture, and there are several residences throughout. In the northwest portion of the project area are several actively worked hay fields separated by a network of linear ditches. These hay fields are bordered to the north by seasonally inundated lands covered in tall grasses and shrubs (**Photo 3**).

Photo 1. Hayfield Within an Oxbow
Located in the southern part of the APE with a dike on the right; view is to the north.

Photo 2. APE Looking South From a Levee Near the Tillamook River
Tillamook River is on the far right.

Photo 3. Wetlands and Dense Vegetation in the Northwest Part of the APE
Road at the left crosses over the levee paralleling the Tillamook River. A concrete control gate is in the far background on the left. View is to the west-northwest.

The southeast corner of the APE borders the City of Tillamook and has been disturbed by the former Tillamook Spruce Veneer plant and the Aberdeen Plywood Company's mill. Associated earthen levees topped by dirt roads were used to create log ponds. These facilities were in operation between the 1920s and the 1950s and have been almost completely demolished.

Undeveloped portions of the APE, mainly in the northeast and southeast, contain mature second growth mixed deciduous and evergreen forests. The remainder of the project area is a seasonally inundated marshland covered in tall grasses and shrubs.

2.1.1 Flora

Franklin and Dyrness (1973:294-296) classify the area as a "tideland community." Existing vegetation consists of blackberries (*Rubus* sp.), huckleberries (*Vaccinium* sp.), cape jewelweed (*Impatiens capensis*), English ivy (*Hedera helix*), canary grass (*Phalaris canariensis*), Scotch broom (*Cytisus scoparius*), skunk cabbage (*Veratrum californicum*), and various grasses, reeds, and sedges. The overstory is made up of red alder (*Aluns rubra*), Douglas fir (*Pseudotsuga menziesii*), and Western red cedar (*Thuja plicata*), while shrubs cover the ground surface.

Much of the APE and vicinity was cleared in the late 1800s and into the 20th century for urban and agricultural uses. Approximately 91 percent of the historic tideland community is now non-tidal wetland (Ewald and Brophy 2012:11). Much of the area is now used for agricultural purposes, principally hay and pasture.

2.1.2 Soils

Soils in the APE consist primarily of Coquille silt loam, 0 to 1 percent slopes and similar silt loams and soils such as the Fluvaquents-Histosols complex, 0 to 1 percent slopes, diked (Natural Resources Conservation Service [NRCS] 2013). Coquille silt loam is a very poorly drained soil found in tidal marshes, and is derived from estuarine deposits. It consists of silt loam to a depth of about 14 inches, with silty clay loam from about 14 to 60 inches (NRCS 2013).

The Fluvaquents-Histosols complex is found on rises in tidal marshes and is derived from estuarine deposits. Its uppermost seven inches are mucky silt loam, with underlying silt and sandy loam to about 25 inches. The lower layer is loam, and very gravelly sandy loam at about 70 inches (NRCS 2013).

SECTION 3 Cultural Setting

3.1 Cultural Chronology

As defined by archaeologists, the APE is located in the Northwest Coast culture area of North America. The Northwest Coast culture area extends from Alaska's Copper River delta on the Gulf of Alaska to just north of the California–Oregon state line. Inland, the Northwest Coast culture area ranges from the Chugach and Saint Elias mountain ranges of Alaska through the Coast Range of British Columbia, and includes the area between the coast and the Cascade Range in Washington and Oregon (Suttles 1990:1).

The prehistory of the Pacific Coast of Oregon and Washington is, in general, poorly understood. Archaeological evidence documenting sites dating prior to ca. 2,000 years before the present (abbreviated as B.P.) is relatively scarce, presumably the result of rising sea levels following deglaciation at the end of the Pleistocene. As sea levels rose, the shorelines exposed during the Pleistocene glaciations would have been the likely locations for early archaeological sites and would have become inundated, thus precluding their discovery.

Attempts to synthesize the prehistory of the Oregon Coast are relatively few and have been developed only since the 1980s. For the purposes of this report, the Northwest Coast chronology developed by Ames and Maschner (1999) is summarized below.

3.1.1 Archaic (11000–5500 years B.P.)

No definitively early Archaic period sites are known on the Washington and Oregon Coasts (Lyman 2009:283). The few recorded early Archaic period sites are found at higher elevations in southeast Alaska and the central coast of British Columbia (Ames and Maschner 1999:67, Ames 2003:23). The lithic toolkit of these northern sites is characterized by microblades; whereas, foliate bifaces dominate late Archaic sites further south. These types of tools are similar to those found in late Archaic sites in the Columbia Plateau (Ames 2003:23).

Scrapers, blades, and groundstones have also been found at later Archaic coastal sites (Ross 1990:554). On the northern Oregon Coast, components of the Youngs River Complex, composed of shouldered and leaf-shaped points, are found on high terraces near the mouth of the Columbia River (Ames and Maschner 1999:67, Minor 1983, Minor 1984).

3.1.2 Early Pacific (5500–3500 B.P.)

The beginning of the Early Pacific period reflects cooler and wetter post-glacial environmental conditions (Ames and Maschner 1999:83) and sea-level stabilization along the Oregon Coast (Lyman 2009:80). Archaeological sites from this period typically contain lanceolate projectile points used for darts and spears, as well as scrapers. While many different kinds of plant and animal resources were used during this period, resources - including sea mammals - acquired from intertidal and coastal zones became more important. The newly stabilized sea level led to increased biological diversity and productivity; thus providing more numerous and diverse resources for the indigenous coastal peoples. The relatively abundant plant and animal resources led to increased sedentism among pre-contact peoples of the region.

3.1.3 Middle Pacific (3500–1500 B.P.)

Villages first appeared during the Middle Pacific period on the northern part of the Northwest Coast. At Oregon coastal sites, shell middens became much larger than in the preceding period

(Ames and Maschner 1999). More use of storage technology is evident, as is increased reliance on salmon in some areas (Ames and Maschner 1999:108). More types of bone and antler tools appear in artifact assemblages, including unilaterally barbed harpoons and multipart tools, such as the composite toggling harpoon (Ross 1990:555).

3.1.4 Late Pacific (1500–200 B.P.)

Modern climatic conditions were in place by 2000 B.P. Native American lifeways seen at the time of European and American contact were fully in place by the beginning of the Late Pacific period. These included settlement in permanent winter villages and a variety of field camps used seasonally to obtain and process resources as they became available. Faunal remains are highly variable in Late Pacific period sites, and a wide array of bone and flaked stone tools are found.

3.2 Ethnography

The project APE is part of the traditional territory of the Nehalem Tillamook, who spoke the Nehalem dialect of the Coast Salish language group. Their territory extended from Nehalem on the north to the Siletz River on the south.

The Tillamook lived in permanent winter villages near the mouths of streams and in estuaries and bays (Jacobs 2003:69-70, Seaburg and Miller 1990:561). These villages were spaced around seven to eight miles apart and were reached primarily by canoe. During the spring months the Tillamook would leave their winter villages for temporary camps to gather and process resources for storage and later consumption.

Fishing, hunting, and plant gathering took place at these camps from spring through autumn. Fish, roots, berries, terrestrial and sea mammals, and shellfish were the most common of the Tillamook foods (Jacobs 2003:75, 80–81, Seaburg and Miller 1990:562). Fish weirs and traps were often used to capture fish in areas of shallow water, where they were easier to catch (Sauter and Johnson 1974:54). In the spring, a variety of berries were gathered and camas and other roots were collected and dried or cooked for storage. Large mammals such as elk, deer, and bear were taken, as were smaller mammals such as beaver and muskrat (Jacobs 2003:75). Men hunted alone year-round, and groups of men hunted together during the fall elk season. Sea lions and seals were also hunted and large amounts of shellfish gathered and dried. Fresh and saltwater fish were widely used and salmon was an important staple.

Each Tillamook village had a headman whose status was based at least in part on possession of a spirit guardian or a task-related responsibility. Leadership tasks included slave raiding expeditions and the coordination of hunting and fishing parties. Slaves had the lowest status among the Tillamook, while freeborns who had guardian spirits achieved the highest status (Seaburg and Miller 1990:565).

Trading took place with neighboring groups such as the Lower Chinook and Kalapuya. Canoes, baskets, and beaver pelts were traded for buffalo hides, dentalium shells, and dried salmon (Seaburg and Miller 1990:560).

Early Euro-American contact resulted in the spread of infectious diseases among the Tillamook and other native groups in the Pacific Northwest. A smallpox outbreak around 1775 probably affected the entire coastal region. Outbreaks of measles, smallpox, and other diseases occurred periodically between the 1820s and the 1860s. The cumulative effect of the epidemics reduced the population of the Tillamook from an estimated 4,320 in the early 1800s to 193 in 1854 (Boyd 1990:136, Table 1).

The Tillamook signed treaties in 1851 and, although these were never ratified, the end result was the cession of Tillamook traditional lands. Perhaps because of the Tillamook people's relatively small population, neither Euro-American settlers nor the military made a concerted effort to remove them to either the Siletz Reservation (established in 1855) or the Grand Ronde Reservation (established in 1858). While some of the Tillamook remained on the Oregon Coast, others left for the Grand Ronde Reservation.

3.2.1 Ethnographic Villages in the APE

Three ethnographic Tillamook villages, Tow-er-quot-ton, Chisucks, and Chuck-tins, have been reported in the vicinity of the APE (**Figure 4**). (Figure REDACTED in accordance with federal (Section 304 54 U.S.C. 470w-3a NHPA) and Oregon Revised Statute [192.501 (11)] laws pertaining to confidentiality of cultural resources locations.) These are three of the eight Tillamook villages noted by Lewis and Clark when they explored the Oregon Coast in 1806 (Hodge 1910:750-751). According to an Oregon SHPO map, the village of Tow-er-quot-ton may have been located [REDACTED in accordance with federal (Section 304 54 U.S.C. 470w-3a NHPA) and Oregon Revised Statute [192.501 (11)] laws pertaining to confidentiality of cultural resources locations.] …(Jacobs 2003:xii; Seaburg and Miller 1990:Fig. 1, p.561) and amateur archaeologists Sauter and Johnson (1974), but no descriptions of its size or occupation have been recorded. Sauter and Johnson state that the vicinity of the site (presumably in the 1970s) was covered in thick brush and alder trees as well as deposits of mud and silt (1974:172).

Chuck-tins may have been located near the mouth of the Trask River, on its south bank, near Dry Stocking Island (Seaburg and Miller 1990:Fig. 1, p.561). According to Sauter and Johnson (1974:172) Chuck-tins is located ". . . somewhere between the mouth of the Trask River and the mouth of Tillamook River. Most of this area is presently used as pasture for dairy cows, and present-day farmers have constructed large levees to reclaim the land. This construction and the necessary plowing of pasture lands have destroyed all evidence of Indian encampments."

According to Tillamook residents John Sauter and Bruce Johnson (1974:142-159) Chisucks village was located [REDACTED in accordance with federal (Section 304 54 U.S.C. 470w-3a NHPA) and Oregon Revised Statute [192.501 (11)] laws pertaining to confidentiality of cultural resources locations]. They state that the site was an important salmon fishing location and the southern terminus of a trade route with the Chinook people on Sauvie Island in the Portland Basin (1974:144). No citation is provided for this information and its veracity is unclear. Nevertheless, Sauter and Johnson undertook an extensive amateur excavation of Chisucks village beginning in 1970. They describe dense, intact deposits of bone, bone tools, lithic tools, early historic-era trade items that include beads and beeswax, midden, and house and storage pit features (1974:144-159). The final curation of the artifacts excavated at Chisucks is not known, although Sauter writes that he had been ". . . amassing a large collection of Tillamook artifact by excavating ancient village sites" (1974:198). Some of the collection was given to the Tillamook County Museum, though how great a percentage of the total is unclear. That portion is currently in the process of being transferred into the possession of the Confederated Tribes of the Grand Ronde (Dustin Kennedy, Grand Ronde Archaeologist, personal communication with archaeologist Robin McClintock).

Figure REDACTED in accordance with federal (Section 304 54 U.S.C. 470w-3a NHPA) and Oregon Revised Statute [192.501 (11)] laws pertaining to confidentiality of cultural resources locations.

Figure 4. [Redacted]

3.3 History

Euro-American settlement of Tillamook began when Joseph C. Champion arrived in 1851, followed by two families and several bachelors within a few years (Marschner 2008). Most of the settlers began small subsistence farms, usually near the Bay or one of the five rivers that drain into the Bay. Because the growing season was short, rainy, and cool, most crops did not fare well. Many farmers turned to dairy farming, for which the area seemed well-suited (Marschner 2008). By 1900, there were 631 farms in the area (Siegel 1994).

Because the area around Tillamook lacked reliable means of transportation, travel in and out of the region was based on local waterways and ocean going vessels. From 1851 through the turn of the twentieth century, boats and ships were used to transport people and merchandise (Levesque 2010:3). Attempts to facilitate shipping on Tillamook Bay drove many of the historic alterations to the sloughs and waterways of the area.

Historically, Tillamook Bay was relatively shallow and in the mid- to late 1800s contained areas of tidal sloughs, accumulations of woody debris near the mouths of rivers, deeply scoured holes, and other impediments to safe navigation (Phillip Williams & Associates, Ltd. 2001: 5-2 and 5-7). Formerly managed by USACE, Hoquarten Slough and other waterways, such as the Trask River, were dredged and tree snags were removed to improve navigability (Coulton et al. 1996:40). Over 9,300 snags were removed between 1890 and 1920, and dredging was nearly continuous during that time. Dredge spoils were disposed of on the banks of the slough (Coulton et al. 1996:41). Similar dredging took place through the 1970s (Coulton et al. 1996:23).

Potential agricultural land was drained using ditches, subsurface drain tiling, and tide gates:

> Drainage tiles, placed below the surface of agricultural land, removed excess water and increased the length of the growing or grazing season. It is understood that drain tiles were installed across much of the Tillamook Bay lowland valley floodplains to provide seasonal subsurface drainage of lands protected by levees. However, information on the exact location and extent of these drainage features is not readily available (Phillip Williams & Associates, Ltd. 2001: 5-11).

After 1911, shipping activities on Tillamook Bay began a rapid decline (Levesque 2010:36). The Pacific Railway & Navigation Company line from Hillsboro to Tillamook was completed in that year, providing a safe and reliable method of shipping and transportation that had never been achieved on local Tillamook Bay waterways. The rail line, under different ownership over the years, sent timber products and feed six days a week to the Willamette Valley for nearly 100 years before flooding caused extensive damage in 2007. The decision was made in 2009 not to rebuild the railroad (Levesque 2010:83).

3.3.1 Sawmills and the Lumber Industry

During the earliest years of Euro-American settlement in Tillamook County, the dense forests of the region were not seen as a marketable resource. Rather, the large old-growth trees were considered a nuisance to be cut and taken to rivers or tidelands to be carried out to sea. In 1863 three mills were located in Tillamook County and were primarily for expedient use in the construction of homes and farm buildings. All three mills had ceased operation by 1870 (E&S Environmental Chemistry, Inc. 2003:2-15).

As San Francisco and Portland entered a period of rapid growth, timber and lumber mill industries were quickly established to fill the high demand for wood products used in urban and maritime construction. By 1894, “the timber industry was considered Tillamook County’s most important industry” (E&S Environmental Chemistry, Inc. 2003:2-16). Lumber mills became a common feature across this part of Oregon, and by 1923, 20 such mills were operating in Tillamook County (E&S Environmental Chemistry, Inc. 2003:2-16).

Ten years later, the first of at least three large wildfires, collectively known today as the Tillamook Burn, devastated the regional forests. Large-scale salvage logging in the Tillamook Burn area began in the late 1930s and increased substantially in the early 1940s, in response to need created by World War II. Salvage logging reached its peak by 1953 and had largely ended by 1959, replaced by the new method of clear cutting (E&S Environmental Chemistry, Inc. 2003:2-16). As the supply of old growth and salvage trees diminished, so too did the need for sawmills. Only three sawmills were operating in Tillamook County by 2009 (Tillamook Headlight-Herald 2009).

The site of a former lumber mill and veneer factory is located at the northwest margin of the city of Tillamook, near the intersection of Front Street and Douglas and Cedar streets (tax lot 1S10250000200). Tillamook Spruce Veneer Company began operations sometime around 1926 on the southwest side of Hoquarten Slough (Levesque 1985:436) (**Photo 4**). The property was so low and presumably wet that its facilities were placed on pilings. Among these were saws, dry kilns, a woodworking house, a boiler house, a machine shop, and an oil house. Logs arrived at the mill via Hoquarten Slough and were stored in a narrow inlet on the north side of the mill. Power for the mill is thought to have been derived from steam generated by burning wood waste (Anderson Geological, Inc. 2014:2). After eight years in business, the owners of the Tillamook Spruce Veneer mill moved the operation to Coos County, abandoning the mill’s buildings and log ponds (Levesque 1985:437).

The mill property sat vacant until 1944 when the Aberdeen Plywood Company constructed a new mill west of the old Tillamook Spruce Veneer site and demolished the old Tillamook Spruce Veneer structures (Levesque 1985:441). While plywood was never produced at the Tillamook site, wood logs were peeled at the mill and the veneer was sent to the company's plywood plant in Tacoma, Washington for production (Anderson Geological, Inc. 2014:2-3). Plywood was a key component in the construction of barracks, PT boats, and other items used by the U.S. during World War II. So crucial was plywood that this material was deemed an essential war material, with strict controls on production and distribution (APA - The Engineered Wood Association 2014).

The new mill was built on pilings and included a lathe room, a filing room for saw and knife sharpening, a clipper room for trimming veneer, and a power room. A new log pond was dug to the west, and in the mid- to late-1950s another mill pond was dug west of the existing pond (**Photo 5**). Logs were no longer transported via Hoquarten Slough or stored in the Hoquarten Slough inlet (Anderson Geological, Inc. 2014:2-3).

The Aberdeen Plywood Company’s mill initially used electricity and steam for power, but may have abandoned steam power in the late 1950s. At this time a new burner was constructed near the former Tillamook Spruce Veneer mill for burning wood wastes. After the mill closed in the mid-1960s, the log ponds were drained and fill material “possibly from the areas around the former mill buildings” was deposited on the southeast corner of the west log pond (Anderson Geological, Inc. 2014:3). **Photo 6** through **Photo 8** depict the changes at the property over time.

Photo 4. Tillamook Spruce Veneer Plant in 1939
Oregon Department of Transportation (ODOT) aerial photograph of the City of Tillamook

Photo 5. Aberdeen Plywood Mill and Log Ponds – 1962
ODOT aerial photograph of the City of Tillamook

Photo 6. Demolished Aberdeen Plywood Mill with Intact Log Pond - 1967

ODOT aerial photograph of the City of Tillamook showing the mill at the upper left

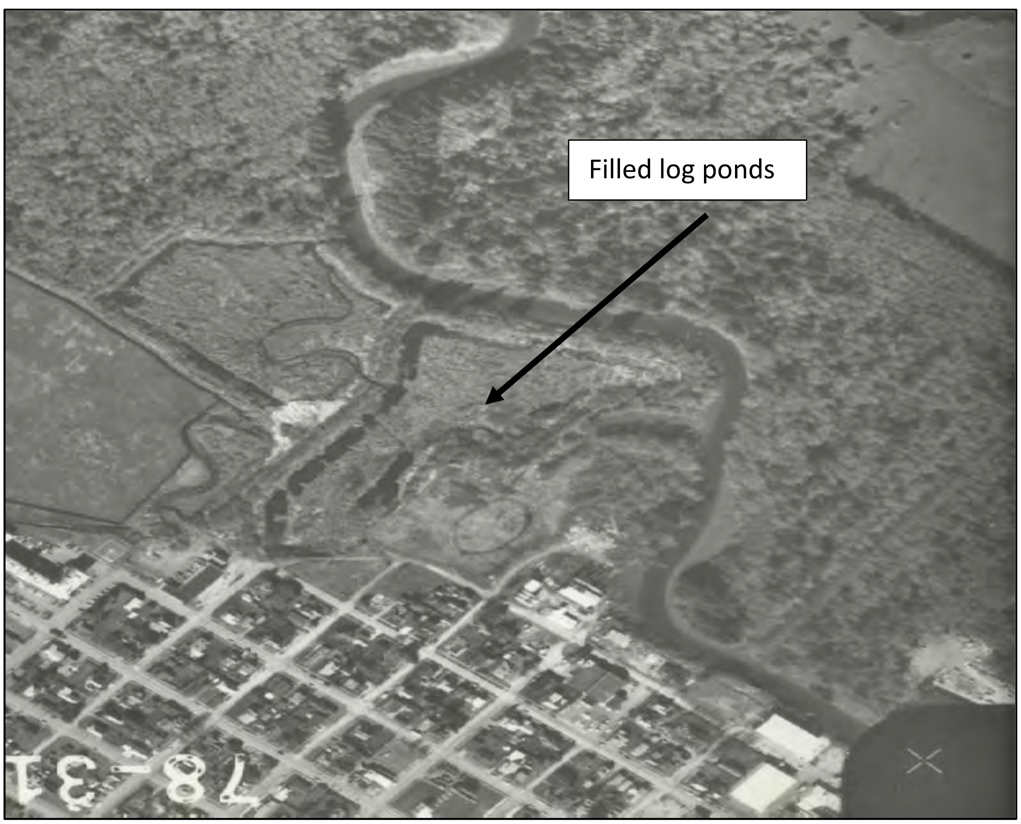


Photo 7. Demolished Remains of the Former Aberdeen Plywood Mill and Tillamook Spruce Veneer Mill - 1978

ODOT aerial photograph of the City of Tillamook

Photo 8. Overgrown Former Mill Sites and Log Ponds - 2005
Google Earth aerial image

Section 4 Literature Review

Background research was conducted to identify pre-contact and historic sites previously recorded within the APE and within a radius of one half mile, and to assess the potential for lands in the APE to contain unrecorded cultural resources. This research included a review of pertinent site distribution maps, site form files, and reports on previous archaeological research for the proposed APE and vicinity.

Background research indicates that no pre-contact sites have been recorded within the APE, and with minor exceptions, the property has not been previously subject to archaeological investigations. Two archaeological sites have been recorded within one half mile of the APE: 35TI90, a large pre-contact site about one quarter mile southwest of the APE in the City of Tillamook, and 35TI101, a historic bridge about 775 feet east of the APE in the City of Tillamook. Following the field investigations and as this report was being completed, two historic-era sites associated with the previously described Tillamook Spruce Mill (35TI109), the Aberdeen Plywood Mill (35TI110), and an isolate , 30662-IF-1) were recorded.

Site 35TI90, located [REDACTED in accordance with federal (Section 304 54 U.S.C. 470w-3a NHPA) and Oregon Revised Statute [192.501 (11)] laws pertaining to confidentiality of cultural resources locations], was occupied between about 1,300 and 250 years ago. It is interpreted as a base camp for fishing and hunting activities, and a place where various related tools were manufactured (Roulette et al. 2012:ii). Artifacts recovered include projectile points, flake tools, scrapers, and related lithic debitage. Animal bone remains identified include salmon, trout, elk, deer, and birds (Roulette et al. 2012:141). A unique artifact, a zoomorphic groundstone club and/or abrader was also recovered from the site. This item is in the shape of a club with a knob handle that was fashioned into the head and neck of an animal, possibly a seal or otter. It is unique not only because it was the only one of its kind recovered from the site, but because it does not resemble other decorated or zoomorphic items that have been found in the region (Roulette et al. 2012:141).

In addition to the pre-contact artifacts, a small amount of historic demolition and household debris was found at 35TI90. These materials were deposited after the site was abandoned and represent a secondary deposit.

Site 35TI101 is the remains of the A.F. Coats Mill Bridge over Hoquarten Slough, located on the north side of Tillamook where U.S. Highway 101 crosses the slough. The site consists of the bridge piers that once connected the A.F. Coats Lumber Company mill to the City of Tillamook. The mill operated from 1902 until shortly after it was sold in 1950. The bridge was demolished sometime between 1960 and 1976 (Wilt 2011a).

Site 35TI109 is the archaeological remains of the Tillamook Spruce Veneer Plant as described in Section 3.3.1. This site was recommended not-eligible for listing in the NRHP.

Site 35TI110 is the archaeological remains of the Aberdeen Plywood Company as described in Section 3.3.1. This site was unevaluated when recorded.

Archaeological isolate 30662-IF-1 was left unevaluated.

As noted previously, three ethnographic villages that could have archaeological deposits have been reported in the vicinity of the APE (**Figure 4**). One is the ethnographic village of Tow-er-quot-ton, which may be within the APE. Tow-er-quot-ton was purportedly located [REDACTED in accordance with federal (Section 304 54 U.S.C. 470w-3a NHPA) and Oregon Revised Statute [192.501 (11)] laws pertaining to confidentiality of cultural resources locations] (Roulette et al., 2012:29). Thirteen archaeological investigations have been carried out within 0.5 mile of the APE. One of these (Ogle and Goodwin 2011) extended into a small part of the APE but did not result in the recordation of any archaeological sites or isolates. **Table 2** lists the studies, results, and locations relative to the APE.

Table 2. Archaeological Investigations Within One Half Mile of the SFC APE

Title	Location	Description	Results	Reference
Results of Cultural Resources Monitoring for the Sadri-East Parcel Environmental Investigation Project, Tillamook County, Oregon (SWCA Project No. 30662)	Sadri Parcel adjacent to Hoquarten Slough within SFC project APE	Cultural Monitoring of soil testing	35TI109, 35TI110, and isolate 30662-IF-1 Recorded: Monitoring recommended	Blake, 2014a
Archaeological Investigations at Site 35TI90, Tillamook, Oregon	**	Evaluative testing at pre-contact site 35TI90	Recommended eligible for the NRHP	Roulette et al. 2012
Wilson River Bank Protection, Cultural Resources	On the south bank of the Wilson River about 0.55 mile northeast of Hall Slough and tax lot 1S10230000200	Pedestrian survey of six locations on the west bank of the lower Wilson River	No archaeological sites or materials observed	Martin 1984
Archaeological Monitoring of Soil Sampling at the Schmidt Property, Tillamook County, Oregon	Within the APE in tax lot 1S1025AD00190	Archaeological monitoring on the west side of Hoquarten Slough on the north side of Tillamook	No archaeological sites or materials observed	Ogle and Goodwin 2011
Stillwell Location Bank Protection, Cultural Resources	On the south bank of Hoquarten Slough opposite tax lot 1S10230000900	Pedestrian survey on the north channel of the Trask River just downstream from its confluence with Hoquarten Slough	No archaeological sites or materials observed	Martin 1986
Archaeological Survey of the Dougherty Slough-Tillamook Section, Oregon Coast Highway, Tillamook County, Oregon	On U.S. Highway 101 from 1st Street to Dougherty Slough, about 400 feet east of tax lot 1025AA01400	Pedestrian survey of U.S. Highway 101 from the north edge of Tillamook to Dougherty Slough	No archaeological sites or materials observed	Pettigrew and Cole 1977
Results of a Cultural Resources Assessment of the Tillamook Wastewater Treatment Plant Project Area, Tillamook County, Oregon	About 0.37 mile southwest of the APE at the corner of Birch and 1st streets	Background and research only, no field studies, at the Tillamook Wastewater Treatment Plant on the east bank of the Trask River	The Tillamook Wastewater Treatment Plant Project was found to have a high potential to contain archaeological resources	Solimano and Roulette 2005

Title	Location	Description	Results	Reference
Results of an Archaeological Survey of the Proposed Tillamook Wastewater Treatment Plant Expansion Project Area, Tillamook, Oregon	**	**	Pre-contact site 35TI90 recorded	Becker et al. 2007
Results of a Cultural Resources Assessment of the Verizon Wireless Fiber Optic Cable – Cape Meares Route, Tillamook County, Oregon	About 600 feet southwest of tax lot 1S1025AC04500	Pedestrian survey along both sides of the Netarts Highway between the western edge of the City of Tillamook and the Coast Range	No archaeological sites or materials observed	Finley 2013
Archaeological Reconnaissance of the North Fork Nehalem, Miami, Kilchis, Wilson, Trask, Nestucca, and little Nestucca Rivers Stream Protection Projects	About 0.33 mile southwest of APE lands on the Trask River	Pedestrian survey	No archaeological sites or materials observed	Swanson 1976
Oregon Archaeological Survey form	About 460 feet southwest of tax lot 1S10220000200	Unspecified type of survey just downstream from Dry Stocking Island	Recorded one site, possibly pre-contact with historic-era artifacts; site likely inundated or washed away by tidal action. No Smithsonian number assigned and no location or site form at the Oregon SHPO	Collins 1951
Results of a Cultural Resource Investigation of the Proposed Tillamook PUD Transmission Line Project, Tillamook County, Oregon	Along the western part of Front Street just south of tax lot 1S10250000200	Pedestrian survey along the north side of the City of Tillamook and on the north side of Netarts Highway to the Coast Range and beyond	No archaeological sites or materials observed	Wilt 2012
Cultural Resources Survey Report for the Tillamook U.S. Highway 101 /Oregon State Highway 6 Project, Tillamook County, Oregon	About 500 feet east of tax lot 1S1025AA01400	Shovel test survey at the U.S. Highway 101 bridge over Hoquarten Slough	No archaeological sites or materials observed	Wilt 2011b

** *REDACTED in accordance with federal (Section 304 54 U.S.C. 470w-3a NHPA) and Oregon Revised Statute [192.501 (11)] laws pertaining to confidentiality of cultural resources locations.*

As noted previously, Sauter and Johnson (1974) undertook extensive excavations of an archaeological site they identified as Chisucks Village. No professional documentation of these excavations was made and the only reporting is available in their book, *Tillamook Indians of the Oregon Coast* (1974).

4.1 Cartographic Research

Julie Wilt, SOI qualified archaeologist, conducted archaeological file searches at the Oregon SHPO for information concerning archaeological sites and investigations in and near the SFC

APE. In addition to research conducted at the Oregon SHPO, General Land Office (GLO) maps of T1S, R9W, United States Geological Survey (USGS) maps, and Sanborn Fire Insurance Maps (Sanborn maps) were analyzed to identify potential historic-era cultural resources present in the APE, and to assess the potential for the APE to contain historic resources

A 1913 copy of an 1857 GLO map of T1S, R9W, shows a structure and agricultural field in the Donation Land Claim (DLC) for "Thomas" on "Ouquarten" [Hoquarten] Slough in the northwest quarter of Section 30. An unnamed road borders the Thomas property on the north and largely conforms to the current alignment of Oregon Route 6.

Edrick Thomas was an early settler in the area, arriving in Oregon in 1850 (Flora 2004). In 1861, Thomas Stillwell bought out Thomas and began laying out a townsite he called Lincoln; the name was eventually changed to Tillamook. By the 1890s the town had stores, hotels, saloons, a bank, and a courthouse, much of which burned in an 1893 fire (Orcutt 1951:215). By 1900, the rebuilt town had a telegraph and police and fire departments. Municipal water was available by 1905.

A 1913 copy of an 1858 GLO map of T1S, R10W, shows the western part of the Thomas property in the northeast quarter of Section 25. The Thomas property was located in what is today the vicinity of Sue H. Elmore Park and Front Street under the existing US 101 bridge in Tillamook. A ship landing is depicted just north of the Thomas property on "Ouquarten Slough." No roads, homes, fields, or other improvements are shown in Sections 14, 22, or 23.

A 1921 copy of an 1863 GLO map of T1S, R10W shows no developments, improvements, or DLCs anywhere in the APE.

The 1955 USGS Tillamook, Oregon 32-minute quadrangle shows that the only homes and businesses in the APE outside of the City of Tillamook are along the banks of the major streams and the major and minor roadways in the area. No homes or roads are shown in the interior between streams. The former Tillamook Spruce Veneer Company's log pond is depicted on this map just outside the northwest corner of the City of Tillamook.

SECTION 5 Research Design and Field Methodology

As noted previously, the field methodology and research goals were outlined in the Southern Flow Control Research Design (McClintock and Wilt 2014) provided to SHPO in June 2014. The Research Design and SHPO concurrence letters are provided in Appendix A. Field methodologies for the Built Environment and the Archaeological Environment are detailed below.

5.1 Built Environment

The field work expectation was that most structures within the project APE would likely be related to agriculture and to construction of the existing levees. In planning the field work, General Land Office (GLO) maps from 1858, 1863, and 1893 were reviewed. These historic maps showed no improvements or structures within the project APE. However, smaller structures such as small bridges and culverts may have been present. Lori D. Price, SOI qualified architectural historian, reviewed the Oregon historic sites and NRHP databases to determine if there were any known historic properties within the APE that would need to be accounted for during field work. A review of aerial photographs, project maps, and previous reports indicated a likelihood of numerous, interconnected levees, a series of approximately 16 ditches, and possible historic roads and culverts in the APE. Levees and ditches, as well as any other man-made structures 45 years or greater located during the field work would be recorded. The eligibility of individual built environment resources would be evaluated for listing in the NRHP. Additionally, built environment resources recorded during the field work would be evaluated collectively as potential contributing resources to a larger historic district, if appropriate.

On July 24th, 2014, a pedestrian survey of the project area was conducted, to the greatest extent possible, to photograph and record any potential historic properties. A four-wheel drive vehicle was used to access and traverse the APE, and sites were inspected on foot whenever possible. Some areas were not accessible due to wet or overgrown terrain. Properties identified in the field were photographed with a digital camera and their location, condition, and details were noted. After the field work, research was conducted to gather information for historic context and for specific resources. This research included personal interviews with long-time residents of the area and with contractors who had worked in the area for many years, as well as online sources, historic maps and aerials, and previous reports. Oregon Inventory of Historic Properties Section 106 Documentation Forms were prepared for each property. The forms contain a detailed property description and a statement of significance sufficient to make a recommendation of NRHP eligibility.

5.2 Archaeological Field Methodology

5.2.1 Shovel Probes

The archaeological inventory was used to document the presence or absence of archaeological sites and isolates within the APE. All fieldwork was consistent with the Guidelines for Conducting Field Archaeology in Oregon issued by the Oregon SHPO (final version dated November 2013a).

Due to the dense surface vegetation that severely limited surface visibility, shovel testing was used in lieu of a pedestrian survey to locate buried or obscured archaeological deposits. Prior to the start of the fieldwork, a GIS-generated overlay was produced of the entire APE with the locations of shovel test units (STUs) spaced at about 20 meter intervals. Field teams used hand-held Trimble GPS units to access the location of the STUs, which had been loaded into the Trimble units. The overlay contained STU numbers in addition to coordinates.

Several factors precluded the complete use of all of the overlay's STU locations. Principle among these were areas of standing water, tidal and seasonal inundation, impenetrable vegetation, locations on roads or other disturbed areas, lands where owners had not granted access, and fields in which liquid manure fertilizer had been sprayed. The reconnaissance survey found that a significant portion of the northern portion of the APE is active wetland with meandering rivulets. Much of the area exhibited standing water at the time of the field investigations. Shovel probing in these areas was not attempted. Locations for the STUs were also based on the perceived sensitivity of the APE to contain archaeological deposits, and on the possible location of Tow-er-quot-ton ethnographic village, and the availability of non-inundated ground. Although it was recognized that the dryer areas of the APE were likely simply drained wetlands, those areas still provided the best opportunity for subsurface samples

A total of 115 STUs and one auger not associated with an STU were placed across the APE as shown in **Figure 5**. [Figure REDACTED in accordance with federal (Section 304 54 U.S.C. 470w-3a NHPA) and Oregon Revised Statute [192.501 (11)] laws pertaining to confidentiality of cultural resources locations.] The STUs consisted of cylindrical pits, minimally 30 centimeters (cm) in diameter that were excavated to a minimum of 50 cm where feasible. An auger with a 3-inch-diameter bucket was used in twelve of the STUs in order to provide a more detailed soil profile or to investigate the presence of charcoal or other potential cultural features.

The STUs were excavated in 10-cm or thinner levels to better track the vertical distribution of artifacts, should they be present. All sediment removed from the probes was passed through 1/4-inch mesh hardware cloth. Standardized information included depth, width, types of sediment, and the presence of any intrusions (charcoal, roots, and other forms of bioturbation) were recorded for each STU. Upon completion, the STUs were completely backfilled.

Figure REDACTED in accordance with federal (Section 304 54 U.S.C. 470w-3a NHPA) and Oregon Revised Statute [192.501 (11)] laws pertaining to confidentiality of cultural resources locations.

Figure 5. [Redacted]

SECTION 6 Findings

6.1 Built Environment

The literature search found that no historic properties have been previously identified within the project area. The survey and recordation of potentially historic properties was limited to those that were at least 45 years old at the time of the survey (ca. 1969). Two dwellings were identified, including one with multiple outbuildings; a series of man-made drainage ditches with culverts and tide gates; and a collection of manmade levees along the rivers and sloughs (**Table 3** and **Figure 6**). Each resource was recorded and evaluated for listing in the NRHP (Appendix C). This report recommends that none of the surveyed resources are eligible for listing in the NRHP.

Table 3. Built Environment Properties in the Project Area

Name	Location	Date of Construction	Recommendation for NRHP Eligibility
Jones House	590 Goodspeed Road	1914, 1950, 1955	Not Eligible – lack of integrity
Diamond F House	355 Goodspeed Road	1965	Not Eligible – lack of integrity
System of Drainage Ditches (10) with Culverts and Tide Gates (evaluated as a linear resource historic district)	Former Wilson Property (western end of project area, bordered on south by Tillamook and Trask rivers)	Unknown; likely 1940s; tide gate and culvert are c.1999.	Not Eligible – does not meet criteria
System of Levees(evaluated as a linear resource historic district)	Along rivers and sloughs throughout project area	Unknown/various; late 1800s through 1960s	Not Eligible - lack of integrity

6.1.1 Jones House

The Jones House is a single family, Arts and Crafts style residence from 1914 with several accessory buildings. The house is a one and a half story, wood-framed building over a concrete block foundation (**Photo 9**). The house appears to have been raised on the current foundation walls, likely to escape flooding from the adjacent Hall Slough. The house has a front gable roof of asphalt shingle with a hipped roof over what was originally the front porch. Two large shed-roofed dormers have been added to provide more living area on the second floor, one on each side of the house. There is also a rear addition. The exterior of the house is clad in vinyl siding, including the original knee braces at the roof line on the front elevation. The front porch has been enclosed; wooden steps now lead up to a small entry porch. All windows in the house have been replaced. To the west of the house is a small single car garage, c.1950. It has a front gable roof and a paneled, retractable garage door on the front elevation. It is clad in vinyl siding and appears to be in poor condition.

Photo 9: Jones House, 590 Goodspeed Road, Front (South) Elevation

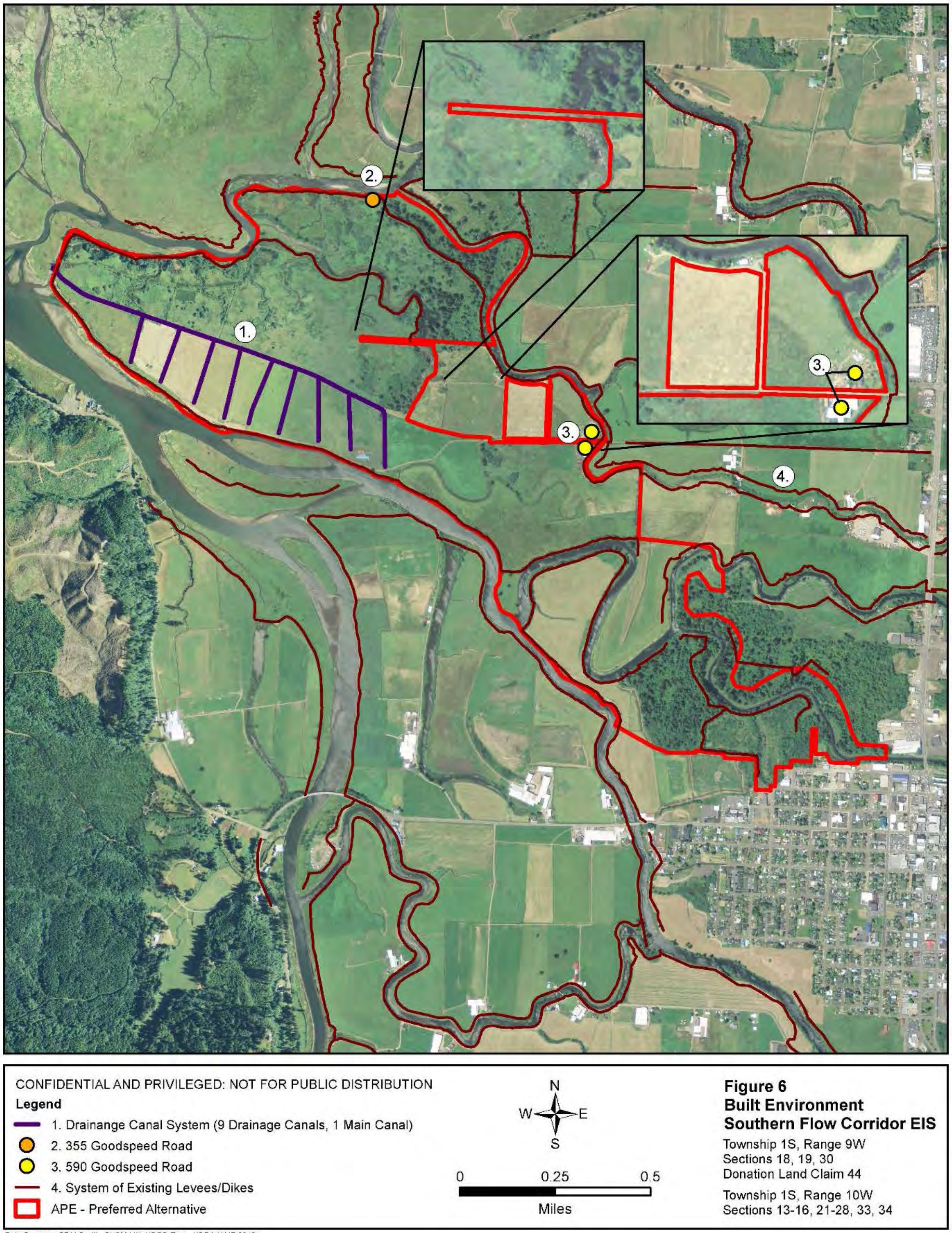


Figure 6. Built Environment in the APE

Across the street from the house, to the south, is an inter-connected complex of agricultural buildings (**Photo 10**). The section closest to the house is from 1950 – all other sections date from 1955 or later. The 1950 section is concrete block with a side gable roof of corrugated metal. The roof structure does not appear to be original. Additional corrugated metal forms a band at the top of the block wall along the front elevation, just under the roofline, and also forms the side gable end. The front elevation contains a single doorway flanked by windows with sliding, aluminum framed sash. The east side elevation contains additional window openings, but they are either boarded over or obscured by vegetation and an assortment of equipment and miscellaneous items.

Photo 10: Jones House, 590 Goodspeed Road, Agricultural Buildings, Front (North) Elevations

The block building is connected on the west side to a larger utilitarian building that appears to serve as storage facility but may have been a hay barn at one time. It is wood framed, with a rectangular footprint and a side gable roof. Both the roof and walls are clad in corrugated metal. There is a large doorway on the front elevation that is slightly recessed, with a metal sliding door. Other openings appear to have no windows or doors. Some sections of metal cladding are missing and the building appears to be in poor condition. Attached at the southwest corner of this building is another large utilitarian building. This third building has a front gable roof with mostly open north and south elevations. The roof and gable ends are clad in corrugated metal and the west elevation is a combination of wood and concrete block. Two additional buildings are attached to the south of the complex, but they are not visible from the public right of way and were not accessible. In aerial photos they have gabled metal roofs and simple rectangular footprints. The first and larger of the two is attached to the south elevation of the large, main barn and to the east elevation of the rear southwest corner building. The second, smaller building is attached to the rear (south) of the first one and also to the rear (south) of the rear southwest corner building. To the west of this complex of connected buildings is a separate, smaller, shed-roofed storage building. It is wood framed and clad in corrugated metal. It is five bays wide and all bays are open except for one. It appears to have had sliding doors originally, but only one remains.

This property contains an early 20th century farmhouse and associated agricultural buildings, and is no doubt associated with the early dairy culture of the Tillamook area (Criterion A). However, both the house and accessory buildings have been extensively altered and the property no longer serves as a dairy farm. The agricultural buildings are in very poor condition. The house has been significantly altered through the front porch enclosure, window replacements, siding replacement, and additions. Only the basic roof structure and the siding-enclosed knee-brackets remain to hint at the original style of the house. No significant persons are known to be associated with the property (Criterion B). The house and its accessory buildings are typical buildings, and the materials and construction methods do not convey important information contributing to the understanding of history or prehistory (Criterion D). The buildings are recommended not eligible for listing in the NRHP because they lack integrity of design, materials, workmanship, and association, and do not convey significance under Criterion A (for association with the dairy industry), or Criterion C (for architecture).

6.1.2 Diamond F House

The Diamond F House, built in 1965, is located on the Wilson River at the end of Goodspeed Road, near where Hall Slough meets the river (**Photo 11**). It was built as a recreational second home and is occupied part-time. The wood-framed, one and a half story house has a mostly rectangular footprint and is built up off the ground on wood posts. It is clad in vertical T1-11 siding with horizontal wood siding in the gable ends and on the two shed dormers. The area beneath the house is enclosed with horizontal boards. The house is surrounded by a raised wood deck with wood railing, and is accessed from the front (south) elevation by wooden steps. The rear of the house faces the river where the deck steps down several steps and expands out toward the river. A large shed-roofed porch, supported on wood posts, spans the width of the north elevation. Many of the doors and some of the windows appear to be recent replacements, including a wall of sliding glass doors on the north elevation. A large opening on the north elevation has been boarded up. A few original two-light sliding sash aluminum windows remain, particularly in the dormers. A small addition is located on the front elevation.

The Diamond F House is recommended not eligible for listing in the NRHP. It is not associated with the significant history of the area (agricultural/dairy or timber - Criterion A). Research did not reveal association with any significant persons (Criterion B). The house is not architecturally distinctive (Criterion C) and in addition, has had several alterations that detract from integrity of materials, design, and workmanship. It represents a typical house of the mid-twentieth century, and the materials and construction methods do not convey important information contributing to the understanding of history or prehistory (Criterion D).

Photo 11: Diamond F House, 355 Goodspeed Road, Southeast Corner

6.1.3 System of Drainage Ditches

In the western end of the project area, formerly the Wilson property, a system of drainage ditches was dug to drain the wetlands located where the Tillamook and Wilson Rivers meet (**Photo 12**). The date of these drainage ditches is unknown but according to the son of the former property owner, they were in place before the 1950s and possibly as early as the 1930s (Ingles 2014). However, the ditches are not indicated on an aerial map from 1939 (Wilson River Aerial 1939). Therefore, an approximate date of construction for this drainage system is the 1940s.

The system contains nine narrow drainage ditches that run mostly north/south, with the south ends terminating at an unpaved road that runs along the levee. The north ends connect to a single, slightly larger drainage ditch that runs east/west, starting at Sissek Road and ending at the Wilson River. This larger drainage ditch accepts the flow of the nine smaller ditches, routing it to a culvert with a tide gate on the Wilson River. The culvert, which pierces a levee along the Wilson River, is not visible but has a square, top-hinged, metal tide gate on the river side. Both the culvert and tide gate were replaced c.1999 (Koontz 2014). The western end of the main ditch is also connected to a small body of water that is served by four flood gates and ten tide gates at the southwestern corner of the property (**Photo 13**). The four cast concrete flood gates with side-hinged gates (2008) and ten gated culverts (1999) are a part of the drainage system and contribute to the drainage management of this property. Aerial views show additional north/south drainage channels on the adjacent property to the north (the former Farris property) that appear to also drain into the central east/west ditch. Unfortunately, this could not be verified, as they were not accessible in the field due to wet conditions and overgrown vegetation.

Many of the ditches are overgrown and difficult to see from the ground, although they appear clearly on aerial photographs, which aided in locating them in the field. The drainage system appears to retain good integrity, although most of the ditches are overgrown and difficult to discern. In addition, non-contributing elements have been introduced in the form of the four large flood gates at the corner of the Tillamook and Wilson Rivers, and the ten culverts/tide gates just south of those flood gates.

In keeping with the guidance provided in *Oregon Parks and Recreation Department Guidance for Recording and Evaluating Linear Cultural Resources* (SHPO 2013b), this system of drainage ditches was evaluated as a potential historic district. While the system is associated with the dairy culture of the area because it was used to drain the land to make it serviceable for cattle grazing and hay production (Criterion A), the drainage system is not significant or unique; the creation of drainage ditches is common practice in the area and more intact examples exist. Research did not indicate any association with significant persons (Criterion B), and the property does not possess any architectural or engineering significance (Criterion C). The drainage system represents a typical example and the materials and construction method do not convey important information contributing to the understanding of history or prehistory (Criterion D). The drainage system is recommended as not eligible for listing in the NRHP.

Photo 12: Drainage Ditch - View to North

Photo 13: 2008 Flood Control Structure - View to Southwest

6.1.4 System of Levees

A system of levees exists along the rivers and sloughs in the project area. Some of these are man-made and some are naturally formed and then enhanced by man. Exact construction dates for these flood management structures are unknown, but construction may have begun as early as the late 1800s and continued through the 1960s (Jones et al. 2012, Koontz 2014). Levees at the mouth of the Wilson and Trask Rivers were built in 1896 and 1901 by the US Army Corps of Engineers (USACE) and then improved in the 1930s and again in the 1950s (Jones et al 2012, Koontz 2014). Other levees, such as the one along Blind Slough, were added in the 1960s (Koontz 2014).

Photo 14: Hall Slough levee - View Southeast from Goodspeed Road

The levees are not uniform in size, although all are earthen structures (**Photo 15**). Some have dirt or graveled roads that run along the side or on the top and some do not. Some are pierced by culverts with tide gates at various points within the project area, but not all. For example, the Trask River levee has a culvert at the Nolan Slough, but the Hall Slough has a levee along the west side for much of the project area with no tide gates or culverts piercing it. Some structures were built for wide-ranging protection by keeping the Tillamook and Trask Rivers in their channels and preventing wide-spread flooding, while others were built only to protect a specific piece of acreage from rising water. Nearly all of the flood management structures in the project area have undergone late twentieth and early twenty-first century repairs and alterations (Jones et al. 2012).

Photo 15: Levee Along Trask River at Nolan Slough - View Southeast

Despite their differences, these flood management structures operate as a system to control the intrusion of water into the APE. This system of levees was evaluated as a potential historic district.

Levees were vital to drying out the land in the APE and allowing agriculture and settlement to occur. Without a system of levees, the early development of the area would have been much more limited. Seasonal inundation and frequent tidal flooding made much of the land unusable for crops, cattle, or homes. Thus the levee system was essential to the development of the area (Criterion A).

However, the system of levees has been significantly altered over the years, as have the individual structures. Little of the original or early versions of the structures are visible, and many are deteriorated and overgrown. Additionally, non-contributing elements have been introduced in the form of newer levees and/or have had newer structures embedded in them such as flood gates. Many structures have been made taller and wider to combat rising water levels. Heavy vegetation has also changed the appearance of many of the structures; some are so overgrown as to be hardly visible. This woody vegetation not only changes the appearance of the levees but also alters their functionality.

Due to the relative simplicity of these structures, changes to their size, appearance, and functionality are significant. In their current condition, many of the levees in this system no longer visually convey their significance in the development of the area. They lack integrity of materials, design, feeling, and workmanship. Some also lack integrity of association where dairy farms no longer exist and log ponds have been filled in.

Research did not indicate any association with significant persons (Criterion B), and the levees do not illustrate architectural or engineering significance (Criterion C). The levees are typical in their construction; the materials and construction methods do not convey important information that could contribute to the understanding of history or prehistory (Criterion D).

Although these levees are associated with the development of the area, they no longer retain sufficient integrity of materials, design, feeling, workmanship, and in some cases, association. The system of levees in the APE is recommended as not eligible for listing in the NRHP.

6.2 Archaeological Survey

No pre-contact artifacts or features were observed on the surface or in any of the STUs. None of the 11 STUs placed in the possible vicinity of the Tow-er-quot-ton ethnographic village site contained any pre-contact materials. Additional geotechnical borings (see below) further support the conclusion that this is an unlikely location for Tow-er-quot-ton.

At the time of the field survey, archaeological sites 35TI109, 35TI110, and isolate 30662-IF-1 had not been recorded and registered with Oregon SHPO. The simultaneous additional recording of the mills associated with the former Tillamook Spruce Veneer Company (35TI109) and the Aberdeen Plywood Company (35TI110) is provided as updates to the site records prepared by Blake (2014b, 2014c). Update forms are provided in Appendix C.

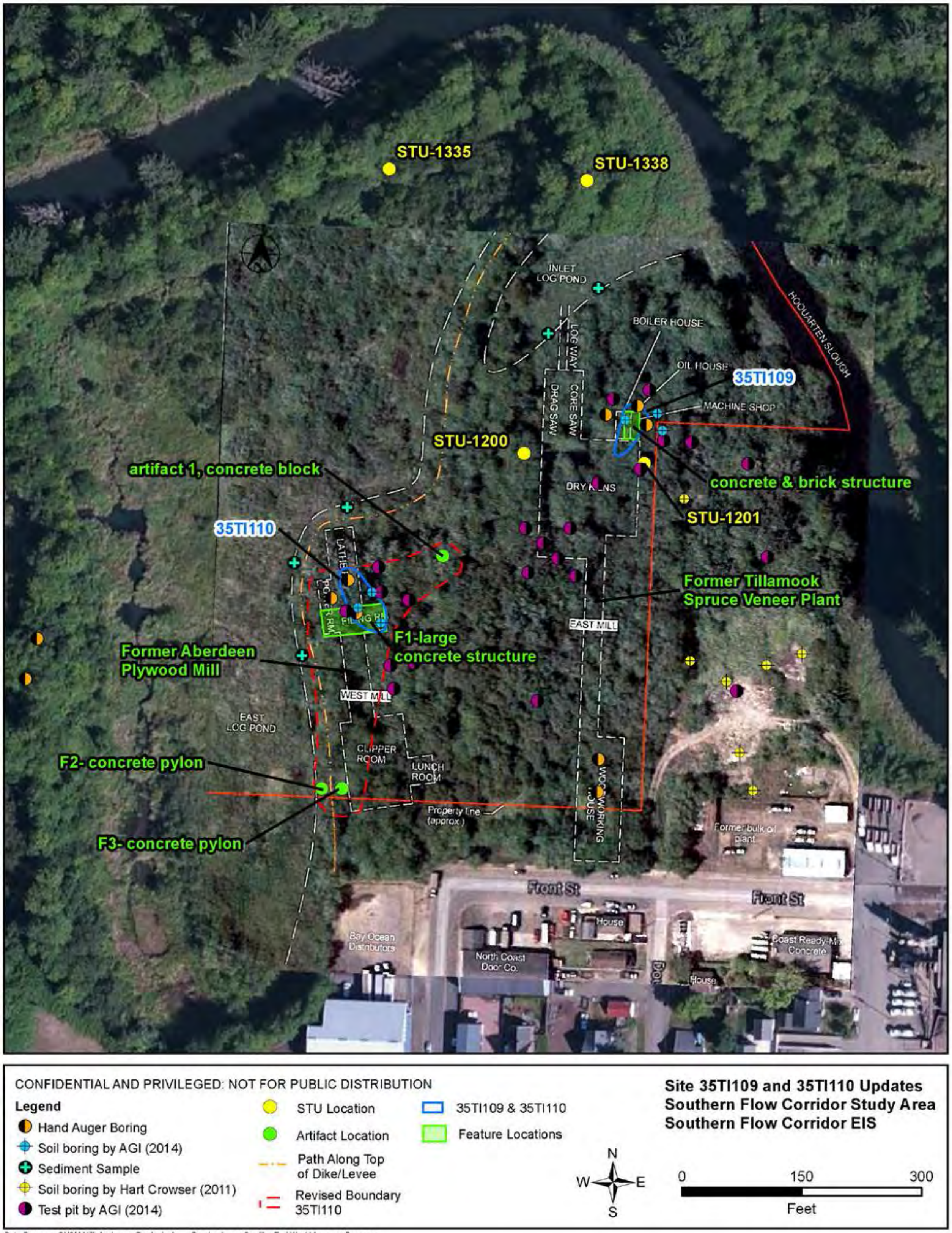
In addition to these sites, the survey recorded one additional historic isolate, I-1. This item, is an abandoned piece of farm machinery, possibly a hay rake. It is located in the southern part of the APE next to a hay field access road on the north side of the Tillamook River. An Oregon State Archaeological Isolate Recordation Form has been completed for this resource (Appendix C).

6.3 Geotechnical Boring

In addition to the archaeological research, geotechnical borings and a test pit were excavated by Anderson Geological, Inc. at the location of the former Tillamook Spruce Veneer Company and the Aberdeen Plywood Company Mill in 2011, 2013, and 2014 (Anderson Geological, Inc. 2014). These locations are also the reported location of ethnographic village Tow-er-quot-ton. Archaeological investigation in this area was hampered by dense vegetation and occasionally by standing water. The geotechnical excavations provided additional viewing of subsurface soils. Thirty-seven bores and test pits were excavated in the property to depths between 1.2 feet below ground surface and 9 feet below surface (Anderson Geological, Inc. 2014) (**Figure 7**). The results of the bores are described in Appendix D. Fill was described in 27 of the 37 bores, of which 19 contained wood chips or other woody debris. Of the 12 bores that did not contain wood debris fill, five were located in former mill ponds, five were within or adjacent to the footprint of the former Tillamook Spruce Veneer Company or Aberdeen Plywood Mill, and one was located near Hoquarten Slough.

6.4 Site 35TI109

The site contains the remnants of the former Tillamook Spruce Veneer Company's facility (**Figure 7** and **Figure 8**). The site is heavily vegetated, with blackberries encroaching on most areas. Other vegetation includes sword fern, bear grass, salmonberry, English ivy, elderberry, various grasses, alder, and big leaf maple. Several semi-maintained trails run through the site. Modern debris including camping gear, tires, bottles, cans, and other transient discards litter the area. Modern concrete debris from a nearby cement factory was also observed.



Data Sources: CH2M Hill, Anderson Geological Service Layer Credits: Esri World Imagery Basemap

Figure 7. Boring Locations Near Sites 35TI109 and 35TI110

This site is characterized by the presence of a rectangular concrete foundation with four protruding concrete footings and partial brick walls above part of the foundation (**Photo 16** and **Photo 17**). It measures approximately 22 feet by 10 feet. The foundation includes an east/west bisecting segment. The brick wall is approximately 13 inches thick and rises no farther than 3 feet above the foundation. This feature is likely the partial remnants of either the Boiler House or Oil House/Machine building. Two STUs (1200 and 1201) were excavated to the south and west of the site. STU 1200 contained no cultural materials. STU 1201 was further augered to 135 cm. Between the surface and 55 cm below surface, woody debris and a piece of tarpaper and a glass fragment from a lamp or light bulb of undetermined age were found.

6.5 35TI110

The site boundary is defined by three features and one artifact that were observed during the archaeological survey. The complete footprint of the mill and associated log ponds was not included because no evidence of these was noted on the surface, in the STUs that were excavated in the area, or in any of the geotechnical bores placed in the vicinity.

Small exposed patches of ground that were observed approximately 30 feet southeast of Feature 1 contained broken industrial glass, light bulbs, and sheet metal fragments. Two STUs (STU 1335, 1338) were placed in the site vicinity to determine if intact buried deposits were present (**Figure 7** and **Figure 8**). No cultural material was observed in these STUs.

The site boundary is expanded from those recorded previously (Blake 2014c) to include additional artifacts and features observed to the north and south of the original site boundary.

6.5.1 Artifact 1

Artifact 1 is a large rectangular concrete cap or slab with a metal loop and single bolt protruding from the top (**Photo 18**) that was observed in a foot trail northeast of Feature 1 (see **Figure 7**). The cap measures 2 feet 6 inches on each side and is approximately 6 inches thick.

6.5.2 Feature 1

Feature 1 is a large, partially demolished concrete structure. It likely represents the partial footprint of the Tillamook Spruce Veneer Company's area where the Lathe Room, Power Room, and Filing Room meet (**Figure 7**). The feature is comprised of board-formed concrete walls reinforced with embedded metal rebar. The south wall measures 28 feet long by 9 feet tall, the west wall is 12 feet, 9 inches long by 12 feet, 6 inches tall, and the east wall is 10 feet, 8 inches long by 9 feet tall. Three concrete abutments protrude from the lower portion of the southern wall approximately 1 foot above ground surface (**Photo 19** through **Photo 23**). Three similar abutments protrude from the north wall, at a height of 5 feet above ground surface. These abutments appear to be supports or structural mounts.

Figure 8. Archaeological Site Locations 35TI109 and 35TI110

Photo 16. South Side of Feature 4 with Footing Shown at Arrow - View to the Northeast

Photo 17. Northern Part of Feature 4 with Remnant Brick Wall Shown in the Center - View to the West

6.5.3 Feature 2

Feature 2 is a conglomerate concrete pad and pylon overgrown with moss located on the west side of the overgrown asphalt road. The pad measures approximately 4 feet by 4 feet. The concrete pylon is a tapered rectangle approximately 20 inches by 20 inches at the base and 3 feet tall (**Photo 24** and **Photo 25**).

6.5.4 Feature 3

Feature 3 is a conglomerate concrete pylon overgrown with moss, similar to Feature 2 in size, although partially buried (**Photo 26**). At its base, it is approximately 18 inches by 18 inches. It is 20 inches tall and tapers to 12 inches by 12 inches at its top. Feature 2 and Feature 3 are found adjacent to an overgrown paved road.

6.5.5 Sadri-East Environmental Contamination Investigation

Subsequent to the cultural resource investigations conducted for the SFC project, soil and sediment contamination investigations were conducted in the vicinity of sites 35TI109 and 35TI110. . The excavation of 20 test trenches within the Sadri East Parcel was monitored by a cultural resources specialist engaged by Tillamook County to observe the soil testing. The test trenches measured approximately 1 m (3.3 feet) wide by 2 m (6.6 feet) long, and were excavated to a maximum depth of 2.3 meters (7.5 feet below surface). It is this monitoring that resulted in the recording of the archaeological remnants of the Tillamook Spruce Veneer facility (35TI109), the Aberdeen Plywood Company Mill (35TI110), and an historic era archaeological isolate (30662-IF-1) ((Blake 2014b, Blake 2014c). No indications of pre-contact era resources were encountered.

6.6 Isolate I-1

Isolate I-1 is a piece of abandoned farm machinery located near the southern boundary of the project area along the north bank of the Tillamook River. It is adjacent to a graveled road used to access hay fields. The isolate consists of a single farm implement of unknown origin, possibly part of a hay rake or mower (**Photo 27**). The implement is made of corroded iron, including axels, spokes, and wheels. Half of one of the wheels is severely bent and deformed. A portion of a metal chain drive was found attached to the axel. Isolate I-1 appears to be missing several component parts and no manufacturer’s marks were found, and for these reasons the precise age and function could not be determined. However, the iron wheels and overall morphology indicate that it was not powered by an internal combustion engine and may have been horse- or tractor-drawn, thus dates to the historic era.

6. Isolate 30662-IF-1

This previously recorded isolate was not relocated during field investigations.

Photo 18. Artifact 1, Concrete Slab or Cap With Metal Eyelet

Photo 19. North Wall of Feature 1 - View to the Southwest

Photo 20. Northwest corner of Feature 1 - View to the Southeast

Photo 21. South Wall of Feature 1 with Abutments Near the Ground Surface - View to the North

Photo 22. Abutments on the North Wall of Feature 1 - View to the East

Photo 23. Abutment on South Wall of Feature 1 - View to the North

Photo 24. Feature 2 –View to the West

Photo 25. Feature 2 - Pylon

Photo 26. Feature 3, Partially Buried - View to the Northwest

Photo 27. Isolate I-1: A Farm Implement - Wheel in Foreground is Damaged - View to the East

SECTION 7 Conclusions

7.1 Built Environment

The inventory for the built environment resulted in the recordation of five historic era properties as summarized below.

The Jones House at 590 Goodspeed Road includes a ca. 1914 Arts and Crafts style residence and a series of interconnected agricultural buildings constructed beginning in 1950. The house and agricultural buildings have been extensively altered and no longer appear to be a working dairy farm. The buildings are recommended not eligible for listing in the NRHP because, as previously discussed; they lack integrity of design, materials, workmanship, and association, and thus do not convey any significance under Criterion A for association with the dairy industry, or Criterion C for architecture.

The Diamond F House at 355 Goodspeed Road was constructed in 1965 as a part-time second home. The Diamond F House is recommended not eligible for listing in the NRHP. It is not associated with the significant history of the area (agricultural/dairy or timber). Research did not indicate association with any significant persons. The house is not architecturally distinctive and has had several alterations. It represents a typical house of the mid-twentieth century, and the materials and construction methods do not convey important information contributing to the understanding of history or prehistory (Criterion D).

A system of drainage ditches including four concrete floodgates and 10 gated culverts is located at the west end of the APE with an approximate construction period of ca. 1940s. The drainage system is recommended not eligible for listing in the NRHP as it does not meet any of the NRHP criteria. While the system is associated with the dairy culture of the area because it was used to drain the land to make it serviceable for cattle grazing and hay production (Criterion A), the drainage system is not significant or unique; the creation of drainage ditches is common practice in the area and more intact examples exist. Research did not indicate any association with significant persons (Criterion B), and the property does not possess any architectural or engineering significance (Criterion C). The drainage system is not unique and the materials and construction method do not convey important information contributing to the understanding of history or prehistory (Criterion D).

A system of levees exists along the rivers and sloughs within the APE. These features were constructed as early as the late 1800s and into the 1960s. This system of levees is recommended not eligible for listing in the NRHP. Although it is associated with the development of the area (Criterion A), it no longer retains sufficient integrity of materials, design, feeling, workmanship, and in some cases, association.

7.2 Archaeological Sites

The archaeological survey of the APE identified two previously recorded historic era archaeological sites (35TI109 and 35TI110) and one historical isolate (I-1). Previously recorded archaeological isolate 30662-IF-1 was not located during this investigation. Site update forms and an isolate form are appended to this document in Appendix C. No pre-contact sites or isolated finds were observed on the surface or in any of the 115 STUs.

Site 35TI109 is the remains of the former Tillamook Spruce Veneer Company's mill. The site consists of the in-ruin remnant of a brick and concrete foundation feature. The site was recommended not eligible for listing in the NRHP (Blake 2014a).

Site 35TI110 is the archaeological remnant of the former Aberdeen Plywood Company Mill. This investigation's site update identified three features and a single artifact. Features 1 through 3 are the only structural remnants of the former mill. No other parts of this facility were observed and it appears that the rest of the structures have been thoroughly demolished and removed.

Although the Tillamook Spruce Veneer Company's mill and the Aberdeen Plywood Company Mill became a complex of structures over time, they do not qualify either as an industrial archaeological district or as resources eligible for listing in the NRHP. "In archeological districts, the primary factor to be considered is the effect of any disturbances on the information potential of the district as a whole" (National Park Service 1997:4). For over 60 years the former mills and their environs have been significantly disturbed by their dismantling and removal, as well as the filling of their associated logs ponds. It is highly unlikely that any intact, buried remains of the mills are extant, as indicated by the results of the STUs and the geotechnical boring in the vicinity (Anderson Geological Inc. 2014).

Additionally, "a district must be significant, as well as being an identifiable entity. It must be important for historical, architectural, archeological, engineering, or cultural values" (National Park Service 1995:5). The location of the former Aberdeen Plywood Company Mill (35TI110) and the Tillamook Spruce Veneer mill (35TI109), and any buried physical remnants, if present, are not considered eligible for listing in the NRHP. As noted earlier in this report, Tillamook County did not lack for lumber mills during the time these mills were in operation. They represent two of many such industries that flourished between the turn of the twentieth century and the late 1950s. No evidence has been found to suggest that either facility was unique in construction, function, or technology. It is highly unlikely that any part of the mills that might be intersected by project construction activities would yield information concerning the history of the mills themselves or of Tillamook in general beyond what has already been documented in the historic record. All readily available and pertinent information regarding the mills was collected during the survey and the literature, cartographic, and photographic review, and its information potential has been exhausted.

The location and physical remains of these mills are recommended as not eligible for listing in the NRHP. No further archival or archaeological work is recommended for sites 35TI109 and 35TI110, the former Tillamook Spruce Veneer Company's mill and the Aberdeen Plywood Company Mill, respectively.

[REDACTED in accordance with federal (Section 304 54 U.S.C. 470w-3a NHPA) and Oregon Revised Statute [192.501 (11)] laws pertaining to confidentiality of cultural resources locations.] … the area surrounding the purported location of Tow-er-quot-ton has been extensively modified [REDACTED in accordance with federal (Section 304 54 U.S.C. 470w-3a NHPA) and Oregon Revised Statute [192.501 (11)] laws pertaining to confidentiality of cultural resources locations.] This does not seem to be a likely location for an ethnographic village. Nevertheless the potential that a remnant of an ethnographic village may remain extant in this area cannot be entirely discounted. Given the potential significance of such a resource, archaeological monitoring is recommended for earth moving activities conducted within the area identified as the potential location of Tow-er-quot-ton. Prior to construction, an Inadvertent Discovery Plan (IDP) should be prepared that outlines procedures and contacts in the event of a discovery during construction activities.

The remainder of the APE was likely utilized for a variety of resource procurement activities by pre-contact populations but was in general found to be largely unsuitable for archaeological sites of the type that are most likely to be discovered with archaeological surveys. Field surveys found almost the entire APE subject to seasonal or tidal inundation with no significantly higher ground that might have provided more suitable locations for the prolonged or repeated uses that are now reflected as archaeological sites. No National Register eligible historic properties were identified or recorded during cultural resources surveys. Therefore, implementation of the SFC project is deemed to have no effect on historic properties.

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Appendix A: Agency and Tribal Coordination

U.S. Department of Homeland Security
Region X
130 228th Street, SW
Bothell, WA 98021-9796

FEMA

February 4, 2014

Roger Roper
Deputy State Historic Preservation Officer
Oregon Parks and Recreation Department
725 Summer Street NE, Suite C
Salem, Oregon 97301-0707

Re: FEMA 1733 DR OR Public Assistance Grant Program;
Southern Flow Corridor Project, Port of Tillamook Bay
NHPA Section 106 Lead Agency Notification

Dear Mr. Roper:

Please consider this notice that the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) proposes to fund the Port of Tillamook Bay (POTB), through Oregon Emergency Management (OEM), for a large flood mitigation and estuarine restoration project (Undertaking); and that it will be the lead federal agency for Section 106 compliance. Funding is available from FEMA's Public Assistance Grant Program, disaster declaration 1733 DR OR from 2007. The proposed Undertaking is being reviewed pursuant to the ongoing FEMA/Oregon Programmatic Agreement (Agreement) among FEMA, your office, and OEM; executed in accordance with Section 106 of the National Historic Preservation Act. Although POTB is FEMA's grant applicant, Tillamook County is also sponsoring the Undertaking with funds from the National Oceanic and Atmospheric Administration's Restoration Center (NOAA) and U.S. Fish and Wildlife Service (USFWS) as well as from other State and local sources. The U.S. Army Corps of Engineers (USACE) will be providing Clean Water Act permitting for the project. Because multiple federal agencies have a nexus in this Undertaking, FEMA has coordinated with National Oceanic and Atmospheric Administration (NOAA), USFWS, and USACE and it has been determined FEMA will be the lead agency for Section 106 compliance, including Tribal consultation, because it is providing the most federal assistance for the Undertaking. FEMA will work collaboratively with NOAA, USFWS, and USACE, as well as other project stakeholders, throughout the consultation process. Furthermore, FEMA will be the lead agency for an Environmental Impact Statement that will be prepared for the project per the National Environmental Policy Act.

The proposed Undertaking encompasses over 600 acres and is generally located northwest of Tillamook and between the Wilson and Trask Rivers, where they discharge into Tillamook Bay. The Undertaking has multiple elements that include: property acquisition; removing some existing levees, floodgates, and roads; lowering some levees; building new tidal setback levees with floodgates; improving hydraulic connectivity between sloughs; and improvements to existing drainage ditches. Once the Undertaking's specific activities are better defined in terms of delineating the Area of Potential Effects, we will consult with your office as well as affected Tribes, on an appropriate identification and evaluation approach for this large project. In the interim, should you have any questions, please contact Ms. Science Kilner, Deputy Regional Environmental Officer at (425) 487-4713 or science.kilner@fema.dhs.gov. Thank you.

Sincerely,

Mark G. Eberlein
Regional Environmental Officer

Email cc: Julie Slevin, OEM
Jen Steger, NOAA
Michael Turaski, USACE
Amy Horstman, USFWS
Sarah Bielski, USFWS
Michelle Bradley, POTB
Paul Levesque, Tillamook County

SK:bb

U.S. Department of Homeland Security
Region X
130 228th Street, SW
Bothell, WA 98021-9796

FEMA

February 4, 2014

Honorable Reyn Leno
Chairman, Confederated Tribes of the Grand Ronde Community of Oregon
9615 Grand Ronde Road
Grand Ronde, Oregon 97347

Re: FEMA 1733 DR OR Public Assistance Grant Program;
Southern Flow Corridor Project, Port of Tillamook Bay
NHPA Section 106 Lead Agency Notification

Dear Chairman Leno:

Please consider this notice that the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) proposes to fund the Port of Tillamook Bay (POTB), through Oregon Emergency Management (OEM), for a large flood mitigation and estuarine restoration project (Undertaking); and that it will be the lead federal agency for Section 106 compliance. Funding is available from FEMA's Public Assistance Grant Program, disaster declaration 1733 DR OR from 2007. The proposed Undertaking is being reviewed pursuant to Section 106 of the National Historic Preservation Act. Although POTB is FEMA's grant applicant, Tillamook County is also sponsoring the Undertaking with funds from the National Oceanic and Atmospheric Administration's Restoration Center (NOAA) and U.S. Fish and Wildlife Service (USFWS) as well as from other State and local sources. The U.S. Army Corps of Engineers (USACE) will be providing Clean Water Act permitting for the project. Because multiple federal agencies have a nexus in this Undertaking, FEMA has coordinated with NOAA, USFWS, and USACE and it has been determined FEMA will be the lead agency for Section 106 compliance because it is providing the most federal assistance for the Undertaking. FEMA will work collaboratively with NOAA, USFWS, and USACE, as well as other project stakeholders, throughout the consultation process. Furthermore, FEMA will be the lead agency for an Environmental Impact Statement that will be prepared for the project per the National Environmental Policy Act.

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Sincerely,

for Mark G. Eberlein
Regional Environmental Officer

Email cc: Eirik Thorsgard, Grand Ronde Tribe
Julie Slevin, OEM
Jen Steger, NOAA
Michael Turaski, USACE
Amy Horstman, USFWS
Sarah Bielski, USFWS
Michelle Bradley, POTB
Paul Levesque, Tillamook County

SK:bb

U.S. Department of Homeland Security
Region X
130 228th Street, SW
Bothell, WA 98021-9796

FEMA

February 4, 2014

Honorable Delores Pigsley
Chairman, Confederated Tribes of Siletz Indians
201 SE Swan Avenue
PO Box 549
Siletz, Oregon 97380

Re: FEMA 1733 DR OR Public Assistance Grant Program;
Southern Flow Corridor Project, Port of Tillamook Bay
NHPA Section 106 Lead Agency Notification

Dear Chair Pigsley:

Please consider this notice that the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) proposes to fund the Port of Tillamook Bay (POTB), through Oregon Emergency Management (OEM), for a large flood mitigation and estuarine restoration project (Undertaking); and that it will be the lead federal agency for Section 106 compliance. Funding is available from FEMA's Public Assistance Grant Program, disaster declaration 1733 DR OR from 2007. The proposed Undertaking is being reviewed pursuant to Section 106 of the National Historic Preservation Act. Although POTB is FEMA's grant applicant, Tillamook County is also sponsoring the Undertaking with funds from the National Oceanic and Atmospheric Administration's Restoration Center (NOAA) and U.S. Fish and Wildlife Service (USFWS) as well as from other State and local sources. The U.S. Army Corps of Engineers (USACE) will be providing Clean Water Act permitting for the project. Because multiple federal agencies have a nexus in this Undertaking, FEMA has coordinated with NOAA, USFWS, and USACE and it has been determined FEMA will be the lead agency for Section 106 compliance because it is providing the most federal assistance for the Undertaking. FEMA will work collaboratively with NOAA, USFWS, and USACE, as well as other project stakeholders, throughout the consultation process. Furthermore, FEMA will be the lead agency for an Environmental Impact Statement that will be prepared for the project per the National Environmental Policy Act.

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Sincerely,

Mark G. Eberlein
Regional Environmental Officer

Email cc: Robert Kentta, Siletz Tribe
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Amy Horstman, USFWS
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Michelle Bradley, POTB
Paul Levesque, Tillamook County

SK:bb

Oregon
John A. Kitzhaber, MD, Governor

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Oregon State Parks
Nature
HISTORY
Discovery

February 18, 2014

Mr. Mark Eberlein
FEMA Region X
130 228th SW
Bothell, WA 98021-9796

RE: SHPO Case No. 14-0197
Southern Flow Corridor Project

Dear Mr. Eberlein:

The Oregon SHPO appreciates FEMA contacting our office at the earliest stages of the proposed Southern Flow Corridor Project for the Port of Tillamook Bay under the previously signed Programmatic Agreement between our offices and Oregon Emergency Management. We look forward to continuing consultation on this project, including finalization of the Area of Potential Effects, identification and evaluation of historic resources, and mitigation of any adverse effects, should that be necessary.

Given the potential scope of the project, the Southern Flow Corridor Project has been assigned a separate SHPO case number, referenced above. Please use this number in all correspondence with our office to expedite service.

Please contact me with any further questions, comments, or concerns.

Sincerely,

Ian P. Johnson, M.A.
Historian
(503) 986-0678
ian.johnson@oregon.gov

U.S. Department of Homeland Security
Region X
130 228th Street, SW
Bothell, WA 98021-9796

FEMA

June 2, 2014

Honorable Reyn Leno
Chairman, The Confederated Tribes of Grand Ronde
9615 Grand Ronde Road
Grand Ronde, Oregon 97347

Re: FEMA 1733 DR OR Public Assistance Grant Program;
Southern Flow Corridor Project, Port of Tillamook Bay
NHPA Section 106 Research Design and Area of Potential Effect (APE)

Dear Chairman Leno:

Please consider this follow-up to our February 4, 2014, letter notifying you that the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) will be the lead agency for Section 106 review of the above project. FEMA proposes to fund the Port of Tillamook Bay (POTB), through Oregon Emergency Management (OEM), for a large flood mitigation and estuarine restoration project (Undertaking). The proposed Undertaking encompasses over 600 acres and is generally located northwest of Tillamook and between the Wilson and Trask Rivers, where they discharge into Tillamook Bay. The Undertaking has multiple elements that include: property acquisition; removing some existing levees, floodgates, and roads; lowering some levees; building new tidal setback levees with floodgates; improving hydraulic connectivity between sloughs; and improvements to existing drainage ditches.

In preparation for the required survey, FEMA's contractor, CH2M Hill, has prepared a Cultural Resources Research Design with the Area of Potential Effects (APE). CH2M Hill is in the process of securing the required survey permits through the Oregon State Historic Preservation Office. We respectfully request the Tribe's review of the enclosed research design and APE to further inform identification and evaluation effort of historic properties that may be of cultural and religious interest to the Tribe. FEMA recognizes that whether you provide comments or decline to at this time, this does not preclude future opportunities to comment. At the Tribe's request, information you might provide to FEMA will be kept confidential. This information will assist FEMA in determining potential project impacts.

Once the survey is complete, a detailed report with findings will be sent to the Tribe for comment. In the interim, should you have any questions, please contact Ms. Jessica M. Stewart, Historic Preservation Specialist at (425) 487-4582 or jessica.stewart2@fema.dhs.gov. Thank you.

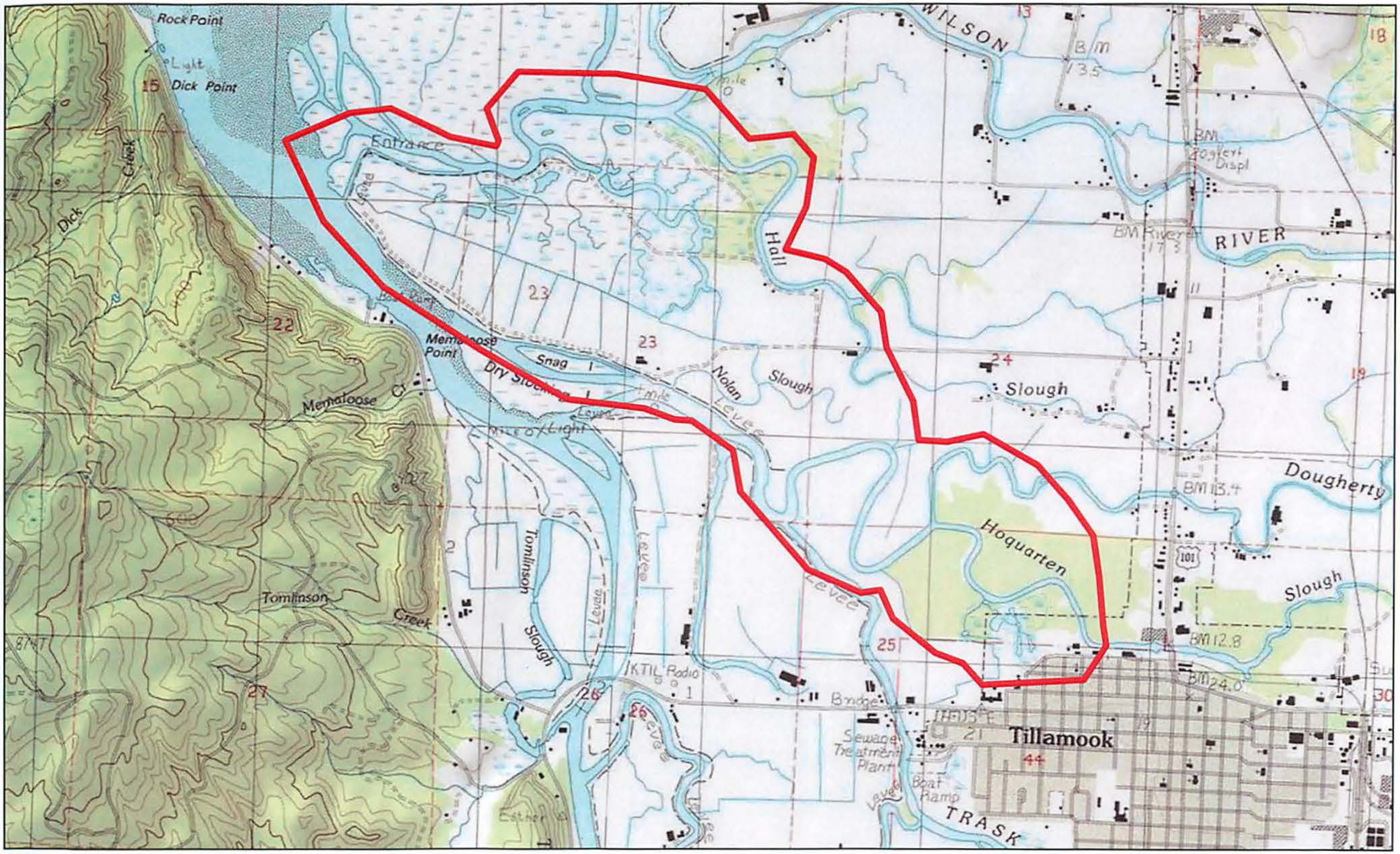
Sincerely,

Mark G. Eberlein
Regional Environmental Officer

Enclosures

SK:bb

Email cc: Eirik Thorsgard, Grand Ronde Tribe



CONFIDENTIAL AND PRIVILEGED: NOT FOR PUBLIC DISTRIBUTION

Legend

Area of Potential Effects

N W E S

0 0.25 0.5 1

Miles

Cultural Resources: Area of Potential Effects
Southern Flow Corridor EIS

Data Sources: CDM Smith, NHC   Service Layer Credits: © 2014 Esri, USGS

U.S. Department of Homeland Security
Region X
130 228th Street, SW
Bothell, WA 98021-9796

FEMA

June 2, 2014

Honorable Delores Pigsley
Chairman, Confederated Tribes of Siletz Indians
1322 N. Larchwood
Salem, Oregon 97303

Re: FEMA 1733 DR OR Public Assistance Grant Program;
Southern Flow Corridor Project, Port of Tillamook Bay
NHPA Section 106 Research Design and Area of Potential Effect (APE)

Dear Chairman Pigsley:

Please consider this follow-up to our letter of February 4, 2014, notifying you of the above project and that the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) will be the lead agency for Section 106 review. FEMA proposes to fund the Port of Tillamook Bay (POTB), through Oregon Emergency Management (OEM), for a large flood mitigation and estuarine restoration project (Undertaking). The proposed Undertaking encompasses over 600 acres and is generally located northwest of Tillamook and between the Wilson and Trask Rivers, where they discharge into Tillamook Bay. The Undertaking has multiple elements that include: property acquisition; removing some existing levees, floodgates, and roads; lowering some levees; building new tidal setback levees with floodgates; improving hydraulic connectivity between sloughs; and improvements to existing drainage ditches.

In preparation for the required survey, FEMA's contractor, CH2M Hill, has prepared a Cultural Resources Research Design with the Area of Potential Effects (APE) delineated. CH2M Hill is in the process of securing the required survey permits through the Oregon State Historic Preservation Office. We respectfully request the Tribe's review of the enclosed research design and APE to further inform identification and evaluation efforts for historic properties that may be of cultural and religious significance to the Tribe. FEMA recognizes that whether you provide comments or decline to at this time, this does not preclude future opportunities to comment. At your request, information you might provide to FEMA will be kept confidential. This information will assist FEMA in determining potential project impacts.

Once the survey is complete, a detailed report with findings will be sent to the Tribe for comment. In the interim, should you have any questions, please contact Ms. Jessica M. Stewart, Historic Preservation Specialist at (425) 487-4582 or jessica.stewart2@fema.dhs.gov. Thank you.

Sincerely,

Mark G. Eberlein
Regional Environmental Officer

Enclosures

SK:bb

Email cc: Robert Kentta, Siletz Tribe

U.S. Department of Homeland Security
Region X
130 228th Street, SW
Bothell, WA 98021-9796

FEMA

June 2, 2014

Roger Roper
Oregon State Historic Preservation Office
725 Summer Street NE
Salem, Oregon 97301

Re: SHPO Case No. 14-0197
Southern Flow Corridor Project, Port of Tillamook Bay
NHPA Section 106 Research Design and Area of Potential Effect (APE)

Dear Mr. Roper:

The U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) proposes to fund the Port of Tillamook Bay (POTB), through Oregon Emergency Management (OEM), for a large flood mitigation and estuarine restoration project (Undertaking). The proposed Undertaking encompasses over 600 acres and is generally located northwest of Tillamook and between the Wilson and Trask Rivers, where they discharge into Tillamook Bay. The Undertaking has multiple elements that include: property acquisition; removing some existing levees, floodgates, and roads; lowering some levees; building new tidal setback levees with floodgates; improving hydraulic connectivity between sloughs; and improvements to existing drainage ditches.

FEMA is the lead agency for an Environmental Impact Statement that will be prepared for the project per the National Environmental Policy Act (NEPA) and for the National Historic Preservation Act (NHPA), and will also work collaboratively with National Oceanic and Atmospheric Administration (NOAA), U.S. Fish and Wildlife Service (USFWS), and U.S. Army Corps of Engineers (USACE), as well as other project stakeholders. In preparation for the Section 106 survey, FEMA's contractor (CH2M Hill) has prepared a Cultural Resources Research Design with the Area of Potential Effects (APE) delineated. Please review the enclosed research design and APE and provide comment or concurrence as soon as practicable. Additionally, FEMA has requested comment from The Confederated Tribes of Siletz Indians of Oregon and The Confederated Tribes of the Grand Ronde Community of Oregon. CH2M Hill is currently gathering information for the archaeological permit application.

Once the survey is complete, a detailed report on findings will be prepared for your office, The Confederated Tribes of the Grand Ronde Community of Oregon, and The Confederated Tribes of Siletz Indians of Oregon. In the interim, should you have any questions, please contact Ms. Jessica M. Stewart, Historic Preservation Specialist at (425) 487-4582 or jessica.stewart2@fema.dhs.gov. Thank you.

Sincerely,

Mark G. Eberlein
Regional Environmental Officer

Enclosures

cc: Julie Slevin, OEM
Jen Steger, NOAA
Michael Turaski, USACE
Amy Horstman, USFWS
Sarah Bielski, USFWS
Michelle Bradley, POTB
Paul Levesque, Tillamook County

SK:bb

Oregon
John A. Kitzhaber, MD, Governor

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

June 20, 2014

Mr. Mark Eberlein
FEMA Region X
130 228th SW
Bothell, WA 98021-9796

RE: SHPO Case No. 14-0197
Southern Flow Corridor Project

Dear Mr. Eberlein:

The Oregon SHPO has reviewed the research design for the Southern Flow Corridor Project as it pertains to the identification and evaluation of above-ground historic resources. Generally, we find the plan to be well conceived, but recommend surveying all properties 45 years old or older to allow for potential project delays and to meet our office requirement that all properties 50 years old or older at the time the project is initiated be documented. Additionally, we ask that the contractor evaluate resources collectively as potential contributing resources to a larger historic district, as appropriate, in addition to considering the individual eligibility of each resource.

This letter pertains to above-ground historic resources only. A separate letter addressing archaeological resources will be sent separately. Please contact our office with any further questions, comments, or concerns.

Sincerely,

Ian P. Johnson, M.A.
Historian
(503) 986-0678
ian.johnson@oregon.gov

Oregon
John A. Kitzhaber, MD, Governor

Parks and Recreation Department
State Historic Preservation Office
725 Summer St NE, Ste C
Salem, OR 97301-1266
(503) 986-0671
Fax (503) 986-0793
www.oregonheritage.org

Nature
HISTORY
Discovery

June 24, 2014

RECEIVED
JUN 27 2014
FEMA REGION X

Mr. Mark Eberlein
FEMA Region X
130 228th SW
Bothell, WA 98021-9796

RE: SHPO Case No. 14-0197
Southern Flow Corridor Project
Flod mitigation and estuarine restoration project
FEMA
Hwy 101, Tillamook, Tillamook County

Dear Mr. Eberlein:

I have recently received a request from your office to review the research design for the project referenced above. Having read through the proposed research design with regards to archaeology I have a few comments to make regarding the approach taken. These include:

1: pg. 3 - List of Oregon Revised Statutes should be corrected or added to to include proper citation for ORS 358-905-961 (rather then only to -955) and add ORS 97.740-760.

2: pg. 3 - Guidelines for Conducting Field Archaeology in Oregon dates to November 2013 rather than 2007 date included in design.

3: pg. 6, 1st para. - Change date for field guidelines as noted above.

4: pg. 6, 2nd para. - High probability areas are usually based not only on the results of the surface survey but also on the results of background research, local geology and knowledge of changes to the local landscape over time. Geology, vegetation, land use history, degree of land modification; these all play a part of such a choice, especially in an area where wetland historic management practices could have changed the land's usability.

5. pg. 6, 3rd para. - Distance of STPs are recommended as being no greater than 20 meters apart. All levels in STPs should be no greater than 10cm.

6. pg. 7 - While the need for a permit when conducting any subsurface investigation on public land is noted, be sure to note that a permit is also needed when working within an identified site on private land. Your statement regarding artifacts taken from private land is fine, although I hope that the consulting archaeologists will recommend curation over private ownership. However, all artifacts slated to be returned to the landowner need to be retained for at least 30 days after the tribe is notified of their content to allow the appropriate tribes to notify the applicant if any sacred objects or objects of cultural patrimony have been found. If such artifacts have been identified, a process requesting repatriation of those artifacts needs to be followed before any artifacts are given to a requesting tribe. Such a process is outlined in SHPO

Guidelines (2013:62-63). A complete catalog of all artifacts should be considered part of the final report and shared with all parties outlined under the state's permitting guidelines.

Let me know if you have any questions regarding my above comments. In order to help us track your project accurately, please be sure to reference the SHPO case number above in all correspondence.

Sincerely,

Dennis Griffin, Ph.D., RPA
State Archaeologist
(503) 986-0674
dennis.griffin@oregon.gov

From:	GRIFFIN Dennis * OPRD
To:	Stewart, Jessica M; JOHNSON Ian * OPRD
Subject:	RE: SHPO Case No: 14-0197
Date:	Monday, August 04, 2014 8:14:42 AM

Jessica,

The project scope of work looks fine to me in regards to archaeology.

\ Dennis /

Dennis Griffin, Ph.D, RPA
State Archaeologist
Oregon State Historic Preservation Office
(503)986-0674
Dennis.Griffin@oregon.gov

Please note: My address has changed and it is now @Oregon.gov rather than the earlier @state.or.us.

From: Stewart, Jessica M [mailto:Jessica.Stewart2@fema.dhs.gov]
Sent: Friday, August 01, 2014 11:59 AM
To: JOHNSON Ian * OPRD; GRIFFIN Dennis * OPRD
Subject: SHPO Case No: 14-0197

Ok, the additional comments have been incorporated. Please let me know if you see anything else.

Have a great weekend.

Thanks,

Jessica M. Stewart
Environmental/Historic Preservation Specialist
FEMA Region X
130 228th Street SW
Bothell, WA 98021

425.487.4582 (O)
425.420.8040 (bb)

jessica.stewart2@fema.dhs.gov

U.S. Department of Homeland Security
FEMA Region X
Federal Regional Center
130 228th Street, SW
Bothell, WA 98021-8627

FEMA

March 11, 2015

Ms. Christine Curran
Interim Deputy State Historic Preservation Officer
Oregon Parks and Recreation Department
725 Summer Street NE
Salem, Oregon 97301

Re: SHPO Case No. 14-0197, Southern Flow Corridor Project, Port of Tillamook Bay, NHPA Section 106 Cultural Resources Survey

Dear Ms. Curran:

The U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) proposes to fund through Oregon Emergency Management (OEM) a large flood mitigation and estuarine restoration project (Undertaking) proposed by the Port of Tillamook Bay (POTB). The proposed Undertaking encompasses over 600 acres and is generally located northwest of the City of Tillamook between the Wilson and Trask Rivers, where they discharge into Tillamook Bay. The proposed Undertaking is being reviewed pursuant to the National Historic Preservation Act (NHPA).

Background
On December 8, 2007, Oregon received a Presidentially declared disaster (FEMA-1733-DR-OR) as a result of severe storms, flooding, landslides, and mudslides. Damaged facilities included a railroad line owned by POTB. The POTB Commissioners determined that the public would not be best served by repairing the damaged railroad line and requested funding to develop alternate projects to better serve the community.

The Tillamook Valley has a history of severe repetitive flooding with widespread damage to property, road closures, and economic losses. In addition, several fish and wildlife species that historically depended on the wetland, tidal marsh, and aquatic habitats of the estuary were listed as threatened or endangered on the Endangered Species List. One of the POTB alternate projects is the Tillamook Bay Southern Flow Corridor project. Its purpose is to reduce life safety risk from floods, reduce damages to property and other economic losses from floods, while also contributing to the restoration of habitat for federally listed Oregon Coast coho, and other native fish and wildlife species. Not only are these species important for commercial and sport fishing, but are also an important cultural resource to the Confederated Tribes of the Grand Ronde and the Confederated Tribes of the Siletz.

Because of the project's scale and other factors, an Environmental Impact Statement (EIS) is being prepared, per the National Environmental Policy Act. FEMA is the lead agency for the EIS and for the NHPA, and is working collaboratively with other federal agencies and project stakeholders who

are providing funding and or permitting for various aspects of the project. FEMA provided your office notification of our lead agency role on February 4, 2014.
Concurrent with FEMA's cultural resource investigation for the EIS, Tillamook County hired a consultant to conduct archaeological monitoring as part of a site investigation for two historic veneer mills and other commercial operations at properties located on the western end of downtown Tillamook (commonly referred to as the Sadri property). The investigation focused on soil and sediment sample collections to measure the extent of contamination from those historic mills. SWCA Environmental Consultants conducted the archaeological monitoring and provided a full report (Case No: 14-1406) to the State Historic Preservation Officer (SHPO). Conducted in September 2014, the investigation did not identify any resources eligible for listing in the National Register of Historic Places. However, the report does recommend archaeological monitoring during future environmental remediation work on the Sadri property.

Proposed Undertaking
The proposed Undertaking encompasses over 600 acres and has multiple elements that may include: property acquisition; removing some existing levees, floodgates, and roads; lowering some levees; building new tidal setback levees with floodgates; improving hydraulic connectivity between sloughs; and improvements to existing drainage ditches. Although the final design will depend on the outcome of the EIS process the affected geographic area is not expected to change.

Area of Potential Effects
The Area of Potential Effects (APE) for the Undertaking is illustrated on Figure 1 in the enclosed report. The APE is generally located northwest of Tillamook between the Wilson and Trask Rivers, where they discharge into Tillamook Bay. FEMA submitted the research design and APE to your office on June 2, 2014.

Historic Property Identification and Evaluation
FEMA sent consultation requests to your office, the Confederated Tribes of the Grand Ronde and the Confederated Tribes of the Siletz Indians to determine if there are any historic properties of religious or cultural significance within the APE. Grand Ronde Archaeologists Dustin Kennedy and Briece Edwards responded to our APE determination, which further informed our research design and subsequent fieldwork. In fact, they conducted a field visit on August 20, 2014. Your office concurred with the proposed research design for this evaluation and issued archaeological permits (1947 and 1976) on August 11, 2014. The enclosed cultural resources report, prepared for FEMA by CCPRS (a joint venture between CH2M Hill and CDM Smith), describes results from the identification and evaluation efforts.

Determination of Effects
The cultural resources survey identified no historic properties that would be impacted by the proposed Undertaking. However, archaeological monitoring is recommended for earth moving activities conducted within the area identified as a potential location of Tow-er-quot-ton, a known tribal village. While a discovery is unlikely in the area, the survey was not able to rule out the potential existence of a village.

Based on identification and evaluation efforts to date, FEMA determined that the proposed Undertaking will result in No Historic Properties Affected. Prior to construction, an Inadvertent

Discovery Plan (IDP) will be prepared that outlines procedures and contacts in the event of a discovery during construction activities. Additionally to further protect historic properties, and in keeping with SHPO's concurrence with SWCA's determination regarding archaeological monitoring during future environmental remediation, FEMA will require an archaeological monitor during earth moving activities within the area identified as the potential location of Tow-er-quot-ton.

To assist your review is enclosed a hardcopy and CD of the cultural resources report. We respectfully request your concurrence with these findings or additional comment. Should you have any questions please contact Ms. Jessica M. Stewart at (425) 487-4582 or jessica.stewart2@fema.dhs.gov. Thank you.

Sincerely,

Mark G. Eberlein
Regional Environmental Officer

Enclosures

cc: Julie Slevin, OEM
Jen Steger, NOAA
Michael Turaski, USACE
Amy Horstman, USFWS
Sarah Bielski, USFWS
Michelle Bradley, POTB
Paul Levesque, Tillamook County

U.S. Department of Homeland Security
FEMA Region X
Federal Regional Center
130 228th Street, SW
Bothell, WA 98021-8627

FEMA

March 11, 2015

Honorable Reyn Leno
Chairman, Confederated Tribes of the Grand Ronde Community of Oregon
9615 Grand Ronde Road
Grand Ronde, Oregon 97347

Re: FEMA 1733 DR OR Public Assistance Grant Program, Southern Flow Corridor Project, Port of Tillamook Bay, NHPA Section 106 Cultural Resources Survey

Dear Chairman Leno:

The U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) proposes to fund through Oregon Emergency Management (OEM) a large flood mitigation and estuarine restoration project (Undertaking) proposed by the Port of Tillamook Bay (POTB). The proposed Undertaking encompasses over 600 acres and is generally located northwest of the City of Tillamook between the Wilson and Trask Rivers, where they discharge into Tillamook Bay. The proposed Undertaking is being reviewed pursuant to the National Historic Preservation Act (NHPA).

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The Tillamook Valley has a history of severe repetitive flooding with widespread damage to property, road closures, and economic losses. In addition, several fish and wildlife species that historically depended on the wetland, tidal marsh, and aquatic habitats of the estuary were listed as threatened or endangered on the Endangered Species List. One of the POTB alternate projects is the Tillamook Bay Southern Flow Corridor project. Its purpose is to reduce life safety risk from floods, reduce damages to property and other economic losses from floods, while also contributing to the restoration of habitat for federally listed Oregon Coast coho, and other native fish and wildlife species. Not only are these species important for commercial and sport fishing, but are also an important cultural resource to the Confederated Tribes of the Grand Ronde and the Confederated Tribes of the Siletz.

Because of the project's scale and other factors, an Environmental Impact Statement (EIS) is being prepared, per the National Environmental Policy Act. FEMA is the lead agency for the EIS and for the NHPA, and is working collaboratively with other federal agencies and project stakeholders who

are providing funding and or permitting for various aspects of the project. FEMA provided your office notification of our lead agency role on February 4, 2014.
Concurrent with FEMA's cultural resource investigation for the EIS, Tillamook County hired a consultant to conduct archaeological monitoring as part of a site investigation for two historic veneer mills and other commercial operations at properties located on the western end of downtown Tillamook (commonly referred to as the Sadri property). The investigation focused on soil and sediment sample collections to measure the extent of contamination from those historic mills. SWCA Environmental Consultants conducted the archaeological monitoring and provided a full report (Case No: 14-1406) to the State Historic Preservation Officer (SHPO). Conducted in September 2014, the investigation did not identify any resources eligible for listing in the National Register of Historic Places. However, the report does recommend archaeological monitoring during future environmental remediation work on the Sadri property.

Proposed Undertaking
The proposed Undertaking encompasses over 600 acres and has multiple elements that may include: property acquisition; removing some existing levees, floodgates, and roads; lowering some levees; building new tidal setback levees with floodgates; improving hydraulic connectivity between sloughs; and improvements to existing drainage ditches. Although the final design will depend on the outcome of the EIS process the affected geographic area is not expected to change.

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Historic Property Identification and Evaluation
FEMA sent consultation requests to your office, the Tribal Historic Preservation Office, and to the Confederated Tribes of the Siletz Indians to determine if there are any historic properties of religious or cultural significance within the APE. Grand Ronde Archaeologists Dustin Kennedy and Briece Edwards responded to our APE determination, which further informed our research design and subsequent fieldwork. In fact, they conducted a field visit on August 20, 2014. The enclosed cultural resources report, prepared for FEMA by CCPRS (a joint venture between CH2M Hill and CDM Smith), describes results from the identification and evaluation efforts.

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Based on identification and evaluation efforts to date, FEMA determined that the proposed Undertaking will result in No Historic Properties Affected. Prior to construction, an Inadvertent Discovery Plan (IDP) will be prepared that outlines procedures and contacts in the event of a discovery during construction activities. Additionally to further protect historic properties, and in keeping with SHPO's concurrence with SWCA's determination regarding archaeological monitoring during future environmental remediation, FEMA will require an archaeological monitor during earth moving activities within the area identified as the potential location of Tow-er-quot-ton.

We respectfully request the Tribe's review of the enclosed cultural resources report to further inform identification and evaluation efforts for historic properties that may be of cultural and religious significance to the Tribe. FEMA recognizes that whether you provide comments or decline to at this time it does not preclude future opportunities to comment. At your request, any information you might provide to FEMA will be kept confidential. If you have any questions or would like to discuss this determination, please contact Ms. Jessica M. Stewart, Historic Preservation Specialist at (425) 487-4582 or jessica.stewart2@fema.dhs.gov. Thank you.

Sincerely,

Mark G. Eberlein
Regional Environmental Officer

cc: David Harrelson, Tribal Historic Preservation Officer, Grand Ronde Tribe
Dr. Dennis Griffin, Oregon State Archaeologist

U.S. Department of Homeland Security
FEMA Region X
Federal Regional Center
130 228th Street, SW
Bothell, WA 98021-8627

FEMA

March 11, 2015

Honorable Delores Pigsley
Chairman, Confederated Tribes of the Siletz Indians of Oregon
PO Box 549
Siletz, Oregon 97380

Re: FEMA 1733 DR OR Public Assistance Grant Program, Southern Flow Corridor Project, Port of Tillamook Bay, NHPA Section 106 Cultural Resources Survey

Dear Chairman Pigsley:

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Concurrent with FEMA's cultural resource investigation for the EIS, Tillamook County hired a consultant to conduct archaeological monitoring as part of a site investigation for two historic veneer mills and other commercial operations at properties located on the western end of downtown Tillamook (commonly referred to as the Sadri property). The investigation focused on soil and sediment sample collections to measure the extent of contamination from those historic mills. SWCA Environmental Consultants conducted the archaeological monitoring and provided a full report (Case No: 14-1406) to the State Historic Preservation Officer (SHPO). Conducted in September 2014, the investigation did not identify any resources eligible for listing in the National Register of Historic Places. However, the report does recommend archaeological monitoring during future environmental remediation work on the Sadri property.

Proposed Undertaking
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Sincerely,

Mark G. Eberlein
Regional Environmental Officer

cc: Robert Kentta, Siletz Tribe
Dr. Dennis Griffin, Oregon State Archaeologist

Oregon
Kate Brown, Governor

Parks and Recreation Department
State Historic Preservation Office
725 Summer St NE Ste C
Salem, OR 97301-1266
Phone (503) 986-0690
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April 16, 2015

Mr. Mark Eberlein
FEMA Region X
130 228th SW
Bothell, WA 98021-9796

RE: SHPO Case No. 14-0197
Southern Flow Corridor Project
Flod mitigation and estuarine restoration project
Hwy 101, Tillamook, Tillamook County

Dear Mr. Eberlein:

We have reviewed the materials submitted on the project referenced above, and we concur with the determination that the properties identified within the Area of Potential Effects (APE) for the Southern Flow Corridor Project are not eligible for listing in the National Register of Historic Places due to a critical lack of historic integrity. We also concur that there will be no historic properties affected for this undertaking.

This letter refers to above-ground historic resources only. Comments pursuant to a review for archaeological resources, if applicable, will be sent separately.

This concludes the requirement for consultation with our office under Section 106 of the National Historic Preservation Act (per 36 CFR Part 800) for above-ground historic properties. Local regulations, if any, still apply and review under local ordinances may be required. Please feel free to contact me if you have any questions, comments or need additional assistance.

Sincerely,

Ian P. Johnson, M.A.
Historian
(503) 986-0678
ian.johnson@oregon.gov

Oregon
Kate Brown, Governor

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Mr. Mark Eberlein
FEMA Region X
130 228th SW
Bothell, WA 98021-9796

RE: SHPO Case No. 14-0197
Southern Flow Corridor Project
Flod mitigation and estuarine restoration project
Hwy 101, Tillamook, Tillamook County

Dear Mr. Eberlein:

Our office received a report from you on archaeological investigations associated with the Southern Flow Corridor Project. Having begun my review of the project, I encountered an issue with site designations in the project Area of Potential Effect (APE) that needs to be corrected before I can complete my review.

The consultant for this project (CCPRS) recorded a historic site containing the remains of two separate mill sites and gave it one temporary site number (S-1). There appears to have been some overlap when the present project was being conducted and another unrelated project that recorded the same two mill sites as separate sites with two separate permanent Smithsonian numbers (30662-S-WB-1/35TI00109 & 30662-S-WB-2/35TI00110)). There is good reason to have these sites split up, because they represent two different and unrelated mills that operated at different times (and do not overlap each other-they are side by side). Since our office received your report after the other report (and because there are two separate sites present), you will need to have the one site split into two sites with the appropriate site numbers. These changes also need to be made within the report so it reflects the information and recommendations in the site forms. The two sites are currently "unevaluated" for National Register eligibility, so each site needs a discussion to address why the site would or would not be eligible. Please have your consultant revise the report and site form to reflect the two separate sites with their own descriptions, histories, and recommendations (two site updates). If the consultant needs more information on the previously recorded sites they can be found in our online database or they can contact us directly for copies of the previously recorded site forms.

I look forward to receiving the revised report and site forms so I can complete my review. Please make reference to the SHPO Case No. above when corresponding about this project. If you have any questions, please feel free to contact me at your convenience.

Sincerely,

Ross Curtis

Ross Curtis
SHPO Archaeologist
(503) 986-0676
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Oregon
Kate Brown, Governor

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June 4, 2015

Mr. Mark Eberlein
FEMA Region X
130 228th SW
Bothell, WA 98021-9796

RE: SHPO Case No. 14-0197
Southern Flow Corridor Project
Flod mitigation and estuarine restoration project
Hwy 101, Tillamook, Tillamook County

Dear Mr. Eberlein:

Our office recently received a report of archaeological investigations for the Southern Flow Corridor project referenced above. The report has been assigned SHPO Report# 27391 and added to the SHPO Library. We concur that sites 35TI109 and 35TI110 would not be eligible for inclusion in the National Register of Historic Places because the two historic mill sites have very poor integrity with very little of the original facilities remaining. We have reviewed the report and concur that a good faith effort has been implemented and the project will likely have no effect on any significant archaeological objects or sites. We agree that because there is the possible location for the ethnographic Tillamook village of Tow-er-quot-ton within the project area, a qualified archaeological monitor should be present during any ground breaking activities within this part of the APE. Our office would like a report of the monitoring upon completion. We also agree that it would be good to prepare an Inadvertent Discovery Plan (IDP) for the project.

In the unlikely event an archaeological object or site (i.e., historic or prehistoric) is encountered during project implementation, all ground disturbance at the location should cease immediately until a professional archaeologist can be contacted to evaluate the discovery. Under state law (ORS 358.905-955 & ORS 97.740) archaeological sites, objects and human remains are protected on both public and private land in Oregon. If you have not already done so, be sure to consult with all appropriate Indian tribes regarding your proposed project. If you have any questions regarding any future discovery or this letter, feel free to contact me at your convenience.

Sincerely,

Ross Curtis

Ross Curtis
SHPO Archaeologist
(503) 986-0676
ross.curtis@oregon.gov

Appendix B: STU Tables

Appendix B has been REDACTED in accordance with federal (Section 304 54 U.S.C. 470w-3a NHPA) and Oregon Revised Statute [192.501 (11)] laws pertaining to confidentiality of cultural resources locations.

Appendix C: Site and Isolate Forms

Appendix C has been REDACTED in accordance with federal (Section 304 54 U.S.C. 470w-3a NHPA) and Oregon Revised Statute [192.501 (11)] laws pertaining to confidentiality of cultural resources locations.

Appendix D: Geotechnical Bores Table

Description of Geotechnical Bores and Test Pits

Bore or test pit no.	Depth (feet)	Description	Location
WM-1	3.5	0 to 1 feet, damp dark brown silty topsoil with abundant organic matter; 1 to 2.5 feet, fill consisting of silty sand with wood chips and sawdust; 2.5 to 3.5 feet, medium grayish brown silty clay with abundant wood chips and sawdust	In the interior of the former Tillamook Spruce Veneer plant's power room
WM-2	1.5	0 to 5 inches, damp dark gray silty topsoil with abundant organic matter; 5 inches to 1.5 feet, medium brown silty fill with abundant organic matter (wood chips, sawdust, roots)	Between the former Tillamook Spruce Veneer plant's power room and filing room
WM-3	1.2	0 to 1 feet, damp dark brown silty topsoil with abundant organic matter; 1 to 1.2 feet, wet dark brown dense woody material (wood chips)	In the interior of the former Tillamook Spruce Veneer lathe room
EM-1	2	0-2 feet, medium grayish brown loose sandy fill with abundant brick fragments; wet at 1.5 feet	Adjacent on the eastern exterior to the former Aberdeen Plywood Company's machine shop
EM-2	3	0 to 3 feet, medium grayish brown loose sandy fill with abundant brick fragments; wet at 2.5 feet	In the interior of the former Aberdeen Plywood Company's oil house
EM-3	3	0 to 3 feet, damp medium grayish brown loose sandy fill with abundant brick fragments; wet at 2.5 feet	On the exterior west side of the former Aberdeen Plywood Company's boiler house
EM-4	2	0 to 1 feet, damp medium brown silty fill with sawdust and wood chips, gravel at 1 feet to 1.2 feet; 1 to 2 feet, damp sawdust and wood chips. Terminated in hard woody debris at 2 feet.	In the interior of the southernmost part of the former Aberdeen Plywood Company mill
EM-5	2	0 to 1 feet, damp medium brown silty fill with sawdust and wood chips, wet at 1 feet; 1 to 2 feet, damp sawdust and wood chips. Terminated in hard woody debris at 2 feet	In the interior of the southernmost part of the former Aberdeen Plywood Company mill
FILL-1	1	0-1 feet, damp medium brown sofeet clayey silty fill with abundant fine roots. Terminated at 1 feet in dense roots.	In the fill material of the log pond west of the former Aberdeen Plywood Company mill

Bore or test pit no.	Depth (feet)	Description	Location
FILL-2	1.5	0 to 1.5 feet, damp medium brown sofeet clayey silty fill with abundant fine roots. Terminated at 1.5 feet in dense roots.	In the fill material of the log pond west of the former Aberdeen Plywood Company mill
EP-1	1	0 to 1 feet, wet medium to dark gray loose silty mud with fine roots and organics	In the former log pond west of the former Tillamook Spruce Veneer plant
EP-2	1	0 to 1 feet, wet, cohesive medium to dark gray loose clayey silty mud with fine roots and organics	In the former log pond west of the former Tillamook Spruce Veneer plant
EP-3	1	0 to 1 feet, medium to dark brown loose silty mud with fine roots and organics	In the former log pond west of the former Tillamook Spruce Veneer plant
IP-1	1	0 to 1 feet, dark gray loose silty mud with fine roots and sticks	In the former inlet used as a log pond by the former Tillamook Spruce Veneer plant
IP-2	1	0 to 1 feet, dark gray loose silty mud with fine roots and sticks	In the former inlet used as a log pond by the former Tillamook Spruce Veneer plant
TP-1	7	0 to 1 feet, medium to dark brown silt fill with some roots and wood chips; 1 to 6 feet, wood chips and water; 6 to 7 feet, wet gray silt (bay mud)	About 45 feet east of the central part of the former Aberdeen Plywood Company facility
TP-2	5.5	0 to 2 feet, medium brown clayey silt fill, loose, damp, abundant root matter; 2 to 4 feet, medium silty sand fill with about 50% wood chips and sawdust; 4 to 5 feet, wet wood chips and the top of a steel; 55-gallon drum; 5 to 5.5 feet, matted grasses and roots	In the central part of the former Aberdeen Plywood Company facility
TP-3	7	0 to 2.5 feet, medium to light brown silty sandy fill; 2.5 to 7 feet, medium clayey silt fill with a few wood chips and a coiled wire at 6.5 feet	In the northwestern part of the former Aberdeen Plywood Company facility
TP-4	5	0 to 2.5 feet, medium to light brown silty sandy fill; 2.5 to 5 feet, dark clayey silt fill with some sawdust between 3 and 5 feet	In the northernmost part of the former Aberdeen Plywood Company facility
TP-5	5	0 to 2.5 feet, timber and lumber in silty sand; 2.5 to 3.5 feet, dark gray/black wood chips (toothpick size),wet at 3.5'. Dark oily appearance and odor; 3.5 to 5 feet, dark gray clayey silt	On northeastern edge of the former Aberdeen Plywood Company facility

Bore or test pit no.	Depth (feet)	Description	Location
TP-6	6	0 to 0.5 feet, medium brown silty sandy fill; 0.5 to 2 feet, medium brown silty gravel fill; 2 to 6 feet, dark gray wood or veneer chips with sawdust and numerous used oil filters	About 10 feet north of the eastern edge of the filing room at the former Aberdeen Plywood Company facility
TP-7	6	0 to 6 feet, sawdust with some clay and silt, and a few large logs	About 45 feet west of the dry kiln room at the former Tillamook Spruce Veneer plant
TP-8	3.5	0 to 2 feet, sandy gravelly fill with about 30% sawdust; 2 to 3.5 feet, sandy gravelly fill	About 45 feet southwest of the former sawdust burner
TP-9	3	0 to 0.3 feet, medium brown silty sand fill; 0.3 to 1 feet, medium brown sandy silty fill with about 10% sawdust; 1 to 3 feet, medium brown sandy gravel fill	A few feet south of the northern part of the former Tillamook Spruce Veneer plant
TP-10	7	0 to 6 feet, sawdust and wood chips with very little sediment; 6 to 7 feet, medium brown silty sandy gravelly fill with 10% sawdust	Inside the southwest part of the dry kiln room in the former Tillamook Spruce Veneer plant
TP-11	4	0 to 0.5 feet, medium brown silty sandy fill; 0.5 to 4 feet, medium brown silty gravel fill	Inside the southwest corner of the dry kiln room in the former Tillamook Spruce Veneer plant
TP-12	6	0 to 2 feet, medium brown sandy fill with about 20% sawdust; 2 to 5 feet, medium gray sawdust and some roots; 5 to 6 feet, medium gray clay silt, moist/wet with minor flecks of charcoal	Inside the former sawdust burner
TP-13	4	0 to 1 feet, medium to dark gray silt fill with abundant tree roots; 1 to 2.5 feet, medium to dark gray clayey silt fill with abundant sawdust and some wood fragments; 2,5 to 3.5 feet, dark gray sandy gravelly fill with abundant charred wood; 3.5 to 4 feet, medium to dark gray silt (bay mud) with tree limbs	A few feet east of the core saw room at the former Tillamook Spruce Veneer plant
TP-14	4	0 to 1.5 feet, medium gray silty fill with abundant tree roots; 1.5 to 3 feet, dark gray clayey silt fill with about 50% sawdust and a few large branches; 3 to 4 feet, medium to dark gray silt (bay mud)	Inside the east part of the dry kiln room at the former Tillamook Spruce Veneer plant
TP-15	5.5	0 to 1 feet, dark grayish black fill with abundant tree roots and brick fragments; 1 to 2.5 feet, dark grayish black sandy fill with a few brick and wood fragments; 2.5 to 5.5, medium gray clayey silt (bay mud) with a few tree roots	In the machine shop of the former Tillamook Spruce Veneer plant

Bore or test pit no.	Depth (feet)	Description	Location
TP-16	3	0 to 1 feet, medium to dark gray silt fill with abundant tree roots; 1 to 2.5 feet, medium to dark gray clayey silt fill with abundant sawdust and wood fragments, and a large piece of sheet metal at 2 feet; 2,5 to 3 feet, dark gray silt (bay mud)	About 40 feet north of the boiler house at the former Tillamook Spruce Veneer plant
TP-17	4	0 to 1 feet, dark grayish black silty fill with tree roots and plaster-like material; 1 to 2 feet, dark grayish black silty fill with sawdust and tree branches; 2 to 3 feet, dark grayish black silty fill with sawdust; 3 to 4 feet, dark gray silt (bay mud) with wood fragments and branches	About 35 feet east of the machine shop at the former Tillamook Spruce Veneer plant
TP-18	6.5	0 to 5 feet, medium brown silty fine grained sand; 5 to 6.5 feet, medium gray clayey silt (bay mud)	About 112 feet southeast of the machine shop at the former Tillamook Spruce Veneer plant
TP-27	6 feet, 2 inches	0 to 20 inches, medium brown silty topsoil with fine roots; 20 inches to 3 feet, mixed silty fill and wood debris; 3 to 5 feet, wood chips, no soil; 5 to 6 feet, wet gray silty fill with abundant sawdust; 6 feet to 6 feet, 2 inches, gray silt (possible bay mud)	Inside the central part of the former Aberdeen Plywood Company facility
TP-28	6	0 to 6 feet, coarse wood chips and short pieces of lumber with a few fragments of glass	About 90 feet west of the central part of the former Tillamook Spruce Veneer plant
TP-29	9	0 to 1 feet, medium brown silt topsoil with a little sawdust and a few roots; 1 to 2.5 feet, mixed brown silty fill with wood chips and sawdust, which increase with depth; 2.5 to 7 feet, wood chips, sawdust and long pieces of wood; 7 to 8.5 feet, medium to light gray clayey silt with woody debris and spruce needles; 8.5 to 9 feet, medium to light gray clayey silt (bay mud)	Near the center of the dry kiln room in the former Tillamook Spruce Veneer plant
TP-30	7	0 to 1.5 feet, medium brown clayey silt topsoil; 1.5 to 2.5 feet, light orange fill; 2.5 to 5 feet, dark grayish black silty fill with abundant small woody material and possibly ash as well as abundant trash such as plastic, metal scraps, fabric, and shoes; 5 to 6.5 feet, medium brown clayey fill; 6.5 to 7 feet, bay mud	About 170 feet east of the dry kiln room at the former Tillamook Spruce Veneer plant