APPENDIX F.4

Aquatic Conservation Strategy Assessment

Jordan Cove Natural Gas Liquefaction and Pacific Connector Gas Pipeline Project

Draft EIS

Appendix F4

Aquatic Conservation Strategy Assessment

Pacific Connector Gas Pipeline

Umpqua, Rogue River, and Winema National Forests

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Acronyms Used

ACOE	Army Corps of Engineers
ACS	Aquatic Conservation Strategy
BLM	Bureau of Land Management
BMP	Best Management Practices
CWM	Course Woody Debris
CWA	Clean Water Act
DBH	Diameter at Breast Height
ECRP	Erosion Control and Revegetation Plan
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FEMAT	Forest Ecosystem Management Assessment Team
FLPMA	Federal Land Policy and Management Act
HUC	Hydrologic Unit Code
KOAC	Known Owl Activity Center
KV	Knutsen Vandenberg
KWS	Key Watershed
LMP	Land Management Plan
LRMP	Land and Resource Management Plan
LSOG	Late-Successional and Old-Growth
LSR	Late Successional Reserve
LWD	Large Woody Debris
MAMU	Marbled Murrelet
MP	Mile Post
NEPA	National Environmental Policy Act
NFMA	National Forest Management Act
NFS	National Forest System
NSO	Northern Spotted Owl
NWFP	Northwest Forest Plan
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
OHV	Off-highway Vehicle
OHWM	Ordinary HighWater Mark

PCGP	Pacific Connector Gas Pipeline
POD	Plan of Development
PUR	Partnership Umpqua Rivers
REO	Regional Ecosystem Office
RMP	Resource Management Plan
ROD	Record of Decision
RR	Riparian Reserve
SSC	Suspended Sediment Concentration
SSTEMP	Stream Segment Temperature Model
TEWA	Temporary Extra Work Area
TMP	Transportation Management Plan
TSZ	Transient Snow zone
TSS	Total Suspended Solids
UCSA	Uncleared Storage Area
USDA	United States Department of Agriculture
USDI	United Stated Department of the Interior
USGS	United States Geological Survey
WA	Watershed Assessment, or Watershed Analysis
WODIP	Western Oregon Digital Imagery Project

1.0 INTRODUCTION

The purpose of this assessment is to provide the information and independent analysis necessary to support findings by USDA Forest Service (Forest Service) decision makers regarding the consistency of the proposed Pacific Connector Gas Pipeline project (PCGP or project) with the Aquatic Conservation Strategy (ACS) contained in Attachment A to the Record of Decision (ROD) for Amendments to Forest Service Planning Documents within the Range of the Northern Spotted Owl (Forest Service and BLM 1994a), also known as the Northwest Forest Plan (NWFP).

The ROD for the NWFP includes a description of the components and objectives of the ACS. The ACS was developed to restore and maintain the ecological health of watersheds and the aquatic ecosystems contained within them on public lands (Forest Service and BLM 1994b: B-9).

The Land and Resource Management Plans (LRMPs) for the Rogue River, Umpqua, and Winema National Forests were amended by the NWFP, including ACS. It is intended that the ACS be implemented through these Forest Service land management plans as a landscape-scale management strategy at the site (project), watershed, and regional scales (Forest Service and BLM 1994b).

The proposed PCGP would traverse portions of National Forest System (NFS) lands in the High Cascade, Western Oregon Cascade, and Klamath-Siskiyou provinces, as described in the Report of the Forest Ecosystem Management Assessment Team that was used to develop the NWFP (Forest Service et al. 1993) (figure 1-1). These provinces are highly diverse in terms of landscapes, climate, and land uses. Natural vegetation ranges from temperate rain forest with more than 120 inches of precipitation a year near the coast to the east-side grasslands near Klamath Lake that have an average of 12 inches of precipitation annually that falls primarily as snow. Within these four aquatic provinces, the PCGP would cross NFS lands in portions of seven fifth-field watersheds. Table 1-2 shows the watersheds that would be traversed by the PCGP. The effects of the project must be addressed in the context of site- and watershed-scale conditions for each fifth-field watershed traversed by the project (Goodman et al. 2007).

Complying with ACS objectives means that the Forest Service must manage the riparian-dependent resources needed to maintain existing conditions and implement actions to restore degraded conditions. Improvement relates to restoring biological and physical processes to their ranges of natural variability. This is a long-term process that may take decades to a century or more for some watersheds, so it is not expected that any single project would completely accomplish this objective; it is expected that projects be designed so as not to prevent attainment of ACS objectives and that actions be taken where possible to restore degraded habitats to their historic range of natural variability (Forest Service and BLM, 1994a, 1994b). Watershed analysis (WA) (also called "watershed assessment") provides the baseline from which to assess the processes necessary for maintaining or restoring watershed conditions. Watershed assessments have been developed for all the fifth-field watersheds where the ACS applies that would be crossed by the PCGP project.

Since the decision maker must use the results of watershed analyses to support a finding that a project "meets" or "does not prevent attainment" of ACS objectives, this assessment makes full use of the relevant WAs. In order to support such a finding, the analysis must:

- Provide a description of the existing conditions in each fifth-field watershed, including important physical and biological components and processes.
- Evaluate both the immediate (short-term) and the long-term effects of the proposed action.
- Review the effects of the project against the ACS objectives at the project or site scale as well as at the watershed scale for each of the fifth-field watersheds included in this analysis. This review should consider the incremental effect of the project added to the existing condition and the effects of other present and reasonably foreseeable future actions on watershed conditions.
- Consider any proposed restoration or mitigation activities that are associated with the PCGP.
- The analysis must show that the effects of an action would be within the range of natural variability (Reeves 1999) at the various scales (site to watershed) where the effects occur or that the effects would not prevent attainment of ACS objectives (Forest Service and BLM 1994b: B-10). Minor or short-term adverse effects would not, in and of themselves, constitute noncompliance with the ACS.

The Federal Land Policy and Management Act (FLPMA) of 1976 and the National Forest Management Act (NFMA) of 1976 require that projects or activities be consistent with the management plans of the Forest Service unit where the activity occurs. Consistency with land management plans is gauged by whether an activity accomplishes or does not prevent attainment of the goals and objectives of the relevant plan, and whether the activity is consistent with applicable standards and guidelines (36 CFR 219.15,). Standards and Guidelines in Forest Service LRMPs are rules that regulate or prohibit activities to ensure that the land management plan objectives are achieved (USDA Office of the General Counsel 2002).

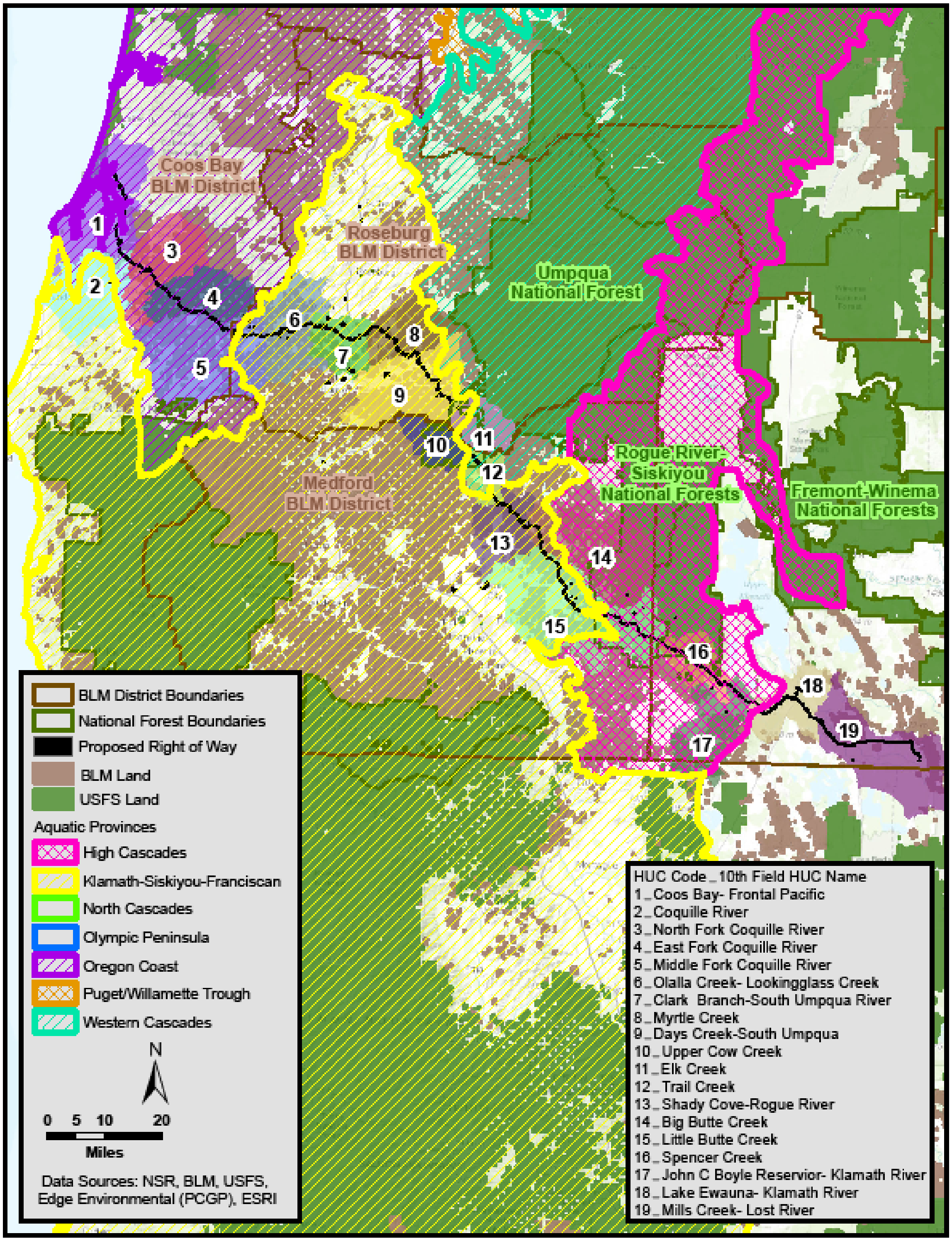
Amendments to land management plans that propose to significantly reduce protection for species associated with late successional old growth (LSOG) forests, or to reduce protection for aquatic ecosystems, are subject to review by the Regional Ecosystem Office (REO) to determine whether the objectives of the ACS would be significantly affected (Forest Service and BLM 1994b). Amendments of Forest Service land management plans that would require review by the REO are discussed in Section 1.2.3.

The governing NWFP standard and guideline for linear projects in Riparian Reserves is LH-4, which states that permits for rights-of-way are to be issued in a way that avoids effects that retard or prevent attainment of ACS objectives (Forest Service and BLM 1994b: C-37). This means that the BLM Right-of-Way grant for the PCGP project must contain the terms and conditions necessary for the project to conform to the ACS. Other standards and guidelines applicable to the ACS are provided in Section 1.2.2.

The ROD for the NWFP requires that agency decision makers—in this case, the Forest Supervisor of the Umpqua National Forest, "finds" that agency decisions related to the PCGP, and construction and operation of the project itself, "meet" or "does not prevent attainment" of the ACS objectives (Forest Service and BLM 1994b). This finding would be made in the subsequent ROD for issuance of the Right-of-Way grant by the Forest Service decisions to amend their respective land management plans for the project. It would be based on evidence and facts presented in the environmental document prepared to comply with the National Environmental Policy Act (NEPA) and appendices, including this ACS assessment.

Private lands dominate the landscape in many of the watersheds that would be crossed by the project. The ACS applies only to lands managed by the Forest Service within the area covered by the NWFP. On private lands, compliance with the Clean Water Act (CWA) is the best evidence of protection of aquatic values. Issuance of permits for the PCGP project under Section 401 of the CWA from the Oregon Department of Environmental Quality (ODEQ) and Section 404 of the CWA from the U.S. Army Corps of Engineers (ACOE) would demonstrate compliance with the CWA. The proponent's application to the Federal Energy Regulatory Commission (FERC) would include the necessary information for the ODEQ and ACOE permits. The Forest Service requires that the proponent secure those permits prior to making any findings related to the ACS. Section 4.3 of the DEIS for the PCGP describes watershed impacts of the project on private lands.

Figure 1-1 Regional and Provincial Setting of the Pacific Connector Gas Pipeline Route



1.1 ORGANIZATION OF THIS ASSESSMENT AND SCALE OF ANALYSIS

The proposed Pacific Connector Gas Pipeline would cross National Forest System (NFS) lands in portions of seven fifth-field[1] watersheds where the Aquatic Conservation Strategy (ACS) applies. To maintain a watershed-scale connection across multiple watersheds, this ACS assessment is structured at the fifth-field watershed scale but provides linkages to the river basin and aquatic province scales. Chapter 1 provides an overview of the ACS and discusses general project effects. Chapter 2 provides a regional and river basin context for the watersheds that would be crossed by the PCGP and discusses project effects in each fifth-field watershed by ACS objective. Chapter 3 provides references.

The discussion for each fifth-field watershed addresses each component of the ACS and considers the existing condition, the range of natural variation as described by the watershed analysis for relevant watersheds, compliance with standards and guidelines of the affected Forest Serviceland and resource management plans (LRMP), and the relationship of the proposed management action to the recommendations of the applicable watershed assessments.

The ACS requires that project impacts be evaluated at multiple scales. While the Pacific Connector is a large project, its impact in any single watershed is typically very small. Modern Geographic Information Systems (GIS) allow very precise measurements. Inventories of land allocations and watersheds at larger scales are rounded to the nearest acre for simplicity. Area measurements at the project scale and percentage of areas affected by the project are carried to 2 decimal places to ensure small portions of the affected landscape are not overlooked. Working at that scale of precision, rounding of small numbers may result in slightly different values for the same data set. In some circumstances, numbers were simply too small to be meaningful. Where numbers would not round up to at least 1/100 of an acre or 1/100 percent, they are shown as zero. These are very small areas. The table below provides a physical sense of scale that may be useful for readers to evaluate effects.

Unit of Area Measure	Area	Square dimension	Circular Dimension
1 Acre	43,560 square feet	208 feet	117-foot radius circle
0.10 or 1/10 Acre	4,356 square feet	66 feet	37 foot radius circle
0.01 or 1/100 acre	437 square feet	21 feet	11.8 foot radius circle
Percentage	**Proportion**	**Portion 100 acres**	**Portion of 1000 acres**
1 percent	1/100 of a unit.	1 acre out of 100	10 acres out of 1000
0.1 percent	1/1,000 of a unit	0.1 acre out of 100	1 acre out of 1000
0.01 percent	1/10, 000 of a unit	0.01 acre out of 100	1/10th acre out of 1000

Impacts at the site Riparian Reserve and other land allocation inventories and impacts at the subwatershed, watershed and subbasin scale are described both in acres and as a percentage of the affected land allocation. Typically, the portions of landscapes affected by the Pacific Connector project are very small. An impact of 0.1 percent would affect 1 acre out of 1000 of a given land

[1] A "fifth field" watershed refers to the hierarchical coding system used by the US Geological Survey to stratify watersheds. A fifth-field watershed is typically 50-200 square miles and is the analytical basis for most Forest Service watershed assessments and ACS assessments.

allocation or landscape. An impact of 0.01 percent would affect 1 acre out of 10,000. If the assessment showed the project affecting 0.25 percent of a watershed, that would equate to

- 0.25 acres or 1/4 acre out of 100 acres,
- 2.5 acres out of 1000 acres or
- 25 acres out of 10,000 acres.

Inventories at the site scale are precise since they are based on the project corridor and in many cases, site-specific surveys. Inventories at larger scales are derived from agency inventories or estimates in watershed analyses that are reasoned estimates based on samples or GIS exercises.

Riparian Reserve effects are categorized according to the nature of the construction action.

- The construction corridor and associated Temporary Extra Work Areas (TEWA) clear most of the vegetation from the designated areas. All trees are removed, and most low growing vegetation is cleared. Accordingly, these areas are described as “cleared”.

- Uncleared Storage Areas (UCSA) are places where stumps and other material are stored. In these areas, only smaller trees are cut as needed for safe and efficient operations. In the Riparian Reserves, UCSAs are described as “modified’.

The nature of effects on a stream channel and its associated Riparian Reserve depends on whether the stream channel is actually crossed by the pipeline trench. In some circumstances, the pipeline trench crosses the stream channel and its associated Riparian Reserve; in other cases, only Riparian Reserve vegetation is removed and the pipeline trench does not cross a stream channel. These types of impacts are separated in this assessment because a stream channel crossing has different effects than removal of vegetation only.

- Where the pipeline trench crosses a stream channel, the impact on the Riparian Reserve of the corridor clearing and TEWAs are described as “crossed”. UCSAs are tallied as they occur in Riparian Reserves where streams are crossed but are counted separately from the area where vegetation is cleared as part of the construction corridor or TEWA.

- Where the “cleared” or “modified” areas affect a portion of the Riparian Reserve, but the pipeline trench does not cross the associated stream channel, the affected area is described as “clipped”.

Because of rounding, small differences in GIS layers or the way GIS queries are constructed, there may be slightly different values between inventories in this assessment and those found in Pacific Connector’s Resource Reports. For example, Pacific Connector acre estimates may include pipe yards in existing rock pits that are already cleared. Those are not included in this evaluation since the character of the landscape is not changed by the action or use. We do not consider these minor inventory differences to be significant, nor do these minor differences affect conclusions of significance of effects.

1.2 COMPONENTS OF THE AQUATIC CONSERVATION STRATEGY

1.2.1 Riparian Reserves

As a key element of the ACS, Riparian Reserves provide an area along all streams, wetlands, ponds, lakes, and unstable and potentially unstable areas where riparian-dependent resources receive primary emphasis. Riparian Reserves are important to the terrestrial ecosystem as well, serving, for example, as dispersal habitat for certain terrestrial species. Riparian Reserves may be unstable or potentially unstable terrains in earthflows. Within Riparian Reserves, special NWFP standards and guidelines control NFS land use. These reserves constitute the key ecosystem component of the ACS, as described in the NWFP standards and guidelines. All Riparian Reserves in the fifth-field watersheds crossed by the PCGP corridor are either in the late successional reserve (LSR) or matrix allocation.[2]

Under the ACS, Riparian Reserves serve to maintain and restore riparian structures and the functions of intermittent and perennial streams, confer benefits to riparian-dependent and associated species other than fish, enhance habitat conservation for species dependent on the transition zone between upslope and riparian areas, improve travel and dispersal corridors for terrestrial animals and plants, and provide for greater connectivity of the vegetation community within and between watersheds, particularly with regard to LSRs. The width of Riparian Reserves is typically one site-potential tree height (height of mature riparian tree in the particular fifth-field watershed) on each side of wetlands, intermittent and non-fish bearing perennial streams, and two potential heights on each side of fish-bearing streams. Irrigation ditches do not have Riparian Reserves and are not considered as stream crossings.

Unstable areas may also be designated “Riparian Reserves” so that they can be managed under the framework of the ACS (Forest Service and BLM 1994b: B-30). Potentially unstable areas were initially identified during the project planning process for the PCGP. Areas determined to pose potential risks to either the PCGP project or the surrounding landscapes were further evaluated in the field to ensure that construction and operation of the project would not destabilize these areas. Reviews by licensed engineers and geologists concluded that none of the earthflow terrains that would be crossed by the PCGP were unstable. Therefore, no earthflow terrains that would be crossed by the PCGP were identified as areas that should be mapped as Riparian Reserves because of inherent instability.

Table 1-1 shows estimated acres of Riparian Reserves in each fifth-field watershed crossed by the Pacific Connector project. Acreage estimates were derived from watershed assessments for each of the affected watersheds.

[2] Within the hierarchy of land allocations on page A-5 of the Standards and Guidelines for the Northwest Forest Plan, acres of the Late Successional Reserve land allocation are withdrawn before the acres for Riparian Reserves. Some have read this to mean that Standards and Guidelines for Riparian Reserves do not apply in Late Successional Reserves. That is not correct. The hierarchy on page A-5 is primarily an explanation of inventory layers. Riparian Reserves and their appurtenant standards and guidelines also apply where these reserves overlap with any other land allocations (Forest Service and BLM 1994(b): B-12)

TABLE 1-1

Forest Service Land Allocations in Fifth-Field Watersheds Crossed by the Pacific Connector Project

Unit	Unit Total (acres)	Land Ownership (acres)				Federal Land Allocation (acres)						
		Other Federal Lands	NFS	Total Federal	Non-Federal Other	Late Successional Reserve		Matrix		Riparian Reserves a/		
						Other Federal	NFS	Other Federal	NFS	Other Federal	NFS	Total
South Umpqua River Sub-Basin												
Myrtle Creek	76,250	31,111	133	31,244	45,006	NAb/	—	NA	133	NA	54	54
Days Creek S. Umpqua	141,569	57,997	2,807	60,804	80,765	NA	2,417	NA	390	NA	142	142
Elk Creek S. Umpqua	54,356	370	34,187	34,558	19,798	NA	14,271	NA	19,916	NA	12,641	12,641
Upper Cow Creek	47,499	9,866	24,151	34,017	13,482	NA	2,350	NA	21,801	NA	11,827	11,827
South Umpqua River Sub-Basin Total	**319,674**	**99,345**	**61,279**	**160,623**	**159,051**	**NA**	**19,039**	**NA**	**42,240**	**NA**	**24,665**	**24,665**
Upper Rogue River Sub-Basin												
Trail Creek	35,338	14,701	4,353	19,055	16,283	NA	—	NA	4,353	NA	957	957
Big Butte Creek	158,243	29,520	58,181	87,701	70,541	NA	1,636	NA	56,545	NA	8,334	8,334
Little Butte Creek	238,879	54,843	59,900	114,743	124,135	NA	52,813	NA	7,088	NA	5,631	5,631
Upper Rogue River Sub-Basin Total	**432,459**	**99,065**	**122,435**	**221,499**	**210,960**	**NA**	**54,449**	**NA**	**67,986**	**NA**	**14,922**	**14,922**
Upper Klamath Sub-Basin												
Spencer Creek	**54,247**	**8,751**	**22,323**	**31,074**	**23,172**	**NA**	**5,319**	**NA**	**17,004**	**NA**	**535**	**535**
Total All Watersheds	**1,155,305**	**271,855**	**212,495**	**484,349**	**670,955**	**NA**	**78,807**	**NA**	**132,144**	**NA**	**43,295**	**43,295**

a/ Riparian Reserves occur within all land allocations. Acre estimates are derived from watershed assessments for watersheds crossed by the project.
b/ Not applicable to BLM for this table

1.2.2 Key Watersheds

The NWFP identifies "key" watersheds that have regional significance for the protection of water quality and aquatic habitat. Tier 1 Key Watersheds are intended to benefit at-risk fish species and stocks by providing refugia for maintaining and recovering habitat. Tier 2 Key Watersheds provide high-quality water. Key Watersheds include areas of both high quality and degraded habitat. Key Watersheds with high-quality habitat serve as anchors for the potential recovery of depressed stocks. Those of lower quality habitat have a high potential for restoration and would become areas of high-quality habitat if appropriate restoration measures are implemented. The NWFP designates Key Watersheds as the highest priority for restoration. Table 1-2 identifies Key Watersheds that would be crossed by the PCGP right-of-way.

TABLE 1-2

Miles of PCGP Project Right-of-Way in Key Watersheds by Administrative Unit

Watershed					Umpqua NF Miles	Rogue River NF Miles	Winema NF Miles	Total NF Miles
Elk Cr.-South Umpqua	—		—	—	2.66	—	—	2.66
Days Cr. South Umpqua (Tier 1) (These 5th field watersheds are both part of the South Umpqua Key Watershed)	—		—	—	1.56	—	—	1.56
North and South Forks Subwatersheds, Little Butte Cr. (Tier 1)	—	—		—	—	8.44	—	8.44
Spencer Cr. (Tier 1)	—	—	—		—	—	6.05	6.05
Clover Cr. Subwatershed, Spencer Cr.(Tier 2)	—	—	—		—	—	—	—
Total		**6**			**4.22**	**8.44**	**6.05**	**18.71**

Source: Resource Report 2, Table 2.2-4

1.2.3 Watershed Analysis

The ACS establishes procedures for conducting watershed analyses (documented in a "watershed analysis" or "watershed assessment") to provide a baseline for geomorphic and ecologic processes operating at the watershed level. Watershed assessments provide the framework for formulating monitoring and restoration programs, delineating Riparian Reserves, and describing key watershed conditions. Watershed assessments provide information but they are not decision documents; they do not authorize or prohibit projects or change decisions made in land management plans or project-level NEPA documents.

Watershed condition refers to more than the state of stream channels and riparian area. It also includes the condition of the uplands, type and distribution of seral classes of vegetation, land use history, effects of previous natural and land use–related disturbances, and distribution and abundance of species and populations throughout the watershed. All of these attributes can influence the structure and functioning of aquatic and riparian ecosystems.

Effective protection strategies for riparian and aquatic habitat on NFS lands under the jurisdiction of the ACS must accommodate the wide variability of landscape conditions across the Pacific Northwest. Watershed assessments play a key role in the ACS process by ensuring that protection of aquatic systems is tailored to the specific landscape(s) at the appropriate scale(s).

Watershed assessments have been completed for all of the fifth-field watersheds where NFS lands would be crossed by the PCPG project. For this ACS assessment, each watershed assessment was reviewed and key information was summarized and synthesized. Since most of the watershed assessments were written between 10 and 15 years ago, the descriptions of current conditions were updated with information from recently published NWFP Monitoring Reports (Forest Service and BLM 2011, Forest Service and BLM 2011a, Forest Service and BLM 2012) and communication with local field units. A combination of updated information and the original watershed analysis was used to describe the important physical and biological processes and components of each fifth field watershed crossed by the PCGP. Table 1-3 lists the watershed assessments reviewed for this assessment.

TABLE 1-3

Watershed Assessments Reviewed for Watersheds Affected by the Pacific Connector Project

Fifth-Field Watershed	Watershed Assessment
Days Creek South Umpqua	Bureau of Land Management. 2001. South Umpqua Watershed Analysis and Water Quality Restoration Plan, Second Iteration, March 2, 2001. Bureau of Land Management, Roseburg District, South River Resource Area. Roseburg, OR. March 2, 2001.
Elk Creek South Umpqua	Forest Service. 1996. Elk Creek Watershed Analysis. Forest Service, Umpqua National Forest, Tiller Ranger District. Roseburg, OR. October 16, 1996.
Upper Cow Creek	Forest Service. 1995a. Cow Creek Watershed Analysis. Forest Service, Umpqua National Forest, Tiller Ranger District, Roseburg OR. September 30, 1995
Trail Creek	Bureau of Land Management. 1999b. Trail Creek Watershed Assessment. Prepared by Western Watershed Analysts. Bureau of Land Management, Medford District. Medford, OR. June 1999.
Big Butte Creek	Forest Service 1995b. Upper Big Butte Creek Watershed Analysis. Rogue River National Forest, Butte Falls Ranger District. Medford, OR. December 1, 1995
	Bureau of Land Management. 1999d. Lower Big Butte Watershed Analysis. Bureau of Land Management, Medford District, Butte Falls Resource Area. Medford, OR. September 1999.
Little Butte Creek	Bureau of Land Management and Forest Service. 1997. Little Butte Creek Watershed Assessment, Version 1.2. Bureau of Land Management, Medford District, Ashland Resource Area, Rogue River National Forest, Ashland Ranger District, Medford, OR. November 1997.
Spencer Creek	Bureau of Land Management, USDA Forest Service, U.S. Environmental Protection Agency, and U.S. Fish and Wildlife Service. 1995. Spencer Creek Pilot Watershed Analysis. Lakeview District, Bureau of Land Management, Lakeview District and Klamath Falls Resource Area; USDA Forest Service, Winema National Forest; U.S. Environmental Protection Agency; and U.S. Fish and Wildlife Service. August 1995.

1.2.4 Watershed Restoration

Watershed restoration is intended to be a comprehensive, long-term program to restore watershed health and aquatic ecosystems, including habitats that support riparian-dependent and riparian-related organisms. Watershed restoration recommendations in the watershed assessments provided guidance for the development of mitigation plans for the PCGP project. For example, a key element of the mitigation plans is upgrading or removing (decommissioning) roads. Such actions have been shown to be effective in controlling runoff and reducing sediment transport to aquatic habitats. Mitigation projects also include channel stabilization and restoration elements that would enhance channel and aquatic habitat complexity by placing large woody debris (LWD) in selected stream reaches. Another key element is accelerating the growth of large trees in the Riparian Reserves by thinning and fuels reduction to reduce the risk of stand-replacing fire in Riparian Reserves. These measures and others recommended in watershed assessments and recovery plans for threatened or endangered species guided development of mitigation measures with the intent that those measures contribute to watershed restoration objectives wherever possible.

These components—Riparian Reserves, Key Watersheds, Watershed Analysis, and Watershed Restoration—are designed to operate together to maintain and restore the productivity and resiliency of riparian and aquatic ecosystems. Late-Successional Reserves are also an important component of the ACS. The standards and guidelines under which Late-Successional Reserves are managed provide increased protection for all stream types. Because these reserves possess late-successional characteristics, they offer core areas of high-quality stream habitat that would act as refugia and centers from which degraded areas can be recolonized as they recover. Streams in these reserves may be particularly important for endemic or locally distributed fish species and stocks (Forest Service and BLM 1994b: B-12).

1.3 DETERMINING CONSISTENCY WITH THE ACS

1.3.1 ACS Objectives

The nine objectives of the ACS are listed in appendix B of the Standards and Guidelines for the NWFP (Forest Service and BLM 1994b). Accordingly, NFS lands within the range of the northern spotted owl would be managed to:

1. Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.

2. Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life-history requirements of aquatic and riparian-dependent species.

3. Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.

4. Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, right-of-way, reproduction, and migration of individuals composing aquatic and riparian communities.

5. Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.

6. Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.

7. Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.

8. Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation; nutrient filtering; and appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse, woody debris sufficient to sustain physical complexity and stability.

9. Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.

These ACS objectives provide a framework for managing aquatic ecosystems with a focus at the fifth-field watershed and aquatic province (i.e., multiple watershed) scales. They address the distribution and attributes of aquatic ecosystems believed necessary to maintain viable populations of fish and other aquatic and riparian-dependent species and to recover degraded ecosystems. The objectives are intended to be flexible in that they can be applied at all spatial scales of concern. Application of the ACS is intended to maintain or move aquatic ecosystem functioning toward the range of natural variability at these several scales (Reeves 1999).

1.3.2 Standards, Guidelines, and Management Direction

Standards and guidelines are implementation rules designed to regulate or prohibit activities to ensure that the objectives associated with a given land allocation are achieved. In other words, by following the standards and guidelines for a given activity, the project or activity should not prevent attainment of objectives. In the NWFP, some standards and guidelines are applicable to all activities in all land allocations while others are specific to a particular activity and/or land allocation. The NWFP standards and guidelines for management activities are important for meeting ACS objectives (Reeves et al. 2006). These standards and guidelines were developed specifically to regulate or prohibit activities that may prevent attainment of ACS objectives. The efficacy of these standards and guidelines for achieving the desired benefits of fish habitat protection and restoration are described in the EIS for the NWFP (Forest Service and BLM 1994c).

The NWFP clearly anticipated that development projects, including utility corridors, could occur in Key Watersheds and Riparian Reserves, and provided standards and guidelines to ensure that ACS objectives would be achieved if such projects were implemented (table 1-4). All relevant standards and guidelines in table 1-4 except those related to protection of Survey and Manage (S&M) species are specific to Riparian Reserves. Evaluating compliance with these relevant standards and guidelines is an essential step for determining consistency with ACS objectives. Table 1-4 cross-references NWFP standards and guidelines

Standard and Guideline LH-4 is the governing ACS direction for new developments that may affect aquatic resources. This standard and guideline does not prohibit new developments; rather, it directs the Forest Service to include terms and conditions in right-of-way grants to ensure that ACS objectives are achieved. The right-of-way grant issued by the BLM for the project would include Plans of Development (PODs) with attachments such as an Erosion Control and Revegetation Plan (ECRP), a Transportation Management Plan (TMP) and a Mitigation Plan that are intended to ensure compliance with standards and guidelines and accomplishment of ACS objectives. The PODs are conditions of the right-of-way grant and are binding on the applicant.

TABLE 1-4

Governing NWFP Standards and Guidelines Relevant to the ACS for Utility Corridors

Standard/Guideline	Land Allocation	Description	Applicability
Standards and Guidelines Applicable to New Developments			
LH-4: Issuing leases, permits, rights-of-way and easements.	Riparian Reserves	For activities other than surface water developments, issue leases, permits, rights-of-way, and easements to avoid adverse effects that retard or prevent attainment of Aquatic Conservation Strategy objectives.	Directs the Forest Service to include terms and conditions in right-of-way grants to ensure that ACS objectives are achieved.
Standards and Guidelines Related to Road Construction, Reconstruction and Maintenance			
RA-4: Locating water withdrawal sites.	Riparian Reserves	Locate water-drafting sites to minimize adverse effects on stream channel stability, sedimentation, and in-stream flows needed to maintain riparian resources, channel conditions, and fish habitat.	Applicable to water drafting sites for construction needs such as compaction, dust control, and hydrostatic testing.
RF-2: Road construction standards and guidelines.	Riparian Reserves	For each existing or planned road, meet Aquatic Conservation Strategy objectives by: a. minimizing road and landing locations in Riparian Reserves. b. completing watershed analyses (including appropriate geotechnical analyses) prior to construction of new roads or landings in Riparian Reserves. c. preparing road design criteria, elements, and standards that govern construction and reconstruction. d. preparing operation and maintenance criteria that govern road operation, maintenance, and management. e. minimizing disruption of natural hydrologic flow paths, including diversion of streamflow and interception of surface and subsurface flow. f. restricting sidecasting as necessary to prevent the introduction of sediment to streams. g. avoiding wetlands entirely when constructing new roads.	Applicable to roads constructed or reconstructed for the PCGP. Objectives of this Standard and Guideline are accomplished through the terms of the right-of-way grant that includes a Transportation Management Plan (TMP) Plan of Development (POD)
RF-4: New culverts, bridges and other stream crossings.	Riparian Reserves	New culverts, bridges, and other stream crossings shall be constructed, and existing culverts, bridges, and other stream crossings determined to pose a substantial risk to riparian conditions would be improved to accommodate at least the 100-year flood, including associated bedload and debris. Priority for upgrading would be based on the potential impact and the ecological value of the riparian resources affected. Crossings would be constructed and maintained to prevent diversion of streamflow out of the channel and down the road in the event of crossing failure.	Provides direction for construction or reconstruction of permanent road crossings associated with the PCGP project through the TMP. (RF-4 is not applicable to crossings associated with the pipeline corridor because the pipeline is not a road.)

TABLE 1-4

Governing NWFP Standards and Guidelines Relevant to the ACS for Utility Corridors

Standard/Guideline	Land Allocation	Description	Applicability
RF-5: Minimizing sediment delivery from roads.	Riparian Reserves	Minimize sediment delivery to streams from roads. Outsloping of the roadway surface is preferred, except in cases where outsloping would increase sediment delivery to streams or where outsloping is unfeasible or unsafe. Route road drainage away from potentially unstable channels, fills, and hillslopes.	Applicable to the roads constructed, reconstructed, and maintained by the PCGP. RF-5 is accomplished through the terms of the TMP.
RF-6: Maintaining fish passage.	Riparian Reserves	Provide and maintain fish passage at all road crossings of existing and potential fish-bearing streams.	Applicable to stream crossings constructed or reconstructed by the PCGP. RF-6 is accomplished through the terms of the TMP.
RF-7: Transportation Management Plan development.	Riparian Reserves	Develop and implement a Road Management Plan or a TMP that would meet the Aquatic Conservation Strategy objectives. As a minimum, this plan shall include provisions for the following activities: a. inspections and maintenance during storm events. b. inspections and maintenance after storm events. c. road operation and maintenance, giving high priority to identifying and correcting road drainage problems that contribute to degrading riparian resources. d. traffic regulation during wet periods to prevent damage to riparian resources. e. establish the purpose of each road by developing the Road Management Objective.	Applicable to roads used by the PCGP during construction and operation of the project. RF-7 is accomplished through the terms of the TMP.
Standards and Guidelines Applicable to Mitigation Measures and Watershed Restoration			
WR-3: Proper use of planned mitigation and restoration.	Riparian Reserves	Do not use mitigation or planned restoration as a substitute for preventing habitat degradation.	Applicable to the project. Mitigation measures are not to be used as a substitute for appropriate design measures or applications of Best Management Practices.

TABLE 1-4

Governing NWFP Standards and Guidelines Relevant to the ACS for Utility Corridors

Standard/Guideline	Land Allocation	Description	Applicability
Standards and Guidelines for Survey and Manage Species			
Management direction for Survey and Manage Species in the NWFP ROD was replaced by the 2001 ROD and Standards and Guidelines for Amendments to the Survey and Manage, Protection Buffer, and other Mitigation Measures Standards and Guidelines as Modified by the 2011 Settlement Agreement in Conservation Northwest v. Sherman, Case No. 08-CV-1067-JCC (W.D. Wash.)	All Allocations	Survey and Manage species protection is a mitigation measure to ensure the persistence of species listed in the 2001 Survey and Manage ROD, as amended by the 2011 Settlement Agreement in Conservation Northwest v. Sherman, Case No. 08-CV-1067-JCC (W.D. Wash.)	Applicable to the known sites of Survey and Manage species that are dependent on riparian habitats and whose persistence in the area of the NWFP would be threatened by construction of the PCGP. This is responsive to ACS objective 9.
Standards and Guidelines for Retention of Late Successional Forest			
Retain late-successional forest patches in landscape areas where little late-successional forest persists. This management action/direction would be applied in fifth-field watersheds (20 to 200 square miles) in which federal forest lands are currently comprised of 15% or less late-successional forest. (The assessment of 15% would include all federal land allocations in a watershed.) Within such an area, protect all remaining late-successional forest stands.	All Allocations	Landscape areas where little late-successional forest persists should be managed to retain late-successional patches. This standard and guideline would be applied in fifth-field watersheds (20 to 200 square miles) in which federal forest lands are currently comprised of 15% or less late-successional forest. This assessment should include all allocations in the watershed. Within such an area, all remaining late-successional stands should be protected.	Applicable in each watershed affected by the project. This evaluation is included in the ACS evaluation since it is watershed-based. None of the watersheds that would be crossed by the Pacific Connector project are below the 15% threshold or would be reduced below the 15% threshold by the project.
Standards and Guidelines Related to Key Watersheds a/			
Outside Roadless Areas – Reduce existing system and nonsystem road mileage. If funding is insufficient to implement reductions, there would be no net increase in the amount of roads in Key Watersheds.	Key Watersheds	Where opportunities exist, system and nonsystem road miles should be reduced in Key Watersheds. This is accomplished by off-site mitigation measures.	Applicable in all Key Watersheds. Mitigation plans document relationship of projects to Key Watershed objectives.
Key Watersheds are highest priority for watershed restoration.	Key Watersheds	Watershed restoration accomplished with project mitigation should prioritize Key Watersheds commensurate with project effects.	Applicable in all Key Watersheds. Mitigation plans document relationship of projects to Key Watershed objectives.

TABLE 1-4 **Governing NWFP Standards and Guidelines Relevant to the ACS for Utility Corridors**			
Standard/Guideline	**Land Allocation**	**Description**	**Applicability**
Watershed analysis is required prior to management activities, except minor activities such as those Categorically Excluded under NEPA (and not including timber harvest). Watershed analysis is required prior to timber harvest.	Key Watersheds	This requires a Watershed Assessment to be completed prior to activities that affect vegetation in Key Watersheds.	Applicable in Key Watersheds. All Key Watersheds crossed by the Pacific Connector project have completed Watershed Assessments. While the Pacific Connector project is neither a "management activity" related to LMP implementation nor a "timber harvest," watershed assessments provide useful information to ensure objectives of Key Watersheds are attained.
Standards and Guidelines for all Land Allocations Related to Watershed Analysis			
Watershed analysis is required to change Riparian Reserves widths in all watersheds.	Riparian Reserves	Modification of Riparian Reserve widths requires a Watershed Assessment.	The Forest Service does not propose to modify Riparian Reserve widths; however, the Pacific Connector project would cross Riparian Reserves. Watershed assessments have been completed for all watersheds that would be crossed by the Pacific Connector project. Watershed assessments provide useful information to assess crossing effect. None of the watershed assessments made a recommendation to prohibit crossings of Riparian Reserves.
a/ Standards and Guidelines for Key Watersheds also prohibit new road construction in Inventoried Roadless Areas (RARE II). The Pacific Connector project does not cross any portion of, or construct any roads in, RARE II Inventoried Roadless Areas.			

1.3.3 Forest Service Decisions Related to the ACS

Proposals to amend NFS land management plans must consider whether the proposed amendments are related to the ACS; if so, the proposals must address whether the proposed changes to the land management plans would retard or prevent attainment of ACS objectives. BLM's decision concerning whether or not to issue a right-of-way grant for the PCGP project must also consider whether issuing the grant would prevent attainment of ACS objectives. Land management plan amendments that propose to significantly reduce protection for LSOG-related species or reduce protection for aquatic ecosystems are subject to review by the REO to determine if the objectives of the NWFP standards and guidelines would be significantly affected (Forest Service and BLM 1994b: C-29).

Table 1-5 shows which of the proposed land management plan amendments associated with the PCGP project have a nexus with the ACS and whether those amendments require review by the REO.

TABLE 1-5

Agency Decisions with a Nexus to the ACS

Amendment Number	Relevant Federal Jurisdiction	Amendment Description	ACS Nexus	REO Review Required for Aquatic Effects
Forest Service-1	All Forest Service jurisdictions	Waive management recommendations for Survey and Manage species	Yes	Yes. This amendment may reduce protections for aquatic-related Survey and Manage species (ACS Objective 9).
RRNF-1	Rogue River National Forest	Establishes a Forest goal to facilitate transmission of energy	No	No
RRNF-2	Rogue River National Forest	Changes the Visual Quality Objective where the PCGP would cross Big Elk Road	No	No
RRNF-3	Rogue River National Forest	Changes the Visual Quality Objective where the PCGP would cross the Pacific Crest Trail	No	No
RRNF-4	Rogue River National Forest	Changes the Visual Quality Objective where the PCGP would cross Highway 140	No	No
RRNF-5	Rogue River National Forest	Allows the PCGP to cross approximately 2.5 acres of the Restricted Riparian Land Allocation	Yes	Yes. This amendment reduces protection of aquatic habitats by allowing removal of riparian vegetation.
RRNF-6	Rogue River National Forest	Allows the PCGP to exceed restrictions on detrimental soil conditions from displacement and compaction within the project right-of-way on an estimated 60 acres	Yes	Yes. This amendment reduces protection of aquatic habitats by allowing some measure of soil compaction and displacement within Riparian Reserves.
RRNF-7	Rogue River National Forest	Transfers 512 acres from the Matrix Land Allocation to LSR RO 227 while done as a mitigation for impacts to LSRs; also provides additional protections for Riparian Reserves	Yes	No. This amendment does not reduce protections for aquatic habitats. However, it would be reviewed by the REO because it involves LSR.

TABLE 1-5 **Agency Decisions with a Nexus to the ACS**				
Amendment Number	**Relevant Federal Jurisdiction**	**Amendment Description**	**ACS Nexus**	**REO Review Required for Aquatic Effects**
UNF-1	Umpqua National Forest	Amends Standards and Guidelines for Fisheries and Water Quality to allow the removal of 3 acres of effective shading vegetation where perennial streams would be crossed by the PCGP	Yes	Yes. This amendment reduces protection of aquatic habitats by allowing removal of effective shade.
UNF-2	Umpqua National Forest	Amends Prescriptions C2-I (IV-170) and C2-IV (IV-177) to allow the PCGP to run parallel to a Class II stream for approximately 0.1 mile	Yes	Yes. This amendment reduces protection of aquatic habitats by allowing a utility corridor to parallel a Riparian Reserve for 0.1 mile.
UNF-3	Umpqua National Forest	Allows the PCGP to exceed restrictions on detrimental soil conditions on an estimated 70 acres from displacement and compaction within the project right-of-way	Yes	Yes. This amendment reduces protection of aquatic habitats by allowing some measure of soil compaction and displacement within Riparian Reserves.
UNF-4	Umpqua National Forest	Transfers approximately 588 acres from the Matrix Allocation to the LSR 223 land allocation while done as a mitigation for impacts to LSRs; also provides additional protections for Riparian Reserves.	Yes	No. This amendment does not reduce protections for aquatic habitats. However, it would be reviewed by the REO because it involves LSR.
WNF-1	Winema National Forest	Amends Standards and Guidelines for Management Area 3 on page 4-103-4, to allow the 95-foot-wide PCGP corridor in MA-3 from the Forest boundary to the Clover Creek Road corridor	No	No.
WNF-2	Winema National Forest	Allows more time to achieve Visual Quality Objectives in the vicinity where the 75-foot-wide PCGP corridor would cross the Dead Indian Memorial Highway	No	No.
WNF-3	Winema National Forest	Allows more time to meet Visual Quality Objectives for Scenic Management, Foreground Partial Retention, where the PCGP would be in the vicinity of the Clover Creek Road corridor	No	No
WNF-4	Winema National Forest	Allows the PCGP to exceed restrictions on detrimental soil conditions on an estimated 30 acres from displacement and compaction within the project right-of-way	Yes	Yes. This amendment reduces protection of aquatic habitats by allowing some measure of soil compaction and displacement within Riparian Reserves.
WNF-5	Winema National Forest	Allows the PCGP to exceed restrictions on detrimental soil conditions from displacement and compaction on an estimated 4 acres within the project right-of-way that lies within Management Area 8 Riparian Area	Yes	Yes. This amendment reduces protection of aquatic habitats by allowing some measure of soil compaction and displacement within Riparian Reserves.

1.3.4 Determining Consistency with the ACS at Multiple Scales

The ACS does not prohibit project-level impacts so long as the effects of the action do not retard or prevent attainment of ACS objectives (Forest Service and BLM 1994b: B-9). Project impacts that result in minor and short-term degradation of the aquatic habitat do not necessarily constitute noncompliance with the ACS. Where impacts do occur, the analysis must show they are within the range of natural variability for the watershed where they occur or that the action would move the key processes that influence Riparian Reserves toward the range of natural variability (Reeves

1996). Under the ACS, a project cannot have a long-term negative effect on riparian-dependent resources (Forest Service and BLM 1994c: 3&4 68-69). For example, short-term "pulse" disturbances that result in the deposition of sediment in amounts and texture that mimic natural events may fall within the range of natural variability for a watershed and would likely not prevent attainment of ACS objectives. Conversely, actions that result in the chronic deposition of fine sediments that do not fall within the range of natural variability in a given watershed probably would not be consistent with the ACS. In all cases, agency decision makers must use the scale, duration, and intensity of impacts and professional judgment to determine whether an action prevents attainment of ACS objectives.

Spatial scales are defined as follows:

- The "site" in the context of this ACS assessment varies in size depending on effects. It encompasses the project footprint and areas of potential direct or indirect effects adjacent to the project location. The "site" is variable and is intended to reflect the ecological function and variable nature of riparian areas. The "site" may encompass areas outside of Riparian Reserves.
- The "subwatershed" is the sixth field Hydrologic Unit Code (HUC) scale as defined by the U.S. Geological Survey (USGS).
- The "watershed" is the fifth-field HUC scale as defined by the USGS.
- The "sub-basin" is an aggregation of fifth-field watersheds into one logical drainage (i.e., the South Umpqua sub-basin), typically at the fourth-field HUC scale. In the Coast Range Province, it may include small drainages that are not part of a larger river system but have common beneficial use and resource concerns.
- The "basin" is an aggregation of fourth-field sub-basins into a logical drainage. Basins (i.e. the Umpqua Basin) are generally described at the third-field HUC scale.
- The "province" refers to the physiographic (also called aquatic) provinces established in the Report of the Forest Ecosystem Management Assessment Team (FEMAT) (Forest Service et al. 1993: IV-7). These are areas of similar geologic and general climatic conditions.
- "Riparian Reserves" are land allocations in Forest Service land management plans where special standards and guidelines apply. Riparian Reserves adjacent to fish-bearing streams are two site-potential tree heights wide. Riparian Reserves on wetlands and other waterbodies are one site-potential tree height wide.

Temporal scales and intensity of effects are defined as follows:

- Short-term effects are generally limited to the season(s) of construction.
- Long-term effects are those that would persist beyond the season(s) of construction.
- Minor effects are defined as effects that are confined to the general construction site. They either are "short term" effects or longer term effects that are within the range of variability at the scale where the impact occurs and that do not prevent attainment of ACS objectives.

- Effects that are not “minor” are those that are outside the range of natural variability and would prevent attainment of ACS objectives.
- "Cumulative impact" is the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7). Only current and future projects that have environmental consequences that overlap the proposed PCGP spatially and temporally contribute to cumulative effects within the watershed. Cumulative effects are described in the individual watershed sections of this assessment.

The consistency of the project with the ACS is demonstrated by:

- Using watershed assessments to describe watershed conditions and ranges of natural variability for key physical and biological processes for each fifth-field watershed that would be crossed by the PCGP project.
- Evaluating direct, indirect, and cumulative effects at the site and watershed scale against the nine ACS objectives for each fifth-field watershed.
- Compliance with applicable agency management direction (i.e., NWFP standards and guidelines, table 1-4).
- Showing that the environmental consequences of agency decisions regarding land management plan amendments (see table 1-5) do not prevent attainment of ACS objectives.
- REO review of any proposed amendments of NWFP standards and guidelines that have been incorporated into land management plans that would reduce protections for aquatic resources. The purpose of this review is to determine if the objectives of standards and guidelines for the ACS would be significantly adversely affected by the proposed amendment(s) (see table 1-5).
- A finding by the agency decision makers in the ROD, based on evidence and facts presented in the PCGP project EIS and its appendices, that the action taken by the Forest Service (see first paragraph in Section 1.2.3.) would not prevent attainment of the ACS objectives at the appropriate scales.

The Forest Service uses a three-tiered condition class rating (Forest Service 2011) applied at the sixth-field subwatershed HUC. In the Forest Service condition class rating, properly functioning sub-watersheds (Condition Class I) are resilient and able to recover to the desired condition when or if disturbed by large natural disturbances or land management activities. Functioning at risk (Condition Class II) subwatersheds maintain elements of ecological integrity but may lack the resilience to recover from large-scale disturbances or management activities that have a significant adverse impact on watershed function. Functionally impaired (Condition Class III) subwatersheds lack resilience because some physical, hydrological, or biological threshold has been exceeded.

Where available, Forest Service sixth-field HUC condition class assessments have been included in the individual watershed discussions and are found in section 2.2 of this appendix.

Table 1-6 delineates the factors and indicators for the proper functioning of at risk streams. These are applied in determining the three condition classes described above. This table also provides a description for "not functioning" conditions.

TABLE 1-6

General Matrix of Factors and Indicators of Aquatic Health

Factors a/	Indicators	Properly Functioning	At Risk	Not Properly Functioning
Water Quality	Temperature	2nd and 3rd order streams: <58 degrees F. 4th order and larger streams: <65 degrees F.	2nd and 3rd order: 59–65 degrees F. 4th order and larger basins: 66–72 degrees F.	2nd and 3rd order streams: >65 degrees F. 4th order and larger basins: >72 degrees F.
	Sediment/Turbidity	<12% fines (<0.85 mm) in gravel, turbidity low, or cobble embeddedness <35%.	12–17% fines (<0.85 mm) in gravel	>17% fines (<0.85 mm) in gravel, turbidity high, or cobble embeddedness >35%.
	Chemical Contamination/Nutrients	Low levels of chemical contaminants from agricultural, industrial, and other sources, no excess nutrients, no CWA 303d-designated reaches.		Moderate levels of chemical contamination from agricultural, industrial, and other sources, any level of excess nutrients, one or more CWA 303d–designated reaches.
Habitat Access	Physical Barriers	Any man-made barriers present in watershed allow upstream and downstream fish passage at all flows of age 1+ salmonids		Any man-made barriers present in watershed do not allow upstream and/or downstream fish passage at a range of flows of age 1+ salmonids
Habitat Elements	Substrate	Dominant substrate is gravel or cobble (interstitial spaces clear), embeddedness <20%	Gravel and/or cobble is subdominant, or, if dominant, embeddedness between 20–35%	Bedrock, sand, silt, or small gravel dominant, or if gravel and cobble dominant, embeddedness >35%
	Large Woody Debris	>60 pieces/mile, >24 inches in diameter, and >50 feet long. Adequate sources of future LWD to maintain this standard. Little evidence of stream clean out or management-related debris flows.	30–60 pieces/mile, >24 inches in diameter, and >50 feet long or lacks potential sources of LWD sufficient to maintain or achieve the fully functioning standard	<30 pieces/mile, >24 inches in diameter, and >50 feet long and lacks potential sources of LWD. Evidence of stream clean out and/or management-related debris flows
	Pool Characteristics	>30% pool habitat by area. Little reduction in pool volume due to filling by fine sediment or unsorted substrates.	>30% pool habitat by area but with obvious filling by fines or unsorted substrates or <30% pool habitat by area and little reduction in pool volume due to filling	< 30% pool habitat by area and obvious reduction in pool volume due to filling with fines and/or unsorted substrates.
	Off-Channel Habitat	Water velocity refugia present. Backwaters frequent and the resulting structural influence (LWD). Side channel connectivity maintained.		Little or no velocity refugia. Few or no backwaters; no off-channel ponds. Evidence of abandoned side channels due to past management activities.

TABLE 1-6

General Matrix of Factors and Indicators of Aquatic Health

Factors a/	Indicators	Properly Functioning	At Risk	Not Properly Functioning
	Refugia (important remnant habitat for sensitive aquatic species)	Habitat refugia exist and are adequately buffered (e.g., by intact Riparian Reserves); existing refugia are sufficient in size, number, and connectivity to maintain viable populations or subpopulations.	Habitat refugia exist but are not adequately buffered (e.g., by intact Riparian Reserves); existing refugia are insufficient in size, number, and connectivity to maintain viable populations or subpopulations.	Adequate habitat refugia do not exist.
Channel Condition and Dynamics	Width/Depth Ratio	Width/depth ratio and channel types are within historic ranges and site potential as per Rosgen typing.		Width/depth ratios and channel types are outside of historic ranges and site potentials.
	Streambank Condition	Basinwide in low-gradient reaches >90% stable; i.e., on average, less than 10% of banks are actively eroding.	Basinwide in low-gradient reaches, streambanks 80–90% stable. Active erosion limited to outcurves.	<80% of streambanks are stable. Active erosion widespread throughout basin in low-gradient reaches.
	Floodplain Connectivity	Off-channel areas are frequently hydrologically linked to main channel; overbank flows occur and maintain wetland function, riparian vegetation, and succession.		Obvious reduction in hydrologic connectivity between off-channel, wetland, floodplain, and riparian areas; wetland extent noticeably reduced and riparian vegetation/succession altered significantly.
Flow/Hydrology	Drainage Network	Little increase in drainage network due to roads		Substantial increase in drainage network density due to roads (e.g., 20–25%)
Watershed Conditions	Road Density and Location	<2 miles/square mile, with no valley bottom roads	2–3 miles/square mile, with some valley bottom roads	>3 miles/square mile and/or substantial amount of valley bottom roads
	Disturbance History	<5% equivalent clearcut acres/decade (entire watershed) with no concentration of disturbance in unstable or potentially unstable areas, and/or refugia, and/or Riparian Reserves		Riparian Reserves are fragmented, poorly connected, or provide inadequate protection of habitats and refugia for sensitive aquatic species. <80% are in late-seral condition.
	Landslide Rates	Within 20% of historic natural rates. Stream conditions not evidently altered due to management-related landslides	0	Not within 20% of historic natural rates; stream conditions obviously altered

a/ Source: Upper Middle Fork Coquille WA, BLM 1999a: Table C-3. These values are for the Western Cascades Physiographic Province but are referenced here as general indicators of watershed health that could be used in other provinces absent more watershed specific data.

1.4 ENVIRONMENTAL CONSEQUENCES AND MITIGATION

Most of the PCGP is routed on ridge tops to avoid stream and riparian-area crossings. The project's cross-country route primarily follows ridgelines as it traverses the Coast Range Province, the Klamath Province, the Western Cascades Province, and the High Cascades Province. This ridgeline alignment provides the most stable landscape position for the pipeline and minimizes the number of waterbodies and wetlands crossed as the route proceeds in a southeasterly direction from Coos Bay over these mountain ranges toward the terminus of the project near Malin, Oregon. Where Riparian Reserves could not be avoided, the project proponent has worked closely with the Forest Service to minimize effects. Most crossings are near or at right angles to the stream channel, thereby minimizing alterations to riparian zones, banks, and channels. Water quality Best Management Practices would be used throughout the construction process. Timely restoration of stream banks and channels to preconstruction condition and replanting of riparian vegetation to foster succession to conifer forest would be implemented to minimize and mitigate project effects. Most of the waterbodies that are crossed by the PCGP project on NFS lands are intermittent streams that are expected to be dry or at very low flows during the summer construction activities.

1.4.1 General Construction and Stream Crossing Methods and Effects

By their linear nature, utility corridors have unavoidable effects at the site-scale where they cross Riparian Reserves. Pacific Connector would follow the *Stream Crossing Risk Analysis* (GeoEngineers 2013c) to identify design guidance, contingency measures, and monitoring protocols specific to each crossing/risk level. All methods including temporary crossings would be designed according to FERC's Procedures as well as according to the ACOE, Oregon Department of State Lands (ODSL), ODEQ, Forest Service, BLM, Reclamation, and Oregon Department of Fish and Wildlife (ODFW) approvals. See also Section 1.3.1.1 of this assessment, which provides a summary of the GeoEngineers Risk Assessment for crossings on public lands.

As described in the *Stream Crossing Risk Analysis* (GeoEngineers 2013c), once the project is approved and all permits and route access obtained, all stream crossings would have a preconstruction survey to confirm and clarify conditions developed in the risk analysis. This survey would be done by a team of professionals, including agency representatives, qualified to assess terrestrial and aquatic habitat and the geotechnical and geomorphic conditions relative to pipeline construction across stream channels and ditches. Following these surveys, if significant changes occur to parameters of the risk matrix for a crossing, changes would be made to risk level and appropriate final methods of crossing and Best Management Practices made at each stream crossing. Project construction would then move forward as described in these permit documents.

Where stream channels have flowing water, crossings would be accomplished using a dry, isolated crossing method (typically dam-and-pump) consistent with the requirements of federal, state, and local agencies with specific authority to regulate the PCGP project's waterbody crossings. In dry, isolated crossings, the stream is temporarily dammed with sandbags or other structures. Water upstream of the temporary dam is pumped around the construction area. Any water present from hyporheic flows or leakage past dams in the construction area is pumped out and into an upslope sediment detention trap that allows the water to infiltrate back into the soil rather than back into the stream channel. Waterbody crossings would be made nearly perpendicular to the axis of the waterbody channel where practicable based on engineering and routing constraints to minimize parallel stream alignments and multiple stream crossings. To the degree possible, temporary extra work areas (TEWAs) have been located outside of Riparian Reserves to minimize effects.

The project would use temporary construction bridges during all phases of construction to cross stream channels on NFS lands, whether streams are perennial or intermittent or wet or dry. These temporary bridge structures would be designed according to FERC's Wetland and Waterbody Procedures as well as according to ACOE, ODSL, ODFW, BLM, and Forest Service approvals. The temporary equipment bridges would be constructed to maintain unrestricted flow and to prevent soil from entering the waterbody. Soil would not be used to stabilize temporary bridges. Bridges would be designed to withstand and pass the highest flow expected to occur while the bridge is in place, and, where feasible, bridges would be designed to span the entire ordinary high water mark (OHWM) of the waterbody. If it is not possible to span the OHWM with the bridge, a temporary culvert or pier may be required. These culverts/piers would be installed to minimize flow restrictions that may deflect stream flow to banks to prevent streambank erosion or scour. Temporary footings or piers that could cause stream bank erosion or channel scour would be removed over winter if so requested by the Forest Service. Bankfull conditions occur in western Oregon on average every 1.1 to 1.2 years (Castro 1997). Based on this predicted interval, stabilizing the project for winter will be based on the assumption that bankfull conditions could occur in any given winter. The temporary bridges may include:

- equipment mats and culvert(s);
- equipment mats or railroad car bridges without culverts;
- clean rock fill and culvert(s); and
- flexi-float or portable bridges.

All stream crossings on NFS lands (whether intermittent or perennial or wet or dry) would be set during clearing operations in Year One of construction as well as during mainline construction in Year Two. The temporary bridges set during clearing operations would be temporarily removed after clearing is complete and would not be left in place across a waterbody over the Year One/Year Two winter unless approved by the Forest Service. During mainline construction in Year Two, the temporary bridges would be reset and would be removed as soon as possible after permanent seeding. If there would be more than one month between final cleanup and the beginning of permanent seeding and reasonable alternate access to the right-of-way is available, equipment bridges would be removed as soon as possible after final cleanup as required by FERC Wetland and Waterbody Procedures.

Pacific Connector would not allow clearing equipment to cross waterbodies prior to bridge placement. Furthermore, where feasible, Pacific Connector's contractors would attempt to lift, span, and set the bridges from the streambanks. Where it is not feasible to install or safely set the temporary bridges from the streambanks, only the equipment necessary to install the bridge or temporary support pier would cross the waterbody. Any equipment required to enter a waterbody to set a bridge would be inspected to ensure it is clean and free of dirt or hydrocarbons. Temporary bridges that have been used on other projects or in other locations on this project would be cleaned and inspected before and after use to reduce the probability of introduction or transport of invasive aquatic or terrestrial species.

Sediment barriers would be properly installed adjacent to stream crossings and at the edges of cleared areas in Riparian Reserves immediately after clearing and prior to initial ground disturbance (i.e., grading). Sediment barriers would be properly maintained throughout construction and reinstalled as necessary (such as after backfilling of the trench) until replaced by permanent erosion controls or restoration of adjacent upland areas is complete and revegetation has stabilized the disturbed areas. The contours of the streambed and banks would be restored to preconstruction configurations (i.e., contour/elevations) to restore the physical integrity/conditions of these features. At some stream crossings, steep, eroding streambanks may need to be regraded to a stable slope (2:1 to 3:1) to ensure physical integrity. Upslope areas would be restored according to the ECRP, which was developed with input from the Forest Service. Excess material excavated to stabilize banks would be placed by agreement with the Forest Service in a stable location that would not contribute sediment to stream channels. Streambank revegetation measures are outlined in Section 10.0 of the ECRP. In all cases, effective ground cover consistent with agency requirements would be in place prior to the onset of seasonal precipitation (table 1-15 .

The construction corridor width would be narrowed to 75 feet at stream crossings where possible. Low-growing bank vegetation would be maintained to the extent possible.

The pipeline trench would be 4 to 5 feet wide and deep enough to insulate the pipe from channel scour and debris flows during the expected life of the project. Typically, approximately 36 inches of overburden is placed on the pipe, but site-specific conditions may require additional depth. Trench plugs would be installed on each side of the crossing to ensure that water from the channel does not enter the trench or that the trench does not drain adjacent wetlands. After the particular section of pipeline is in place and has been hydrostatically tested, the trench would be backfilled with excavated material and capped with rock and cobble of sufficient size to prevent erosion of the trench fill material. The streambed and banks and associated habitat components (e.g., LWD and boulders) would be restored to preconstruction configurations as determined by the Forest Service.

As a follow-up measure to help ensure crossing actions would not adversely affect stream bank and channel structure, Pacific Connector would monitor all stream crossings quarterly for 2 years after construction, regardless of risk. Any adverse issues found during the monitoring with channel stability or habitat would be remediated. Additional monitoring would occur periodically over a 10-year period with implementation of remediation as needed (See EIS Section 4.4.2.2, Waterbody Crossing Methods).

1.4.1.1 Application of Best Management Practices for Water Quality

“Best Management Practices” are proven methods of reducing impacts on water quality that may result from a construction project. Applicability and selection of Best Management Practices depend on the site conditions and risk of an adverse consequence. The end result of application of Best Management Practices is moderation of effects of an action on water quality to an acceptable level.

At the request of the U.S. Fish and Wildlife Service (USFWS) and ODEQ, Pacific Connector has completed a risk assessment for stream channel crossings and has filed that report as part of its application with FERC (GeoEngineers 2013c). The GeoEngineers’ Risk Analysis provides:

- Predicted project effects on the short-term and long-term stability of the stream channel at the location of pipeline construction as well as upstream and downstream of the crossing site.
- Predicted project effects on the ecological functions and values of the streams and riparian areas being crossed by the project, particularly with respect to hydrogeomorphic and ecological connectivity.

This evaluation is presented in a two-axis matrix, with site or stream response potential on the X-axis and construction impact potential on the Y-axis (figure 1-2). Each of these two factors is evaluated individually on the X and Y axes of the risk matrix and assigned to a management category. Appropriate Best Management Practices are assigned to each management category. Specific results of the analysis are provided in each of the watershed discussions in Chapter 2 of this report. The database and information used to support this analysis are provided in GeoEngineers' Stream Crossing Risk Analysis filed by Pacific Connector as part of the FERC application.

Figure 1-2 Matrix for Evaluation of Construction Impact and Site Response Potential

<table>
<tr><td rowspan="4">Project Impact Potential</td><td>H</td><td colspan="2">Green Management Category:

Pacific Connector Project Typical Construction with habitat enhancement Best Management Practices (Best Management Practices)</td><td>Red Management Category:

Site-Specific Design (in consultation with agency representatives)</td></tr>
<tr><td>M

L</td><td>Blue Management Category:

Pacific Connector Project Typical Construction (in consultation with agency representatives)</td><td>Yellow Management Category:

Pacific Connector Project Typical Construction with Best Management Practices for sensitive bed, bank, or riparian revegetation conditions to be selected by Environmental inspector (in consultation with agency representatives) during construction.</td><td>Orange Management Category:

Pacific Connector Project Typical Construction with Best Management Practices for sensitive bed, bank, or riparian revegetation conditions selected by qualified professional prior to construction-based site-specific information from preconstruction evaluation (in consultation with agency representatives).</td></tr>
<tr><td></td><td>L</td><td>M</td><td>H</td></tr>
<tr><td colspan="4">Site Response Potential</td></tr>
</table>

Note: At the request of ODFW and ODEQ, Pacific Connector, this table provides a framework to segregate stream crossings into different management prescriptions based on the potential site response (the X axis) and potential construction impacts (the Y axis). On NFS lands, 30 stream crossings are in the Blue, or low risk, management category; 8 are in the Yellow, or moderate risk, management category; and 3 are in the Green category and have high risk to valuable aquatic habitats. Application of Best Management Practices is tailored to the risk predicted for the site. During preconstruction inspections, applicable Best Management Practices would be described as needed by the FERC environmental inspector and agency representatives to protect water quality and restore aquatic habitats after construction.

The "X" axis of the matrix addresses potential impacts related to channel stability. The four attributes on which the "X" axis is scored are:

- Channel Slope or Stream Type: Higher gradient slopes—often associated with bedrock or coarse colluvial material in the streambed or banks—represent relatively low risk, while low-gradient channels that are prone to depositional instability, lateral migration, or avulsion (as on an alluvial fan) are associated with high risk. Incised channels are also associated with high relative risk.

- Riparian Corridor: Wide or unconfined riparian corridors represent relatively low-risk and confined or infrastructure-constrained (e.g., with roads, levees) riparian corridors representing high risk.
- Bank Characteristics: Bedrock represents a low-risk bank. Risk increases with more erodible banks, but erodibility is left open to consider the interactions of bank soil grain size, bank stratigraphy and consolidation/cementation, bank angle, and bank vegetation.
- Bed Materials: This attribute is directly related to the ease of erosion and arranged in risk order from low (bedrock) to high (sand). Risk order for granular materials is based on erosion thresholds rather than strictly grain size. Due to cohesion, a clay or silt bedded stream is less erodible than a sand-bedded stream.

The "Y" axis of the matrix addresses potential impacts to riparian structure and function. The four attributes on which this "Y" axis is scored are:

- Artificial Bed/Bank Stabilization: A low risk designation is given to locations where existing bed or bank hardening is removed, allowing greater expression of normative geomorphic processes. The high risk designation is given to locations where rigid (i.e., non-deformable) bed or bank stabilization must be used to stabilize the channel to prevent post-construction instability as evaluated by the "X" axis of the Risk Matrix. Non-deformable stabilization includes any structures that are designed to maintain the location or grade of the channel margin in the face of extreme flood events.
- Construction Methods/Duration: Based on the intensity of surface disturbance, low risk is allocated to trenchless techniques or simple excavated crossings of low-gradient streams while higher risk is associated with locations requiring blasting or other means of invasive rock fracturing. Typical pipeline construction techniques score on the low to moderate part of this axis.
- Channel Disturbance Width: This attribute is based on the assumption that variations in channel geometry, such as pools and riffles, are an indication of high-quality aquatic habitat. Because these morphologic variations typically occur on longitudinal dimensions proportional to channel width, fixed-width construction activities that disrupt a narrower channel could potentially disturb more distinct aquatic habitat units than construction activities that disrupt a wider channel. Therefore, headwater streams would score high on this attribute.
- Floodplain Disturbance Width: This attribute assumes that perpendicular crossings of the stream would be associated with reduced loss of riparian and floodplain habitat because a relatively small proportion of the floodplain is disturbed in the down-valley direction, while alignments that parallel rivers are considered to more readily alter patterns of down-valley riparian values.

Blue Management Category

Waterbody crossings in this category have low or moderate scores for all eight risk factors. Construction and site restoration would follow the methods and typical drawings shown in appendix 1b of the ECRP. Post-construction site restoration would use Best Management

Practices such as seeding, planting, and hydromulch or erosion control blankets to minimize surface erosion while new vegetation becomes established. Typical site revegetation and backfill would be used to address habitat issues at these sites. The "project typical" Best Management Practices used for waterbody crossings in this and the other four management categories are summarized in table 1-7. Stream crossings in the Blue category are found in table 1-8.

TABLE 1-7

Best Management Practices Common to All Crossings and to the Blue Category

Crossing Component	Best Management Practices and (Source)
Streambed	• Dry ditch crossings (5) • Backfill with native material (3, 4) • Backfill to match existing streambed gradation, composition as much as possible (4) • Profile restored to existing profile and grade (4) • Stratified backfill for fish-bearing streams (1)
Streambanks	• Typical erosion and sediment control Best Management Practices, including mulch, hydromulch, placement of coarse woody debris for surface projection, seeding and fertilizing, erosion control blankets, silt fences. • Narrowed construction disturbance (75 feet) corridor where feasible (2, 3, 4) • Narrowed permanent management corridor (2, 3, 4) • Aggressive revegetation with native plant materials (3, 4, 6)
Riparian Vegetation	• Revegetation with native trees to within 15 feet of the pipeline parallel to the alignment (1, 3, 5, 6) • Revegetation with native woody riparian shrubs and trees, widened riparian corridor (federal lands, willing landowners) (3, 6) • Use of fast-growing native tree species to accelerate shading (3)
Aquatic Habitat	• Stratified backfill for fish-bearing streams (1, 2, 4, 6) • Placement of large wood where appropriate (2, 4, 6)
BMP Sources	1. FERC Guidelines 2. FEIS, JPA, Appendix C, Project Description 3. JPA Appendix 1B, ECRP 4. JPA Appendix F, Affected Waters, Section 2.1.8.3 5. JPA Appendices 2C, 2D 6. JPA Appendix H, Compensatory Mitigation Plan Agency representatives of the BLM and Forest Service may require additional measures necessary to meet agency standards under the terms of the Right-of-Way grant.

TABLE 1-8

Stream Channel Crossings, Blue Category

Fifth Field Water-shed	Sixth Field Subwatershed	MP	Type a/	Description a/	Bankfull Width (ft) b/	Width of Crossing (ft) a/	Channel Gradient (%) b/	Channel Incision (ft) b/	Bank Character b/	Streambed Material b/	Turbidity Rating c/	Site Response Rating d/	Construction Impact Rating d/	Overall Rating e/
Upper Cow Creek	SF Cow Cr.	109.69	P	HF-J Perennial stream on FS land, part of AW298 - Willow dominated wetland	12	10.2	13.15		erosion resistant	large cobble	M	L	M	BLUE
Upper Cow Creek	SF Cow Cr.	111.01	I/P	Perennial stream with summer flow diversion. Summer the stream intermittent because of diversion, drainage, U-shaped, cobble 1-2' wide		16.41					I	I	I	BLUE
Little Butte Creek	Salt Cr.	141.17	I	1-2’ wide intermittent stream with little vegetation		2.51					I	I	I	BLUE
Little Butte Creek	Salt Cr.	141.44	I	3-4’ average width, U-shaped channel, 8%gradient	4	43.2	13.89		Highly erosion resistant	bedrock	L	L	L	BLUE
Little Butte Creek	Salt Cr.	141.49	I	1-2’ wide intermittent drainage		4.45					L	I	I	BLUE

TABLE 1-8

Stream Channel Crossings, Blue Category

Fifth Field Water-shed	Sixth Field Subwatershed	MP	Type a/	Description a/	Bankfull Width (ft) b/	Width of Crossing (ft) a/	Channel Gradient (%) b/	Channel Incision (ft) b/	Bank Character b/	Streambed Material b/	Turbidity Rating c/	Site Response Rating d/	Construction Impact Rating d/	Overall Rating e/
Little Butte Creek	Beaver Dam Cr.	166.21	I	Daley Creek. 30-40' wide braided channel, cobble/gravel substrate,		26.51					I	I	I	BLUE
Spencer Creek	Buck Lake	171.06	I	Small, 10 feet wide stream associated with wetland swale	12	154.82	3.3	0.75	Erodible	silt	M	L	M	BLUE
Spencer Creek	Buck Lake	171.57	P	2' wide stream that fans out into a wetland/strea m complex		4.05					L	I	I	BLUE
Spencer Creek	Buck Lake	172.48	I	Wetland/Strea m	5	64.25	1.98		Highly erosion resistant	gravel	M	L	M	BLUE
Spencer Creek	Upper Spencer Cr.	173.74	I	4' wide, snowmelt Intermittent stream		8.17					I	I	I	BLUE
Spencer Creek	Upper Spencer Cr.	174.0	I	1-2' wide, snowmelt intermittent stream	3	3.02	5.3		Highly erosion resistant	gravel/ soil	L	L	L	BLUE
Spencer Creek	Upper Spencer Cr.	176.55	I	1' wide intermittent shrubbed stream Extension of ESI069' - wide, 2' deep	4	2.02	57.99		Erodible	gravel/ soil	M	L	M	BLUE

TABLE 1-8

Stream Channel Crossings, Blue Category

Fifth Field Water-shed	Sixth Field Subwatershed	MP	Type a/	Description a/	Bankfull Width (ft) b/	Width of Crossing (ft) a/	Channel Gradient (%) b/	Channel Incision (ft) b/	Bank Character b/	Streambed Material b/	Turbidity Rating c/	Site Response Rating d/	Construction Impact Rating d/	Overall Rating e/

Sources
a/ Table 2A-3a, Resource Report 2, Water Use and Quality, PCGP 2017
b/ Table A-2, Stream Crossing Risk Analysis, GeoEngineers 2011
c/ Table B-1, Turbidity, Nutrients and Water Quality Analysis, GeoEngineers 2011
d/ Table A-1, Stream Crossing Risk Analysis, GeoEngineers 2011
e/ Figure 4, Stream Crossing Risk Analysis, GeoEngineers 2011

Yellow and Orange Management Categories

Sites in the yellow management category represent moderate risk for stream channel stability based on this risk assessment scoring. This scoring typically requires at least one high-risk channel attribute and the remaining attributes to be at least moderate. These channels occur at all points in the watershed. More robust Best Management Practices, particularly for streambanks and streambeds, would be used in addition to those included in the "Project Typical" set of Best Management Practices, as described in table 1-9. Specific Best Management Practices would be selected by the environmental inspector or suitably trained professionals in consultation with agency representatives prior to construction. Stream crossings in the Yellow category on NFS lands are shown in table 1-9.

TABLE 1-9

Best Management Practices for Crossings in the Yellow and Orange Categories

Crossing Component	**Best Management Practices and (Source)** (These would be selected as needed by the FERC environmental inspector after a preconstruction evaluation with agency representatives.)
Streambed	• Dry ditch crossings (5) • Backfill with native material (3,4) • Backfill to match existing streambed gradation, composition as much as possible (4) Profile restored to existing profile and grade (4) • Stratified backfill for fish-bearing streams (1) • Structural fill placement (2)
Streambanks	• Typical erosion and sediment control Best Management Practices including erosion control blankets, silt fence, etc. • Narrowed construction disturbance (75 feet) corridor where feasible (2,3,4) • Narrowed permanent management corridor (2,3,4) • Revegetation with native plant materials (3, 4,6) • Bank graded/terraced to 3:1 (2,3) • Geotextile reinforced slope (5) • Fiber rolls (3) • Stream barbs/flow deflectors (5) • Toe rock placement (3) • Riprap placement (3) • Biotechnical "vegetation" riprap (3) • Tree revetments (3)
Riparian Vegetation	• Revegetation with native trees to within 15 feet of the pipeline parallel to the alignment (1, 3, 5, 6) • Revegetation with native woody riparian shrubs and trees (3) • Widened riparian corridor (federal lands (3, 6) • Use of fast growing native tree species to accelerate shading (3)
Aquatic Habitat	• Stratified backfill for fish-bearing streams (1,2,4, 6) • Placement of large wood where appropriate (2, 4, 6)
BMP Source	1. FERC Guidelines 2. FEIS, JPA, Appendix C, Project Description 3. JPA Appendix 1B, ECRP 4. JPA Appendix F, Affected Waters, Section 2.1.8.3 5. JPA Appendices 2C, 2D 6. JPA Appendix H, Compensatory Mitigation Plan Agency representatives of the BLM and Forest Service may require additional measures necessary to meet agency standards under the terms of the Right-of-Way grant.

Sites in the orange management category represent the highest potential risk for short- and long-term channel stability. This scoring typically requires more than one high-risk (score of 4 or 5) channel attribute and that the remaining attributes be at least moderate.

Channel conditions that have placed streams in the yellow or orange management categories include:

- Channel Incision: Incised channels represent the greatest risk observed on the Pacific Connector alignment because they are likely to result in continued bank erosion as channel banks evolve into a more stable configuration. For those incised channels that are not already eroded down to bedrock, additional scour is also possible, depending on whether downstream grade control is present in proximity to the crossing site. Channel banks would require the incorporation of deformable stabilization during site restoration.

- Channel Slope: Streams at lower and moderate slopes are more prone to channel migration, and streams on moderate slopes are also prone to channel scour. Channel migration and scour risk were assessed previously for the named waterbodies (GeoEngineers 2007) and are accounted for in locating the pipe overbend and burial depths. Streams with very high channel slopes (>20%) require selective placement of coarse materials available from the pipeline trench to provide additional grade control.

- Riparian Condition: More robust woody vegetation in the riparian zone typically reduces avulsion risk and aids in reducing erosion of stream banks. Revegetation to maintain the continuity of the existing riparian zone is appropriate for these streams.

- Channel Bed and Bank Materials: Erodible materials in the bed or bank present a greater short-term risk of scour or lateral migration than do non-erodible materials. Erodible banks are more likely to require the addition of deformable bank or bank toe stabilization. Channel scour is addressed by selection of the pipe burial depth and by the selective placement of available coarse materials in the backfill.

TABLE 1-10

Stream Crossings in the Yellow Category

Fifth-Field Water-shed	Sixth-Field Subwatershed	MP	Type a/	Description a/	Bankfull Width (ft) b/	Width of Crossing (ft) a/	Channel Gradient (%) b/	Channel Incision (ft) b/	Bank Character b/	Stream-bed Material b/	Turbidity Rating c/	Site Response Rating d/	Construction Impact Rating d/	Overall Rating e/
Upper Cow Creek	SF Cow Cr.	109.17	P	HF-C perennial stream with associated seep wetland with shrubs	5	12.02	18.6		erodible	sand	M	M	M	YELLOW
Upper Cow Creek	SF Cow Cr.	109.33	I	HF-F 3' wide intermittent		7.54					m	m	m	YELLOW
Little Butte Creek	Lick Cr.	140.26	I	Lick Creek, 10-20' wide, U-shaped channel		12.33					M	m	m	YELLOW
Little Butte Creek	Upper SF Little Butte Cr.	162.45	P	U-shaped, 1% gradient	22	19.62	0.87		erosion resistant	gravel/ cobble	M	M	M	YELLOW

Sources
a/ Table 2A-3a, Resource Report 2, Water Use and Quality, PCGP 2017
b/ Table A-2, Stream Crossing Risk Analysis, GeoEngineers 2011
c/ Table B-1, Turbidity, Nutrients and Water Quality Analysis, GeoEngineers 2011
d/ Table A-1, Stream Crossing Risk Analysis, GeoEngineers 2011
e/ Figure 4, Stream Crossing Risk Analysis, GeoEngineers 2011

Green Management Category

Streams in the green management category for sites with high habitat impact potential would use typical site construction methods. In addition to these Best Management Practices, emphasis would be placed on the habitat restoration measures described below. Channels placed in this field typically are those that disturb a greater proportion of the existing floodplain or—in narrower streams—potentially disturb more varied aquatic habitat. During site restoration, however, particular effort would be made for using Best Management Practices for opportunistic habitat enhancement, as detailed from observations obtained during the preconstruction survey. These could include riparian planting to improve existing habitat conditions in the floodplain, placement of large wood or rock to improve in-stream habitat, or modification of existing riprap to improve habitat. Where these channels require the addition of deformable bank stabilization, maximum use would be made of Best Management Practices that promote bank revegetation with woody materials. In addition to the "Project Typical" Best Management Practices, Pacific Connector would propose additional Best Management Practices for use at crossings in this management category, as shown in table 1-11.

TABLE 1-11

Best Management Practices for Crossings in the Green Category

Crossing Component	Best Management Practices and Source
Streambed	• Dry ditch crossings (5) • Backfill with native material (3, 4) • Backfill to match existing streambed gradation, composition as much as possible (4) • Profile restored to existing profile and grade (4) • Stratified backfill for fish-bearing streams (1)
Streambanks	• Typical erosion and sediment control Best Management Practices, including erosion control blankets, silt fences, etc. • Narrowed construction disturbance (75 feet) corridor where feasible (2, 3, 4) • Narrowed permanent management corridor (2, 3, 4) • Revegetation with native plant materials (3, 4, 6) **Additional Measures** • Rootwad enhancement of bank stabilization
Riparian Vegetation	• Revegetation with native trees to within 15 feet of the pipeline parallel to the alignment (1, 3, 5, 6) • Revegetation with native woody riparian shrubs and trees for willing landowners (3) • Widened riparian corridor (federal lands, willing landowners) (3, 6) • Use of fast growing native tree species to accelerate shading (3) **Additional Measures** • Emphasis on prevention and monitoring for invasive weeds and weed control during revegetation establishment.
Aquatic Habitat	• Stratified backfill for fish-bearing streams (1, 2, 4, 6) • Placement of large wood where appropriate (2, 4, 6) **Additional Measures** • Rootwad enhancement of bank stabilization
BMP Sources	1. FERC Guidelines 2. FEIS, JPA, Appendix C, Project Description 3. JPA Appendix 1B, ECRP 4. JPA Appendix F, Affected Waters, Section 2.1.8.3 5. JPA Appendices 2C, 2D 6. JPA Appendix H, Compensatory Mitigation Plan Agency representatives from the BLM and Forest Service may require additional measures necessary to meet agency standards under the terms of the Right-of-Way grant.

Best Management Practices to address specific components of waterbody crossings at sensitive crossing locations (i.e., with high project impact potential and moderate or high site or stream response potential) are summarized in table 1-12. Stream crossings in the green category are listed table 1-12. Specific Best Management Practices would be selected by the environmental inspector suitably trained professionals prior to construction.

TABLE 1-12

Stream Crossings in the "Green" Category

Fifth Field Water-shed	Sixth Field Subwatershed	MP	Type a/	Description a/	Bankfull Width (ft) b/	Width of Cross-ing (ft) a/	Channel Gradient (%)b/	Channel Incision (ft) b/	Bank Character b/	Stream-bed Material b/	Turbidity Rating c/	Site Response Rating d/	Construction Impact Rating d/	Overall Rating e/
Upper Cow Creek	SF Cow Cr.	109.47	P	HF-G EF Cow Creek – 28' wide, broad, cobbles, boulders, 2' wide	12	26.44	3.32	3.5	erosion resistant	cobble and boulders	M	M	H	GREEN
Upper Cow Creek	SF Cow Cr.	109.78	P	HF-K perennial stream on NFS Lands (INCORRECT LY ID AS INT in 2A-3A)	8	5.16	9.61	3	highly erodible	cobble and gravel	M	M	H	GREEN

Sources
a/ Table 2A-3a, Resource Report 2, Water Use and Quality, PCGP 2017
b/ Table A-2, Stream Crossing Risk Analysis, GeoEngineers 2011
c/ Table B-1, Turbidity, Nutrients and Water Quality Analysis, GeoEngineers 2011
d/ Table A-1, Stream Crossing Risk Analysis, GeoEngineers 2011
e/ Figure 4, Stream Crossing Risk Analysis, GeoEngineers 2011

Red Management Category

No channels were found to score in the red management category on NFS lands presenting both a high risk of stream response and habitat impact under the range of construction methods and Best Management Practices proposed for the Pacific Connector project. This field would require site-specific design and specifications such as those required by FERC (2003) for major waterbodies (>100-ft crossing widths) prior to construction. Following the preconstruction survey, a site-specific design would be developed and incorporated into project construction plans if more detailed information results in the reclassification of a site into this field (for example, due to the necessity of adding nondeformable bank stabilization).

Pre-Construction Survey

Forest Service personnel have reviewed stream inventory data and have field-verified all perennial and most intermittent crossings. It is possible, however, for conditions to change between the time of inventory and the time of construction. In order to ensure that prescriptions are still appropriate for the conditions at each crossing, a review of all crossings would be completed prior to construction. At sites where conditions have changed significantly from those described in the Pacific Connector application (PCGP Wetland Delineation Report, 2013, GeoEngineers (2013c), the preconstruction survey would reevaluate whether the management category for these sites should be modified. Channel information to be verified during the preconstruction survey at the higher risk habitat sites (green management category) would include channel configuration/morphology; size and distribution of instream structure that affects the in-channel distribution of hydraulic energy (e.g., logs and large rock), substrate grain size and thickness of the active channel substrate, and bank geometry and material configuration. Appropriate permitting entities would be notified of changes in management approach and the rationale for such changes; with respect to habitat conditions, the preconstruction survey would document the type and frequency of individual aquatic habitat units and specific information on current riparian vegetation. As provided the right-of-way grant, agency representatives would be engaged and consulted during the survey and may require additional measures necessary to accomplish ACS objectives.

1.4.1.2 Water Quality—Sediment

Short-Term Sediment Related to Construction of Stream Crossings

Because of their linear nature, natural gas and oil transmission pipelines must traverse streams, rivers, and other water bodies. The PCGP would cross perennial streams that have flowing water year-round and intermittent streams that typically stop flowing during dry summer months and may or may not have flowing water at the time of construction. Watercourse crossing construction can increase downstream suspended sediment concentrations through trench excavation (trenching), backfilling the storage of excavated material directly in the watercourse, the installation of isolation and diversion structures, erosion and run-off from adjacent upland worksites, and the discharge of water from hydrostatic pipe testing or trench dewatering (Reid and Anderson 1999, Reid et al. 2004). Amounts and concentrations of sediments depend on the nature of the soil and streambed materials (gravel, silt, etc.) at the crossing site, streamflow, construction methods, and other variables (Levesque and Dube 2007).

All PCGP project stream crossings on NFS lands with flowing water at the time of construction would be accomplished using the dry, dam-and-pump method (figures 1-3 , 1-4 , 1-5). This stream crossing method maintains downstream flow while isolating the construction area between upstream and downstream dams from flowing water by pumping the water around the construction area. Dry dam-and-pump stream crossings typical of Forest Service landscapes would likely take from 1 to 5 days to complete, although construction periods can vary significantly depending topography and flows. It is anticipated that many smaller stream channels on Forest Service lands can be crossed in less than 48 hours. On larger flowing streams, flumes may be added to the process if necessary to move water past the crossing or to maintain passage for aquatic biota (figure 1-5).

The objective of the dry dam-and-pump method is to isolate the construction crossing from waters in the stream being crossed to minimize the release of sediment. Sediment effects from isolated dry crossings are generally short term and are associated with:

1. installation and removal of the upstream and downstream dams (figure 1-3);
2. water leaking through the upstream dam into the work area;
3. movement of in-stream rocks and boulders to allow proper pipeline alignment and installation of the dams; and
4. return of streamflow to the construction work area after the crossing is complete and the dams are removed.

Figure 1-3 Installation of a dam in a dry open cut crossing of a small channel

Figure 1-4 Preparation of perennial stream crossing with equipment bridges and sediment fence installed

Figure 1-5 Dam-and-pump crossing of perennial stream with flume.

Background Sediment Concentrations

Background sediment concentrations and range of variation from disturbance provide a baseline for considering potential effects of the project. Project-generated sediment added to background levels provides an estimate of the total sediment concentration associated with project construction. These total sediment amounts can be compared to historical ranges of sediment concentrations to provide a framework to evaluate the effects of the PCGP related to ACS objectives.

Sediment amounts in Pacific Northwest streams vary by orders of magnitude with flows, precipitation, stream position in the watershed, disturbance events, watershed conditions, and many other variables. Episodic high-intensity storms may generate the majority of the sediment transported for the entire year while suspended sediments during summer months generally remain low in the absence of disturbance events. For example, a review of 6 months of USGS gage data in Cow Creek prior to the construction of Galesville Dam showed that 95% of the sediment transport for the reporting period occurred in one 3-day storm. Sediment concentrations reached nearly 1,000 milligrams per liter (mg/L) during this 3-day event but averaged 3.5 mg/L for the rest of the year (Curtis 1982). USGS gage data from watersheds crossed by the project for dates that overlap the ODFW instream work window ranged from 1-13 mg/L and averaged 3.4 mg/L (USGS 2013). Historical USGS gage data (1950–1979) for the Klamath River, which is part of the Klamath Siskiyou physiographic province[3] south of the project area, range from less than 5 mg/L during low summer flows to over 5,000 mg/L during winter high flows, although sediment concentrations greater than 1,000 mg/L have been recorded during summer months (Bureau of Reclamation 2012. VII: C16).

Stand-replacement fire and high-intensity rainstorms are the primary historical disturbance factors that mobilize sediment in Pacific Northwest watersheds (see Section 2.1). Changes in sediment concentrations following a fire vary with fire intensity, rainfall intensity, topography, remaining duff layer, soil type, and many other factors. There are many anecdotal records of flow and sediment increases following fires, but pre- and post-fire measurements that quantify such events are rare because of the stochastic nature of stand-replacement fire and watersheds with instrumentation are only rarely involved in high-intensity fire. Where pre- and post-fire surveys have been completed, high-intensity fire has generally resulted in a substantial increase in sediment transport and deposition in streams.

- The accelerated erosion associated with intense fire combined with normal background levels may cause a five-fold increase in sediment yield in Douglas-fir and western hemlock forests (Swanson 1981, cited in Catching Beaver WA).
- When site disturbances such as severe fire produce hydrologic conditions that are poor (less than 10% of the ground surface covered with plants and litter), surface runoff can increase by more than 70% and erosion can increase by three orders of magnitude (Robichaud et al. 2000).

[3] Portions of the Coquille, Umpqua, Rogue River, and Klamath basins are in the Klamath-Siskiyou geologic province and have similar geology, soils, and weather patterns, and likely have similar sediment responses to storms.

- A study in New Mexico showed a stand-replacement fire in a pine and mixed-conifer forest resulted in flow and sediment concentration increases of two orders of magnitude over pre-fire conditions, with most of the fine sediment transport occurring in the first two years following the fire (Malmon et al. 2007). Timing of precipitation can mitigate these effects in some circumstances. Post-fire measurements in Glacier National Park in the northern Rocky Mountains showed little increase in sediment concentrations when snow fell on the fire area early in the winter, buffering it from high-intensity rainfall events. This is consistent with observations of Pettigrew et al. (2006) in central British Columbia, suggesting that increases in sediment transport following wildfires is transport-limited, not supply-limited.

- In Wyoming, three stations on the Little Granite Creek watershed of the Gros Ventre range near Bondurant were monitored in 2002 and 2003 following a large fire in 2000 that burned most of the Boulder Creek subwatershed. The primary sources of sediment in the watershed are mass wasting, including active earthflows from unstable hill slopes, and slumping from undercut terraces and road cuts. Estimates of peak concentrations during the first post-fire year (2001) ranged from 300 to 1,200 mg/L and 350 to 5,700 mg/L at two different measuring stations during the snowmelt period. During baseflow periods in 2003, suspended sediment concentrations ranged from 2 to 7 mg/L at the upper site and 0.2 to 10 mg/L at the lower site. During a summer thunderstorm, sediment concentrations peaked at 200 mg/L (Ryan et al. 2006).

- In northern California, high-intensity rainfall following a high-intensity fire in 2012 showed a five-fold increase in turbidity (and by inference, sediment concentrations) in the McCloud River. The Forest Service estimates the rain events following the fire mobilized 4.5 million cubic yards of sediment (Shasta-Trinity NF 2014).

- Monitoring of the ACS showed that of watersheds that declined in condition during the 10 years since strategy implementation. The largest declines included watersheds where wildfires burned 30 to 60% of their area (Reeves et al. 2009).

For most of the Klamath-Siskiyou and Western Cascades provinces, high-intensity winter rainfall events have had the most impact on erosional processes. In the High Cascades province, most precipitation falls as snow. In these areas, geologically recent volcanic deposits may be less impacted by rainfall but are subject to mass wasting when saturated by snowmelt.

From this review of data and literature, the following are basic conclusions concerning background sediment concentrations:

- Sediment in Pacific Northwest stream systems is delivered in pulses associated with disturbance events. High-intensity fire followed by high-intensity rainfall can mobilize huge pulses of sediments. Typically, these occur in winter storms, but may occur asn snowmelt runoff at higher elevations, with the onset of seasonal precipitation in the fall and in summer thunderstorms. These events are infrequent.

- Based on USGS gage data, sediment concentrations in high-flow winter events may reach 1,000 to 5,000 mg/L and remain at high levels for days during large storms.

- Based on limited USGS gage data, sediment concentrations in summer base flows in watersheds crossed by the project typically range from 1 to 13 mg/L. Based on this data, sediment concentrations would be expected to range from 0 to 4 mg/L in small mountain streams with gravel substrates. Valley bottom streams with silt and sand substrates would be expected to range from 2 to 7 mg/L. Streams in which ongoing irrigation activities occur may consistently run above these natural ranges, which is consistent with literature citations for the Klamath Basin (Bureau of Reclamation 2012).

- Summer thunderstorms following a stand-replacement fire can cause short-term spikes in sediment concentrations that may increase over ambient sediment concentrations by orders of magnitude. No local data is available. Levels of 200 mg/L have been documented in Wyoming during a summer thunderstorm. USGS gage data showed a sediment concentration spike of 1,000 mg/L in the Klamath River in August, though causality is unknown.

Increases in Sediment Associated with Pipeline Crossing Construction

Measurement of sediment can be expressed many different ways. For example, a 5-gallon bucket of silt could generate suspended sediment concentrations in the thousands of mg/L at the point of origin and remain suspended in the water column for long distances. Without some estimate of the volume of sediment (5 gallons), the concentration (thousands of mg/L) would not provide a meaningful measure of watershed effects. Duration of exposure is also important to aquatic biota. Several days of chronic exposure to lower concentrations of sediment can be much more impacting than a single high spike in sediment concentration. In this assessment, the scale (where and how far), the duration (how long) and magnitude (how much, expressed both as concentration and estimated volume) are used to provide an assessment of effects on aquatic biota. Precise predictions are impossible to make because of background variables and site conditions, so where appropriate, an expected range of values is used to describe project effects.

Several studies concerning construction of buried pipeline stream crossings have evaluated sediment increases associated with dam-and-pump isolated construction methods.[4] Levesque and Dube (2006) reviewed and summarized the effects of various crossing construction methods, noting that pipeline-crossing construction may have detrimental effects on aquatic ecosystems. Reid and Anderson (2002) studied sediment transport at eight dam-and-pump crossings with measurable flow in northern Alberta, Canada, in winter 1999/2000. Habitat alteration (i.e., sediment deposition) was studied at three of these crossings. Between 1 and 9 days were required for instream construction. All but one had flow of 0.1 cubic meters per second (m^3/sec) or less. Samples were collected across the duration of construction. Background sediment concentrations ranged from 2.4 to 14.6 mg/L. Results showed that the dam-and-pump technique was very effective in limiting sediment release in these small watercourses. Mean sediment concentration

[4] The studies cited here are from eastern Canada and the eastern U.S., since that is where most pipeline construction has occurred; these studies provide the best available evidence of possible increases in sediment concentrations. While these may be different environments than for the PCGP, the entrainment, transport, and deposition of sediment are physical processes dependent on flows, sediment texture, etc., not the location of the study. Stream crossings on the PCGP range from silty clays to gravels. By representing a range of likely outcomes, we account for possible differences in background conditions.

increase above background was 8.3 mg/L and median concentration above background[5] was 7.5 mg/L. Increases in downstream concentrations were generally limited to installation and removal of the dams and bypass pumps. Concentrations above background were generally greater during dam-and-pump removal (1.0 to 703 mg/L) than during installation (average less than 76 mg/L over background). Duration of effects during installation and removal of dams and pumps ranged from 20 minutes to 6.5 hours. During other phases of construction (trenching and backfilling), increases above background were generally less than 8 mg/L (Reid and Anderson 2002: 738). Sediment was more evident at crossing sites, with bed and bank materials consisting of fine-grained sediments. No impacts to downstream habitat due to sedimentation were found, and there was no evident pattern related to watercourse size or flow.

In another evaluation, Reid et al. (2002) conducted suspended sediment sampling during dam-and-pump crossings of four brook trout streams in Nova Scotia and Ontario, Canada (watered widths ranging from 1.1 to 3.6 m). Samples were collected at downstream distances ranging from 13 to 30 m. Instream work ranged from 16 hours to 41 hours spread over 2 to 6 days. During periods of increased sediment loading, samples were collected every 30 minutes and less frequently during periods of no instream construction. Sampling continued after completion of construction until downstream turbidity levels returned to background (typically less than 2.5 hours). Background (upstream) sediment concentrations ranged from <2 to 4 mg/L. Mean increases above background ranged from 4 to 20 mg/L for dam-and-pump crossings. Spikes in sediment concentration in association with dam-and-pump installation and removal ranged from 61 to 1,032 mg/L. These spikes were short term, with downstream sediment concentrations returning to the background level within 10 hours. This study found little evidence for downstream deposition of fine sediment or habitat alteration by sediment deposition. Reid et al. (2004) reviewed a number of studies and reported similar findings, noting that 90% of dam-and-pump crossings showed increases in sediment concentrations above background of less than 25 mg/L. In contrast, wet, open-cut crossings where water was not diverted had sediment increases 20 times that of isolated dam-and-pump crossings.

Distance transported and concentration of sediment transported downstream in suspension are highly variable and depend on the particle size (e.g., silt vs. sand, etc.), stream volume, stream velocity, and other variables. Reid et al. (2002) measured sediment deposition 20 and 115 meters downstream of dam-and-pump pipeline crossings and found surficial streambed material was generally unaffected, noting that a thin veneer of fine sediment was temporary and was resuspended within fewer than 3 days.

Pacific Connector calculated watershed-specific projected sediment concentrations for dam-and-pump crossings at the construction site 10 meters, 50 meters, and 100 meters downstream. Estimated total suspended solid (TSS) concentrations downstream from flumed dry open-cut construction ranged from less than 94 mg/L to 2 mg/L (see PCGP Resource Report 3, table 3.2-

[5] Most of the available literature on this topic report measurements of sediment concentrations expressed as mg/L of sediment. Turbidity is also used to measure suspended sediments. Turbidity is a measurement of the decrease in transparency of stream water as light is scattered by suspended particulate matter, generally expressed as nephelometric turbidity units (NTU). Relationships between turbidity and sediment concentrations are complex and vary with instrumentation and the nature of the sediment in suspension and generally need to be calibrated on-site to provide consistent measurement of sediment concentrations. In this review, sediment concentration rather than turbidity is used for comparison of effects.

25). Estimated TSS concentrations downstream from dam-and-pump dry open-cut construction range from about 23 mg/L to 2 mg/L (see PCGP Resource Report Table 3.2-25). Predicted sediment concentrations calculated by Pacific Connector are consistent with empirical data from studies of pipeline crossings using dam-and-pump crossing methods by Reid and Anderson (2002), Reid et al. (2002), and Reid et al. (2004).

Culvert removals are a routine management activity on federal lands and provide a familiar comparison of relative effects. In a study of culvert removals in Idaho and Washington, sediment concentrations were monitored at 11 stream crossings in three areas to measure the sediment concentrations associated with culvert removal (Foltz et al. 2008). Flow rates at two areas (Horse Creek and Wendover Creek) were low (0.1 to 0.6 L/s) and were higher (9-13 L/s) at the third (Granite Creek). In one area (Wendover Creek), the five culverts removed and monitored were log-constructed and old. Mitigation measures, including diverting the stream channel around the work area and installation of straw bales downstream of the crossings, were implemented at four Wendover Creek stations, but not at the others. At one of the Horse Creek stations, culvert removal occurred during several storm events. Peak sediment concentrations at unmitigated removals ranged from 2,060 mg/L to 28,400 mg/L with a mean of 13,000 mg/L. Sediment yields ranged from 3 kilograms (kg) (7 pounds) to 170 kg (375 pounds), with a mean of 67 kg (148 pounds). At the four locations on Wendover Creek where mitigation was applied (diversion and straw bales), peak sediment concentrations were between 300 mg/L and 1,300 mg/L, with a mean of 830 mg/L. Sediment yields ranged from 0.2 kg (1/2 pound) to 3 kg (7 pounds), with a mean of 1.6 kg (4 pounds). At the three locations on Horse Creek with 100-m downstream monitoring stations, concentrations were an order of magnitude lower than at the culvert outlet, and, at 810 m downstream, there was very little increase above ambient levels (10 mg/L) for the two locations not influenced by storms. At three of 10 locations (including the storm-influenced location), suspended sediments exceeded 6,000 mg/L for more than 1 hour, and at five locations, sediment concentrations exceeded 500 mg/L for 10 hours. These sediment concentrations are significantly higher than those predicted for dry isolated dam-and-pump crossings.

Based on these literature reviews, the following basic conclusions can be drawn concerning increases in sediment concentrations associated with dam-and-pump pipeline crossing construction:

- Measured sediment concentrations associated with installation of structures for dam-and-pump crossings at the beginning of crossing construction and removal of structures when the crossing is completed range from 60 to 1,100 mg/L, with an average of 76 mg/L above background levels. These are short-term effects; once work activity stopped, sediment concentrations returned to background levels within 2 to 10 hours.

- Increases in sediment concentration over background levels during the in-stream construction (trenching and backfilling) of crossings using dam-and-pump methods cited in the literature generally ranged from 4 to 20 mg/L, with a mean concentration above background of 8.5 mg/L. Pacific Connector's predicted sediment concentrations are consistent with the literature and well within this range (PCGP Resource Report 3, table 3.2-25).

- Total sediment yield varies with the size of the crossing, stream velocity, substrate and bank material, and other factors. As a comparison, using culvert removal with some mitigation (Foltz et al. 2008), total sediment amounts mobilized during crossing construction are expected to be in the range of 0.1 to 0.5 cubic feet, or less than a wheelbarrow of material on most crossings. This is roughly equivalent to a small bank slough.

- Durations of increased sediment concentrations depend on the time it takes to complete the crossing. Most streams on NFS lands are small and can be crossed in 1 to 2 days. Larger perennial streams may take as long as 5 days to complete construction. Once work activity stops, sediment concentrations typically return to background levels within 2 to 10 hours.

- The distance that increased sediment concentrations and deposition occur downstream depends on the size of the material in suspension, stream velocity, and other variables (see table 3.2-25, Resource Report 3).

- Predicted project-related increases in sediment concentrations are well within the historic range of variation for episodic pulses of sediment in Pacific Northwest watersheds.

- By comparison, culvert removal, which is a routine management action conducted by the Forest Service, may generate sediment concentrations that are an order of magnitude higher than those observed in dam-and-pump pipeline crossings where the construction area is isolated from the stream. Where culvert removal projects diverted the stream from the work area and installed sediment traps, amounts were similar to those expected from dam-and-pump crossings.

Effects of Increased Sediment Concentrations on Aquatic Biota

Effects of sediment on salmonids and other aquatic biota have been the subject of numerous studies. Both fish and invertebrate communities may be impacted by increases in sediment concentration.

One of the most widely cited studies of the effects of sediment concentrations on fish was conducted by Newcombe and Jensen (1996), who used 80 published and adequately documented studies to develop empirical equations (multiple regression models) relating biological response of fish receptor groups to suspended sediment concentrations (mg/L) and duration of exposure (hours), which combined constituted "dose." The five receptor groups of direct relevance to assessing impacts of PCGP Project stream crossings are as follows:

- juvenile and adult salmonids (171 data triplets);
- juvenile salmonids (63 data triplets);
- adult salmonids (108 data triplets);
- salmonid and nonsalmonid eggs and larvae (43 data triplets); and
- adult nonsalmonids (22 data triplets).

For each of these receptor groups, the documented effect(s) of suspended sediment exposure were categorized into one of 15 severity of ill effects categories (SEV), from 0 (no effect) to 14 (>80% mortality). These categories were then aggregated into four effect groups, as follows:

- nil effect (SEV=0);
- behavioral effects (SEV = 1 to 3);

- sublethal effects (SEV = 4 to 8); and
- paralethal and lethal effects (SEV = 9 to 14).

Newcombe and Jensen's paper noted the sensitivity of egg and sac-fry stages to increased sediment concentrations. Instream work windows regulated by the ODFW restrict timing to avoid periods when sensitive life stages of salmonids such as eggs or sac-fry are present.

Following on the work of Newcombe and Jensen (1996), Anderson et al. (1996) developed a dose-response (multiple regression) model to relate habitat alteration and changes in productivity to sediment concentration duration, finding that the duration of exposure played a more dominant role in determining habitat effects than did sediment concentration. The authors suggested that Newcombe and Jensen's (1996) SEV level of 7 be used to identify when sediment concentrations might be expected to cause habitat damage as measured by a change in the invertebrate community (p. 32).

Reid et al. (2004) conducted a detailed examination of the effects of elevated sediments associated with pipeline construction on fish physiology. The author studied the physiological response of caged rainbow trout downstream of simulated open-cut stream crossings on Serviceberry Creek in Alberta (0.46 m3/s discharge, construction duration 30.7 hours, cages 19 and 40 m downstream, background sediment concentration of 226 mg/L) and Conestoga River in Ontario (4.8 m^3/s discharge, construction duration 28.9 hours, cages 40 and 100 m downstream, background SC 50 mg/L). Mean sediment concentrations in Serviceberry Creek were raised to between 55 and 70 mg/L and peaked at >1,400 mg/L. On Conestoga River, mean sediment concentrations were raised by 65 mg/L and peak sediment concentrations by more than 450 mg/L. Physiological stress increased, as reflected by elevated rates of respiration (i.e., oxygen consumption) and loss of equilibrium, as well as by altered blood hematocrit levels, indicating potential damage to gills and hence decreased transfer of oxygen. The authors found that their results were consistent with the acute stress response defined by Newcombe and Jensen (1996).

Applying these concepts to the effects of pipeline construction, Trettel et al. (2002) collected data on sediment concentrations at stream crossings on a pipeline project in New Hampshire constructed using the dam-and-pump method and compared it to Newcombe and Jensen's (1996) SEV model for juvenile and adult salmonids. The average SEV rating for dam-and-pump crossings was 6.42, a sublethal score that would equate to moderate physiological stress on juvenile and adult salmonids on Newcombe and Jensen's SEV model. Thirty-six (36) percent of the crossings in Trettel et al. (2002) exceeded SEV of 7.0. The authors note that it is unlikely that an SEV of 7 would cause long-term damage to fish populations or habitats because of the short-term nature of most crossings and the rapid removal of the small amounts of fine sediments deposited downstream, typically in the first post-construction storm event. Due to the small stream reach impacted by increased suspended sediment loading, fish could temporarily move out of the area if they are under stress. The authors also discuss the relationship of SEV to grain size of sediments in the construction area. One hundred percent of sand and boulder crossings, 80% of sandy crossings, and 81% of loamy sand crossings had SEV <7. By contrast, 29% of crossings with 0 to 20% silt, 42% of the crossings with 21 to 40% silt, and 89% of the crossings with 41 to 60% silt have SEV >7. Trettel et al. (2002) note that high-silt crossings require more time, thereby extending the duration of exposure (and hence increasing the SEV). The study notes that construction during low-flow periods could lead to higher SEV values due to a higher residency time of suspended sediment and concludes that an SEV of 8.0 or 9.0 would better represent damage to fish populations.

Downstream transport and deposition of suspended sediment depends on many factors including the size of particles mobilized, stream gradient, and velocity and stream volume. For most individual crossings, the downstream distance where sediment concentrations above 17 mg/L (a level that may cause avoidance or stress) is estimated to be about 61 feet, with a range of 40 to 211 feet, depending on stream size (FERC 2010, p. 4-367). Typically, a crossing takes 24 to 48 hours at most sites so this displacement would be short term, minor, and generally limited to the construction site.

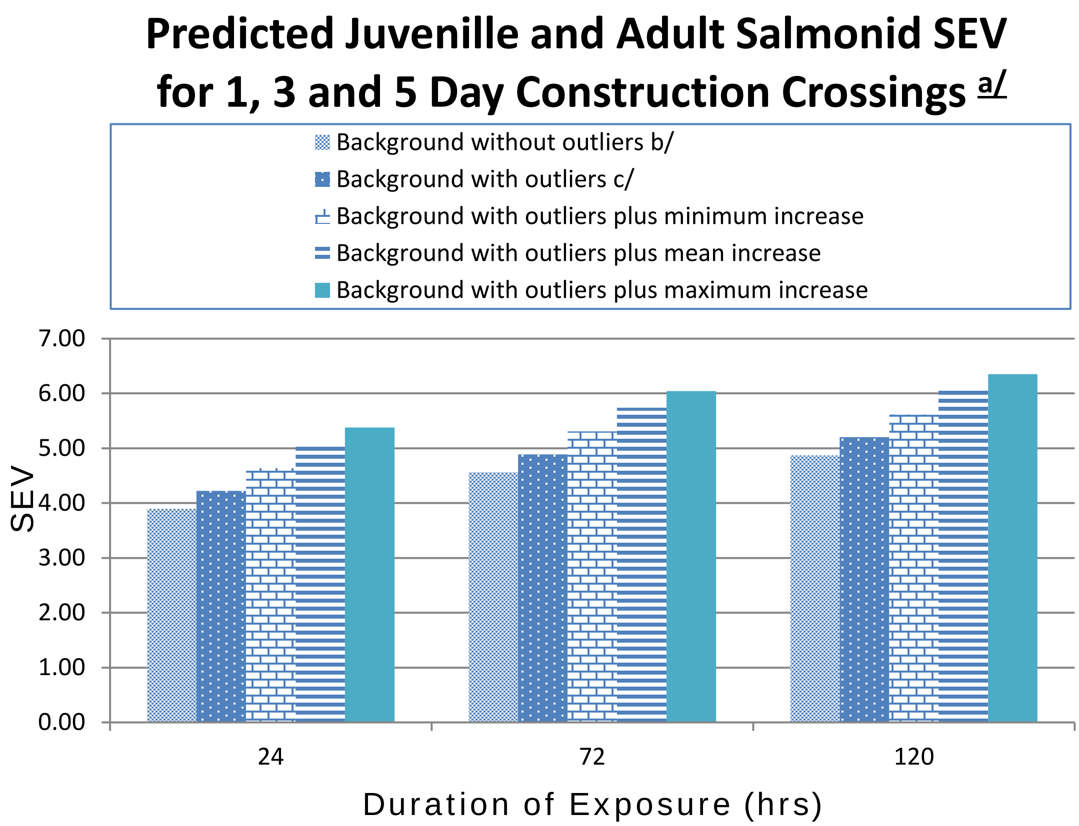
Using Newcombe and Jensen's (1996) model, SEV values for juvenile and adult salmonids were calculated for 1-, 3-, and 5-day sediment concentration exposures predicted for dam-and-pump crossings by the PCGP corridor (figure 1.3-5). Based on this evaluation, sediment associated with construction when added to background is likely to cause behavioral changes such as avoidance or cause minor physiological stress (SEV 4-6) and may cause moderate physiological stress (SEV 6), depending on the duration of exposure, but is unlikely to have paralethal or lethal effects (SEV 9 and above). This evaluation using empirical data is consistent with results from Pacific Connector's application of Newcombe and Jensen's model (Resource Report 3, table 3.2-22 (see Chapter 4, References)).

Many studies have reported a decrease in invertebrate abundance and a change in community composition as a result of sediment increases. Invertebrate species may be affected by pulses in sediment concentrations similar to those predicted with dam-and-pump crossing construction.

Newcombe and MacDonald (1991) reviewed more than 70 papers on the effects of suspended sediments and concluded that aquatic biota responds to both the concentration of suspended sediments and duration of exposure, noting that aquatic invertebrates are at least as sensitive to high levels of suspended sediment as salmonid fishes and perhaps more so. Based on Newcombe and MacDonald's findings, shorter term crossings (1 to 2 days) and/or crossings in coarser sediments (sand and gravel) would have relatively less impact on invertebrate communities than longer duration crossings that may include more silt and clay components.

Shaw and Richardson (2001) exposed invertebrate and juvenile rainbow trout to periodic pulses of sediments every 2 days for 9 days at a concentration of 704 mg/L. This study did not show a dose-related response until the fifth pulse (day 9). By this point, both drift and benthos abundance as well as benthos family richness were altered. This is consistent with Newcombe and MacDonald's (1991) finding that aquatic biota responds to both the concentration of suspended sediments and the duration of exposure. In evaluation of a wet open-cut pipeline crossing (which may generate 20 times the sediment associated with dry, dam-and-pump crossings) in Ohio, Reid et al. (2002) found that increased fine sediments in riffle habitats downstream of the construction site coincided with a reduction in benthic invertebrates; however, populations rebounded and no long-term (>1 year) effects were observed.

Figure 1-6 Range of Predicted Severity Exposure Values (SEV)



a/ Newcombe and Jensen (1996). "Salmonids" include Chinook, coho, and steelhead.
b/ USGS gage data for ODFW work window without irrigation-affected data.
c/ "Outliers" includes gage data from high-sediment concentration irrigation-affected water in the S. Fork Little Butte Cr. This is a conservative analysis intended to account for the full range of current conditions.

In coastal streams, coleoperans (beetles) are most common during summer and fall and benthic and/or lotic habitats would be most likely to be affected locally by downstream turbidity and at the in-stream construction sites. Dipterans, caddisflies, mayflies, and stoneflies are prey for juvenile coho salmon and are likely to be relatively more abundant in some benthos and water columns during summer and fall (FERC 2010).

In the Oregon Cascades, dipterans are most common during summer and fall and benthic and/or lotic habitats would be most likely to be affected locallyby downstream turbidity and at the in-stream construction sites. As noted above, dipterans (true flies) are prey for juvenile coho salmon as are mayflies (ephemeropterans) and stoneflies (plecopterans), which become relatively more abundant in some benthos and water columns during the fall. Mayflies and stoneflies are likely to become more abundant in lotic communities during fall construction while springtails (collembolids) and mayflies are expected to be present in stream water columns during summer and fall, with stonefly abundance increasing during fall in the streams in the South Umpqua watershed. Those species would be most likely to be affected in the short term by turbidity generated during dry open-cut construction (FERC 2010).

Considering the lack of long-term impact on downstream habitats from levels of sediment predicted with dam-and-pump crossings (Reid and Anderson, 2002, Reid et al. 2002), any impact on invertebrate populations is expected to be localized to the area of construction or immediately downstream and of short duration. Since downstream habitat is not likely to be substantially altered by crossing construction, it is expected that affected areas would quickly be recolonized should local populations be affected.

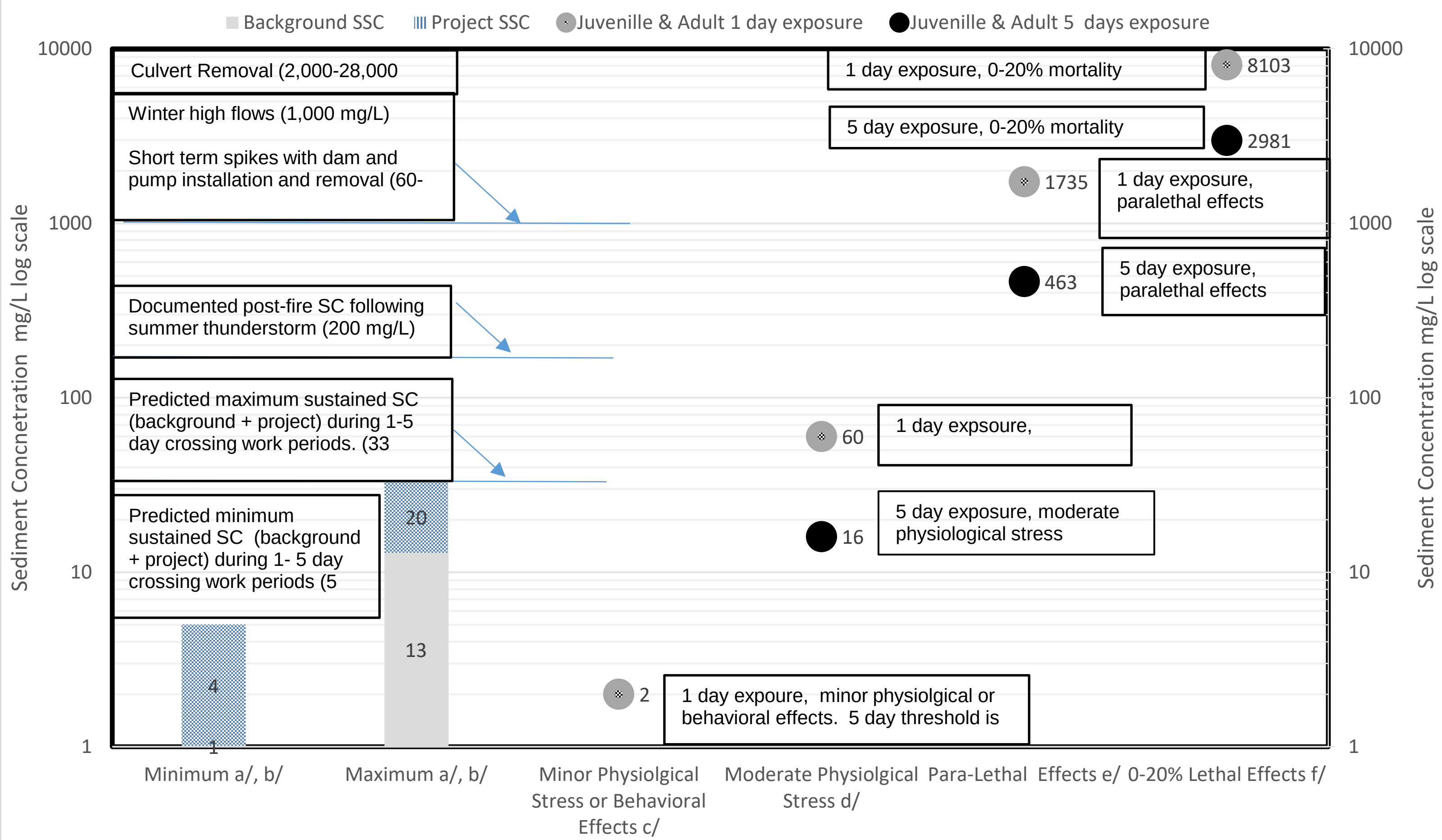
Summary and Conclusions

Figure 1-7 summarizes predicted sediment concentrations and effects of phases of project implementation expressed in terms of suspended sediment concentration (SSC). Based on this review, the following basic conclusions can be drawn concerning increases in sediment concentrations associated with dam-and-pump pipeline crossing construction on aquatic resources:

- Construction-generated sediment concentrations that may adversely affect aquatic biota are generally short term (brief spikes that quickly dissipate) and limited to the construction area or short distances (<100 meters) downstream.
- Juvenile and adult salmonids are mobile and are most likely to simply move away or avoid the affected area during periods of construction.
- Eggs and sac-fry are extremely sensitive to sediment and would likely be adversely affected by predicted sediment levels. These life stages cannot move away to avoid sediment; however, in-stream work windows used during construction also avoid periods when sensitive egg or sac-fry life stages are present.
- Short term spikes in sediments (<24 hours) associated with installation and removal of dams may cause moderate physiological stress for juvenile or adult salmonids that remain in the project area but would be unlikely to cause paralethal or lethal effects because sediment concentrations are unlikely to reach paralethal or lethal concentrations for periods greater than 24 hours and sediment levels would quickly return to background levels once disturbance stops, even when sediment concentrations are above 1,000 mg/L.
- The amounts expressed in total weight of entrained sediment from crossings are expected to be small and comparable to natural events such as a bank slough.
- Duration of exposure has more of an effect than magnitude of exposure (figure 1-6). It is anticipated that stream crossings on NFS land can be accomplished in 1 to 5 days, with most accomplished in less than 48 hours. Based on past studies (Reid and Anderson 2002, Reid et al. 2002, Trettel et al. 2002), elevated sediment concentrations associated with dam-and-pump crossing construction periods are not predicted to reach sustained levels that would have paralethal or lethal effects, even if crossing construction spans several days (figure 1-6).

- Invertebrate populations may experience increased drift or mortality in the immediate project area, but these effects are expected to be short-term and minor in scale because habitat would not be lost.
- Sediment concentrations predicted by Pacific Connector using models developed by Ritter (1984) and Reid et al. (2004) are within the range of sediment concentrations reported from empirical data (Reid and Anderson 2002, Reid et al. 2002). In other words, predicted sediment concentrations using two different approaches (calculated from models vs. empirical data) are consistent and relatively close.
- Sediment-related cause and effect relationship thresholds on salmonids for physiological stress and paralethal and lethal effects are widely separated in terms of magnitude and duration (figure 1-7). Because of this separation in scale, predicted increases in sediment concentration and duration of sediment exposure are unlikely to cause paralethal or lethal effects in salmonids.
- Background sediment concentrations (typically <5 mg/L) plus project-caused sediment associated with trenching and backfilling (typically 4 to 20 mg/L) would result in total sediment concentrations that would likely be in the tens of mg/L during construction of stream crossings with flowing water. Reid et al (2002) found 90% of dam-and-pump crossings increased sediment concentrations over background by less than 25 mg/L. These levels may, depending on duration, cause behavioral changes or moderate physiological stress for any fish that remain in the project area but are unlikely to cause paralethal or lethal effects.
- Sediment concentrations in the hundreds of mg/L for several days are necessary to cause paralethal effects. Although project-related sediment concentrations may have brief spikes (2 to 10 hours) in the hundreds up to 1,100 mg/L, these are of insufficient duration to cause paralethal effects.
- Sediment concentrations in the thousands of mg/L are necessary to cause mortality. Project-related sediment concentrations are not predicted to reach these levels.
- The large differences in magnitude between predicted project effects (tens of mg/L) and thresholds for paralethal (hundreds of mg/L) and lethal effects (thousands of mg/L) reinforces the conclusion that project effects on salmonids would be limited to moderate physiological stress response and that construction-generated sediment is not likely to have paralethal or lethal effects on fish.
- Predicted increased sediment concentrations associated with dam-and-pump crossings are limited in time and space and are not outside the range of variation for timing, duration, or magnitude of effects when compared to sediment concentrations associated with natural disturbance events. The amount of sediment likely to be suspended in the water column is comparable to a site-scale event such as a bank slough or a bankside tree uprooting. A fire or intense rainstorm event would likely generate sediment concentrations and amounts that are orders of magnitude larger.

Figure 1-7 Predicted Sediment Concentrations and Effects on Juvenile and Adult Salmonids for 1 and 5 Day Exposures



a/ Background Sedmient Concentration range is taken from USGS gage data during the ODFW in-stream work window in watersheds where the project occurs.
b/ Predicted Project SC is based on literature review and empirical data collected from dam-and-pump stream crossings (Reid et al., 2002).
c/ Newcombe and Jensen (1996) as summarized by ODEQ (2008). Behavioral effects include avodance, alarm reaction etc. Sublethal effects include reduction in feeding,
minor physiological stress etc.
d/ Newcombe and Jensen (1996) as summarized by ODEQ (2008). Moderate physiological stress, increased respiration, coughing etc.
e/ Newcombe and Jensen (1996) as summarized by ODEQ (2008). Paralethal effects include reduction in feeding rate, poor physical condition, delayed hatching,

Surface Erosion and Sediment Routing

Pacific Connector assumes that the soils within the construction right-of-way would be categorized within the high to very high erosion hazard classes because all vegetation within the right-of-way would be removed and soils would be disturbed during grading, trenching, backfilling, and restoration activities (ECRP, p. 46). Surface erosion risk would be highest in the first winter following clearing for the project. Without application of erosion control measures, significant surface erosion within the construction corridor would likely occur. Where stream intersects occur or where overland flows could reach stream channels, eroded material could be deposited in stream channels and adversely impact aquatic habitats. Possible effects of uncontrolled erosion include loss of topsoil and soil productivity, rill and gulley formation, and excessive sediment transport and deposition to stream systems. While many of the landscapes crossed by the project are erosionally active, the chronic fine-grained sediment created by *uncontrolled* surface erosion would not be consistent with the objectives of the ACS.

No combination of erosion control measures can achieve 100% control of all erosion; however, it is possible to substantially reduce surface erosion and sediment transport to aquatic systems. Seeding, while an excellent erosion control method, has a low probability of reducing the first season erosion because most of the benefits of the seeded grass occurs after the initial early-season events that may cause surface erosion (Robichaud et al. 2000). Conversely, erosion control structures should be considered only as temporary measures to hold the soil in place until vegetation can become established and stabilize stream banks and disturbed surfaces permanently (Forest Service 2013). Effective control of surface erosion would require a combination of mechanical erosion control methods, maintenance of effective ground cover, and aggressive reestablishment of native vegetation.

To minimize potential soil erosion, Pacific Connector has prepared an Erosion Control and Prevention Plan with active participation and engagement from the Forest Service. Pacific Connector would assume that all areas along the construction right-of-way where slash is redistributed would have a high to very high erosion hazard class, and therefore Pacific Connector would apply slash (including wood chips, where available) at a minimum percent effective cover of 65 to 85% of the right-of-way. Table 10.15-1 of the ECRP provides effective ground cover requirements based on potential erosion hazard and is reproduced below as table 1-13.

TABLE 1-13

Minimum Effective Ground Cover Requirements

Erosion Hazard Class	**Minimum Percent of Effective Ground Cover a/, b/**
Low	25%
Moderate	45%
High	65%
Very High	85%

a/ Effective ground cover is considered to be all living or dead herbaceous or woody materials, synthetic materials, and rock fragments greater than 3/4" in diameter that is in contact with ground surface and considered to be stable and resistant to downslope movement.

b/ As recommended by the Forest Service on the Umpqua National Forest, between about MPs 109 and 110 provide 100% post-construction ground cover on all disturbed areas to minimize surface erosion and prevent mobilization of naturally occurring mercury from the Thomason cinnabar claim group (see Contaminated Substances Discovery Plan/Appendix E of the POD).

The ECRP for the project describes the erosion control measures that would be implemented during corridor clearing to minimize transport of sediment to adjacent and nearby aquatic habitats. The FERC environmental inspector, in cooperation with the Forest Service, would determine appropriate temporary measures to be used to minimize potential erosion and sedimentation effects during and after timber-clearing operations. These measures may include:

- Leaving slash generated during timber-clearing operations on the corridor to reduce erosion over the following winter. This minimizes raindrop impacts and overland flow.
- Scarifying compacted surfaces, where appropriate, to promote infiltration and reduce runoff.
- Use of additional slash/brush piles and coarse woody debris (limbs to large logs) at appropriate locations to minimize off-site runoff and sedimentation. Coarse woody debris placed on contour has been shown to be an effective hillslope measure to reduce erosion (Robichaud et al. 2000).
- Installation of slope breakers (water bars) at appropriate locations and spacings to shorten slope lengths, prevent concentrated flow, and divert runoff to stabilized areas. Waterbars are a proven and effective method of reducing the erosive energy of overland flow, diverting overland flow and minimizing sediment transport.
- Installation of silt fences and straw bale sediment barriers to prevent transport of sediment to aquatic habitats. Pacific Connector has committed to install and maintain erosion control structures, including silt fences, at stream crossings until effective ground cover is reestablished. Silt fences are 90 to 95% efficient at trapping sediment (Robichaud et al. 2000).
- Temporary seeding (using appropriate quick-germinating cover crops such as annual ryegrass or other appropriate cover species), where not precluded by federal restrictions on introduced species.
- Mulching of corridor areas that do not have sufficient cover. Geotextile fabric erosion control blankets may also be used to provide temporary ground cover. Mulching reduces raindrop impacts and, when in contact with the ground, limits overland flow and sediment transport.

Mulch materials specified in the ECRP (Pacific Connector Gas Pipeline 2013:44) include:

- Slash from clearing.
- Wood fiber mulch applied as hydromulch at 2,000 pounds/acre.
- Bonded fiber mix (BFM) on slopes greater than 2.5 to 1 (i.e., 40%). BFM is similar to wood fiber mulch, but it has properties that allow it to remain strong and insoluble after its initial drying. BFM reduces erosion by a) absorbing the impact of rainfall while still allowing water to filter through, and b) absorbing water like a sponge to prevent overland water flow and rilling. It creates a strong and durable mat of interlocking fiber strands held together by a bonding agent that is water resistant and would withstand reexposure to

moisture without redissolving or losing its adhesive quality. Once dry, it forms a water-absorbent protective mat that is porous and breathable and secures soil and seed until vegetation is established. BFM is designed to mix and flow easily when wet and yet remain strong and insoluble once dry, protecting the soil surface from repeated rains and sheet flows. BFM can be applied prior to a rainy season or late in the year as it is formulated to endure the harsh conditions of heavy rains and snow. In time, BFM biodegrades completely into natural organic compounds that are beneficial to plant life. It is safe to use in riparian zones and watersheds. Because BFM is sprayed on, the site remains relatively undisturbed, further reducing the risk of erosion.

- Straw mulch that is certified weed-free by the appropriate state certification program. In 2009, Oregon established a voluntary pilot Weed Free Forage Program that certifies both grass and alfalfa hay and straw. The contractor would deliver weed-free certification documents from this program to the environmental inspector prior to applying any straw mulch. However, if the certification program is not in place at the time of construction or if there are not sufficient quantities of certified weed-free straw available for the project, the contractor would request review/inspection of the straw by the local soil and water conservation district, county agent, or other appropriate official or authorized agency representative on federal lands. Any straw that is found to contain noxious weeds during application would be immediately removed from the project right-of-way and properly disposed of in a public landfill. The mulch would be uniformly applied at a rate of 2 tons/acre to cover the ground surface. Mulching would occur immediately after seeding where broadcast- or drill-seeding occurs. Anchoring the mulch is not expected to be necessary because strong winds that could dislodge the mulch typically occur during the winter rainy season when the moist conditions would bind the straw to the soil. Liquid mulch binders are not expected to be used unless hydromulch is applied. Liquid binders would not be used in wetlands or waterbodies.

Erosion control following high-intensity fire provides a useful comparison for effectiveness of erosion control methods. It has been demonstrated that sediment transport in post-fire situations can be reduced by 85 to 95% (Robichaud et al. 2000, Wagenbrenner et al. 2006). Effective erosion control requires a combination of actions. Effective ground cover prevents the mobilization of sediment by absorbing raindrop impacts and, when in contact with the ground, minimizing overland flow of water. Waterbars minimize erosion by shortening the distance water can travel overland and diverting water off disturbed slopes. Erosion control seeding provides temporary vegetation until permanent revegetation is accomplished. Maintained silt fences provide a backstop that is 90 to 95% effective at trapping sediment, including fine-grained silt (Robichaud et al. 2000). Weed-free straw bales placed as part of the installation create a resilient, highly effective sediment barrier that requires little or no maintenance.

The combination of effective ground cover from mulch and coarse woody debris, waterbars to slow and divert water off the construction area, installation and maintenance of silt fences and other sediment barriers, and aggressive grass seeding and fertilization followed by reestablishment of native vegetation is expected to reduce any sediment transport to aquatic systems by 85 to 95% from levels that would be experienced without application of these methods. Sediment contributions from the pipeline corridor are expected to be at or near background levels during dry summer months. During winter rains, some increase in sediment transport from the corridor may occur, but this is expected to be minor and undiscernible against background levels. When compared to current watershed conditions in watersheds crossed by the project, sediment contributions from existing roads, and past management activities, any sediment mobilized from the PCGP corridor would likely be an insignificant contribution to the overall sediment budget of the affected watersheds. It is highly unlikely that the PCGP corridor would become a chronic source of fine sediments with the application of measures specified in the ECRP.

If implementation or post-project monitoring shows evidence of unacceptable sediment transport, as defined by the Forest Service, to aquatic systems, Pacific Connector would be required by the terms of the right-of-way grant to take additional erosion control measures as needed, as directed by the Forest Service, to reduce sediment transport to background levels. Evidence of "unacceptable" levels of sediment transport would include silt fences or other sediment barriers that are not maintained, lack of effective ground cover, visible turbidity at channel crossings, visible evidence of sheet or gulley erosion where sediment is transported to aquatic systems, or chronic deposition of fine sediments as evidenced by turbidity or sediment deposition downstream of crossings.

Site-specific erosion concerns are addressed as needed in individual watershed sections.

General Use and Maintenance of Roads

The TMP, which is part of the POD, provides maintenance standards for use of roads by the project. Standards and guidelines from the NWFP for road maintenance, construction, and reconstruction are part of the TMP (table 1-4). Compliance with these standards and guidelines is intended to ensure the use of roads associated with the project does not prevent attainment of the ACS objectives.

Individual road construction or reconstruction issues are addressed in the watershed where they occur.

1.4.1.3 Water Quality—Temperature

Stream temperatures are highly variable both temporally and spatially (Poole et al. 2001). Stream temperature fluctuations of several degrees in a 12-hour period are possible in small channels. As a result, measuring and interpreting stream temperatures is inherently complex. It is possible to record data at any given point with a great deal of precision, but it quickly becomes speculative to apply that data at broader scales with the same degree of precision.

Topography, slope position, aspect, and effective shade cover influence water temperatures during the summer months. Stream temperatures are also influenced by stream position in the watershed, channel condition, and volume of flow. Large woody debris influences channel condition by narrowing stream channels, creating pools, and affecting water velocity. Conditions favoring high daily maximum stream temperatures include shallow and wide streams, north-south channel orientation, low groundwater influx or hyporheic exchange with the channel, and a low gradient (Nicoleta and Janisch 2007).

The PCGP would remove vegetation that may currently provide effective shade at perennial and intermittent stream crossings. The degree of effective shade loss from corridor construction varies by stream, and depends on stream orientation, topography, channel width, and adjacent tree height.

Loss of shade on intermittent streams is not expected to measurably influence water temperatures because stream crossings are generally widely separated, intermittent streams are typically discontinuous or dry by late summer when water temperature becomes an issue, or when stream volumes are low enough to not influence larger perennial channels. For perennial streams, the position of the stream in the watershed influences the effects of shade loss. Loss of effective shade on reaches of perennial streams in upper parts of a watershed appears to be important to elevation of stream temperatures and may in some cases influence stream temperatures downstream from the point where the loss occurs. On the downstream reaches of perennial streams, shading appears to have much less effect on water temperature (Brown 1970, cited in North Fork Coquille watershed assessment, p. 7-12), possibly due to the higher volume of flow in these lower reaches.

There are five perennial stream crossings on NFS lands where corridor construction potentially could remove shading vegetation (table ES-1). To evaluate whether corridor construction would increase water temperatures, a site-specific field evaluation of stream temperature impacts on the five perennial stream crossings on NFS lands was conducted (NSR 2009). The evaluation showed that with mitigation measures, any temperature increases would be less than 0.2 °C and would be limited to the point of maximum impact. No impacts were predicted at the stream network scale because of the small volume of affected streams, likely groundwater inputs, and the assimilative capacity of the stream network. On-the-ground conditions and water temperature model results suggest that it is unlikely that the stream temperature downstream of any of the perennial crossings would be increased above the ODEQ Core Cold-Water Habitat temperature criteria of 16 °C (61 °F) (NSR 2009:41-42, table 6.1.1).

Perennial crossings on NFS lands in the East Fork of Cow Creek were reanalyzed in 2013 to reflect minor changes in alignment and updated temperature and flow data (NSR 2015, "Technical Memorandum for Water Temperature Impacts Assessment," prepared for BLM and NFS). The Stream Segment Temperature Model (SSTEMP; Bartholow 2002) model was selected for this analysis because it is the modeling tool most often used by the agencies and could provide outputs for single stream segments using available data. This is also the model used in the NSR 2009 analysis. Data recorders were placed at selected locations, and 7-day average high temperatures were recorded for each crossing during the warmest part of the summer with lowest recorded flows. Flows in the 2013 data year were about 33% of those modeled in 2009 and bordered on intermittent at a perennial stream crossing at MP 109.69 (HF-J). This provided a "worst case" assessment of potential project impacts on stream temperatures. To validate the model, existing conditions were entered, and predicted temperatures were compared to measured temperatures. When compared to measured existing conditions, the SSTEMP model overstated actual stream temperature increases by as much as 2.0°F. If the SSTEMP model overstated the existing condition, then it would also be expected to overstate the post-construction impacts. This highlights the inherent uncertainty and high variability in measuring stream temperatures in low volume channels.

Modeling of stream temperatures *with 0% effective shade retention* in the East Fork of Cow Creek on the Umpqua National Forest using SSTEMP showed potential temperature increases *without mitigation* of 1.0°F to 5.1°F.[6] Measured stream volumes ranged from 0.02 cubic feet per second (cfs) to 0.115 cfs, which are very low flows and correlate withmodeled temperature increases. As noted above, this is a drought condition assessment and may not be typical of most years or of

[6] These results have not been indexed or adjusted to reflect the measured overstatement of impacts by the SSTEMP model noted above. Actual temperature impacts are likely to be less.

post-construction shade levels. While there is a great deal of inherent variation in the stream conditions and a measure of uncertainty in the SSTEMP model results, results of the NSR 2014 (NSR 2015) analysis suggest that in a low-flow scenario without mitigation, there could be potential for temperature increases above the total maximum daily load (TMDL) thresholds (0.1°C or 0.18°F at the point of maximum impact) or ODEQ Core Cold-Water Habitat temperature criteria of 16°C (61°F) in small perennial channels in the East Fork of Cow Creek. The 2014 analysis showed larger temperature impacts than those reported in NSR 2009. Model differences between NSR 2009 and the NSR 2014 analysis are explained by the much lower flows measured in the 2013 water year and the sensitivity of the SSTEMP model to low flows (NSR 2015).

Although exposure to solar radiation may cause temperature increases, temperatures downstream from limited stream-side forested clearings have often been found to cool rapidly once the stream re-enters forested regions (Zwienieck and Newton 1999). Other studies have noted downstream cooling below timber harvest areas as well, but the extent of this cooling is not entirely clear and varies by stream (Moore et al. 2005, Poole et al. 2001). Although there is some debate on the magnitude of cooling provided by riparian vegetation and the extent to which stream temperatures return to non-cleared temperature levels after exiting a cleared area, studies emphasize that riparian buffers assist in maintaining water temperatures (Correll 1997, Gomi et al. 2006). Generally, changes in temperature, especially in small streams, may recover quickly from cooler surrounding conditions downstream (e.g., streambed cooling, evaporation, hyporheic inflows, shade). This was validated by stream temperature data recorded on the Umpqua National Forest in 2013. Preliminary results from field measurements of existing conditions on the Umpqua National Forest showed decreasing stream temperatures of as much as -7.6°F/100 feet with an overall average over 2,040 feet of the East Fork of Cow Creek of -0.1°F/100 feet (NSR 2014). The presence of a number of small wetlands adjacent to the stream channel provides evidence of likely groundwater interactions. Most of this 2,040-foot reach also has substantial shade. This suggests the retention of shading structures, or at least partial shade, may greatly reduce increases in stream temperature. This data also supports the NSR 2009 finding that potential temperature increases are partially offset by cooling from groundwater interactions in the stream channel.

Observations as part of both NSR 2009 and NSR 2014 ("Site Specific Stream Crossing Prescriptions") show that large woody debris and low-growing willows, huckleberries and other brush species can provide effective shade for small, narrow channels. For example, Hydrofeature G at MP 109.47 has dense overhanging willows and other brush species that shade much of the channel. In many cases, low-growing brush outside the immediate crossing construction area can be maintained, thus minimizing shade loss. In the mainstem of the East Fork of Cow Creek, large woody debris provides significant shade and creates a complex channel structure with high retention of sand and gravel that helps maintain cooler water temperatures. As described in the ECRP and waterbody crossing requirements for the project, all LWD and boulders removed from the crossing area would be replaced during site restoration and low-growing brush will be retained where possible. Many of the channels crossed by the PCGP are very small and could easily be shaded by the placement of large woody debris, larger logs, and willow plantings. Where site-specific modeling suggests temperature increases may be possible, a restoration plan to reestablish pre-crossing shade conditions using willows, logs, boulders, and large woody debris will be prepared for each of the perennial stream crossings on NFS lands. With the maintenance of existing shading brush on small channels, the placement of large woody debris, and the replanting of willows and other brush species, downstream temperatures are expected to be comparable to the existing condition and to remain below ODEQ thresholds on the East Fork of Cow Creek because these measures would provide immediate and effective shade. In small first- and second-order streams, any temperature increase that does occur would likely be masked by the assimilative capacity of larger streams at the stream network scale (NSR 2009).

In addition to onsite mitigation measures, there are also a number of LWD mitigation projects associated with the PCGP. These mitigation projects are addressed by watershed where the projects are proposed.

Pacific Connector used predictive modeling on a representative cross-section of crossings along the Pacific Connector route, spanning the ecoregions, HUCs, width classes, and aspect classes present from Coos Bay to Malin, Oregon, including stream crossings on NFS lands. Model results show a maximum predicted increase of 0.16°Cover one 75-foot clearing. Thermal recovery analysis shows that temperatures return to ambient within a maximum distance of 25 feet downstream of the pipeline corridor, based on removal of existing riparian vegetation over a cleared right-of-way width of 75 feet. These findings are consistent with NSR 2009. Pacific Connector also assessed the cumulative impact of right-of-way clearing on stream temperatures. Given that mitigation for loss of effective shade would occur and that predictive modeling using SSTEMP shows that the local impacts are small in magnitude and spatially limited, the cumulative effects, including intermittent streams, of the proposed project on the thermal regime in the Coos, Coquille, South Umpqua, Rogue, Klamath, and Lost River basins are expected to be minor and well below detection in the field (GeoEngineers 2013f: 26).

Effects associated with loss of shade at specific crossings are discussed as necessary by watershed (Section 2).

1.4.1.4 Aquatic Connectivity

Connectivity for fish and other aquatic organisms could be affected for a short time while a waterbody is being crossed if water is flowing at the time of construction (most intermittent streams would be dry at the time of crossing and aquatic connectivity would not be impacted). Dry open-cut stream crossings typically take about one to five days to complete, and access to habitat upstream or downstream of the construction area would be interrupted during that time. All stream crossings would be accomplished within the authorized instream work periods established by federal and state fish and wildlife management agencies (typically July 1 through September 15) in order to minimize potential effects. Specific in-channel work periods are addressed in Section 2 for each channel crossing. Once a crossing is completed, bed and banks would be restored to their original configuration, and passage through the construction area would once again be unimpeded. Interruptions in connectivity are expected to be short-term and minor in scale.

1.4.1.5 Watershed Condition

The watershed assessments prepared for the relevant fifth-field watersheds indicate that road networks are extensive on many federal lands crossed by the project. In addition, the watershed assessments document that road construction and timber harvesting within and adjacent to Riparian Reserves have resulted in degraded conditions with respect to flow and sediment regimes as well as riparian vegetation structure throughout these fifth-field watersheds.

Changes to peak flows are influenced by timber harvest; overall basin condition; the age and pattern of forest stands within a larger basin; the location, age, and extent of road networks; and the extent (both laterally and longitudinally) of riparian buffers (Grant et al. 2008). Likely effects of the project on peak flows were assessed in the Final Environmental Impact Statement (FEIS) for the Jordon Cove – Pacific Connector project (FERC 2009). That analysis found that it was highly unlikely that the Pacific Connector project could cause detectable changes in peak flows because of the general ridgetop routing and relative lack of stream intersects when compared to road networks, the dispersed nature of the project across multiple watersheds, and the small area (typically fractions of a percent) affected in any single watershed. The current EIS reached similar conclusions.

Soil conditions may affect watershed conditions. The proposed pipeline right-of-way would be 95 feet wide and consist of a 65-foot-wide construction corridor, with 10 feet of trench and 20 feet of excavation storage. Within Riparian Reserves and visually sensitive areas, the corridor may be reduced to 75 feet where possible. Areas that receive greater than three passes by low p.s.i. equipment result in soil compaction, which is defined on NFS lands as >15% increase in bulk density over an undisturbed reference soil condition (Forest Service 1994b: IV-67). Therefore, for the purpose of this document, it is assumed that on the 65-foot-wide working side, 80 to 100% of the cleared area would be compacted, a 10-foot-wide trench area would be displaced and mixed, and a 20-foot excavation storage area would be compacted or mixed during trenching and backfilling operations.

Compacted soils or barren areas may contribute to soil erosion or altered flow patterns. For the purposes of this analysis, all of the project area on the working side of the construction corridor and TEWAs would be subject to multiple passes of heavy equipment and truck traffic and, as a result, would likely have some degree of compaction. The spoil storage area may experience some degree of compaction depending on heavy equipment passage. Soil texture, moisture content, and exposure (number of passes and type of equipment) would determine the severity of compaction that may occur. Soils in this sensitive group were determined based on the Natural Resources Conservation Service (NRCS) rating of high or severe for the Haul Roads, Log Landings, and Soil Rutting category. Soils in this group are rated based on Unified Soil Texture Classification, rock fragments on or below the surface depth to a restrictive layer, depth to a water table, and slope. Unmitigated soil compaction can result in long-term impacts to soil productivity and increased erosion due to increased runoff (PCGP Resource Report 7, 2013).

Upon completion of construction activities, the construction corridor, with the exception of the area over the installed pipeline, would be decompacted using a winged subsoil ripper. On NFS lands, detrimental compaction would not exceed 15% or more over adjacent undisturbed soils. On NFS lands within 100 feet of perennial or intermittent streams, detrimental compaction would not exceed 10% of the activity area within 100 feet of each stream to ensure maintenance/reestablishment of 90% of pre-disturbance infiltration rates within 100 feet of streams, as confirmed through compaction testing. The FERC environmental inspector would also test for soil compaction on UCSAs on federal lands to determine appropriate measures necessary to mitigate compacted areas (ECRP, p.19). For areas with reclamation sensitivity (see section 4.3.4 of this EIS), the Forest Service would also require soil remediation with biosolids or other appropriate organic materials to ensure successful revegetation.

Specific measurements for the function and value of these and other ACS-relevant indicators of watershed condition, to the degree that they have been reported, are discussed for individual watersheds in Section 2 of this report.

1.4.2 Mitigation

CEQ Regulations (40 CFR 1502.16 (h)) require that the EIS discuss the "means to mitigate adverse environmental effects" and provide appropriate mitigation measures as alternatives if not already part of the proposed action (40 CFR 1502.14 (f)). In cooperation with the Forest Service, the project proponent has identified relevant, reasonable mitigation measures that could alleviate the environmental consequences of the project, including any that are outside the lead agency's (FERC's) jurisdiction (Council on Environmental Quality 1981 #19b). These measures have been included as part of the project description in Chapter 2 of the FERC EIS for the PCGP.

Mitigation, as defined in CEQ Regulations 40 CFR 1508.20, includes:

- avoiding effects altogether by not taking a certain action or parts of an action.
- minimizing effects by limiting the degree or magnitude of the action and its implementation.
- rectifying effects by repairing, rehabilitating, or restoring the affected environment.
- reducing or eliminating effects over time by preservation and maintenance operations during the life of the action.
- compensating for effects by replacing or providing substitute resources or environments.

It is anticipated that the proposed project design and on-site mitigation measures would help maintain or improve current watershed functions on the federal lands crossed within each fifth-field watershed. Wherever practicable, the project corridor has been routed on ridge tops or to avoid stream crossings and other sensitive riparian and aquatic habitats. Areas of potentially unstable soils were thoroughly evaluated prior to routing to help minimize potential effects.

No maintenance roads would be established along the pipeline corridor. Additionally, as described in the project TMP, use of the existing road system would result in improvement of existing conditions, thereby reducing potential sediment source areas.

The project proponent has filed off-site mitigation plans developed in cooperation with the Forest Service to minimize effects of the PCGP project on NFS lands as part of its application to FERC. The actions proposed in the off-site plan supplement on-site mitigations that are part of the project description. These off-site mitigations are intended to provide watershed benefits to offset effects of the PCGP project that cannot be completely addressed at the site level. The right-of-way grant issued by the BLM would include the proposed project mitigation plan to ensure implementation.

Key ACS-related on-site mitigations (shown for each Habitat Element or Process and Key Indicator(s) in table 1-14) include covering streambeds crossed by the project with appropriately sized gravel or cobbles, replacing boulders and LWD at the channel crossing, restoring channel and adjacent banks to preconstruction contours, replanting the adjacent banks and riparian zone to encourage forest growth, and placing LWD (felled during right-of-way clearance) on the floodplains to provide microsite habitat for riparian species and protect riparian vegetation during flood events. These on-site mitigations would contribute to restoring ecosystem structure and functioning and enhancing habitat complexity at the site level.

Table 1-14 summarizes key indicators of aquatic health and site-specific and typical off-site mitigation measures proposed for the project. Each of these habitat elements or processes are discussed in the following sections. The off-site mitigation measures in table 1-14 emphasize LWD placement, road decommissioning/improvement, and replanting of disturbed areas. All of these mitigation measures have been shown to be particularly effective in improving watershed conditions.

Site-specific mitigation projects are described in Section 2 under the appropriate fifth-field watershed. All proposed off-site mitigation projects are site-specific, feasible, and consistent with the relevant agency's land management plan objectives and can be accomplished in a reasonable time.

TABLE 1-14

Habitat Elements, Processes, and Key Indicators for Evaluation of PCGP Project Effects and Identification of Mitigation Measures

Habitat Element or Process	Key Indicator	Mitigation Measure
Water Quality - Sediment	Erosion and sediment transport associated with corridor construction	• On-Site: Apply Best Management Practices and ECRP with onsite FERC environmental inspector oversight. • Off-site: Decommission and improve roads. Place LWD in stream channels to facilitate retention of sediment.
	Affected Riparian Reserves/stream crossing	• On-site: Avoid and minimize stream crossings by using ridge-top routes where possible. Use dry open-cut crossings, with pumping to remove sediment-laden water from the work area. Recontour banks and channel bottom; replace LWD and boulders in channel. • Off-site: Rehabilitate existing road crossings. Place LWD in stream channels.
Water Quality - Temperature	Removal of effective shade by corridor construction	• On-site: Avoid and minimize stream crossings by using ridge top routes. Where possible, narrow right-of-way to 75 feet. Replant trees in riparian zone to provide replacement shade. Replace LWD and boulders at channel crossing. • Off-site: Replant effective shade in Riparian Reserves that currently have inadequate shading. Place LWD and boulders in stream channels.
Habitat Access	Blockage of stream channel during construction	• On-site: Use flumes when crossing fish-bearing streams to facilitate upstream-downstream connectivity across the construction area as appropriate if this is a critical issue. No flumed passages are currently proposed or anticipated on NFS lands. • Offsite: Install fish-friendly culverts at selected sites.
Aquatic Habitat Structure	Substrate at crossing	• On-site: Restore channel bed and banks to original configuration, cap trench with cobble and gravel, restore LWD in stream channel. • Off-site: Place LWD in stream channels.
	LWD at crossing	• On-site: Place LWD in stream channels. • Off-site: Place LWD in stream channels.
	Pool quality	• On-site Select pipeline route to minimize stream intersects. Place LWD in stream channels. • Off-site: Place LWD in stream channels.
	Off-channel habitat	• On-site: Place LWD in stream channels. • Off-site: Place LWD in stream channels.

TABLE 1-14

Habitat Elements, Processes, and Key Indicators for Evaluation of PCGP Project Effects and Identification of Mitigation Measures

Habitat Element or Process	Key Indicator	Mitigation Measure
	Refugia concerns	• On-site: Place LWD in stream channels. • Off-site: Place LWD in stream channels.
Channel Conditions and Dynamics	Stream width-to-depth ratio	• On-site: Restore channel bed and banks to original configuration, cap trench with cobble and gravel, and restore LWD in stream channels. • Off-site: Place LWD in stream channels.
	Streambank condition	• On-site: Minimize disturbance of riparian vegetation. Restore channel bed and banks to original configuration or modify to stable configuration if incised or unstable, cap trench with cobble and gravel, revegetate with plantings and restore LWD in riparian zone and stream channel. • Off-site: Replant areas without effective bank cover.
	Floodplain connectivity	• On-site: Restore channel bed and bank to original configuration. Revegetate construction area with plantings. Restore LWD in stream channels. • Off-site: Replant areas lacking effective bank cover with appropriate riparian vegetation. Decommission roads in and adjacent to riparian zone.
	Peak/base flow regime; effective size of the drainage network	• On-site: Ridge top routing of right-of-way. Implement ECRP during construction. Post-construction recontouring of stream channel in corridor to original condition. • Off-site: Decommission and improve roads.
Watershed Condition	Road density and location	• On-site: Ridge top routing of right-of-way. Post-construction recontouring of stream channel in corridor to original condition. • Off-site: Decommission roads.
	Disturbance history	• On-site: Road decommissioning in Riparian Reserves. • Off-site: Manage stand density to facilitate forest succession and resiliency. Reduce fuel on forest floor to prevent catastrophic fires. Decommission roads. Replant riparian zone and restore adjacent meadows.
	Condition of Riparian Reserves	• On-site: Decommission roads in Riparian Reserves. Thin overstocked stands in Riparian Reserves to accelerate growth of large trees and restore riparian vegetation. • Off-site: Manage stand density to facilitate forest succession. Reduce fuel on forest floor to prevent catastrophic fires. Decommission roads. Replant riparian zone and restore adjacent meadows.

2.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

2.1 REGIONAL CONTEXT

The ACS is applied at multiple scales. In order to provide a logical framework for assessment, the report of the Forest Ecosystem Management Assessment Team (FEMAT) established physiographic provinces (Forest Service et al: IV-7). Physiographic provinces (also referred to as "provinces" or “aquatic provinces") incorporate physical, biological, and environmental factors that shape broad-scale landscapes. Physiographic provinces reflect differences in geology (e.g., uplift rates and recent volcanism, tectonic disruption) and climate (e.g., precipitation, temperature, and glaciation). These factors result in broad-scale differences in soil development and natural plant communities. Within each province, the variable characteristics of rock stability affect steepness of local slopes, soil texture, soil thickness, drainage patterns, and erosional processes. Thus, the concept of physiographic provinces has utility in the description of both terrestrial and aquatic ecosystems (Forest Service et al. 1993).

Within provinces, vegetation types, land-use practices, and responses to disturbance are typically similar. The PCGP would cross the Coast Range, Klamath-Siskiyou, Western Cascades, and High Cascades provinces (figure 2-1). The PCGP does not, however, cross NFS lands in the Coast Range province; therefore, that province is not discussed further in this document. In the following sections, the three provinces that cross NFS lands are described in terms of climate, geology, soils, vegetation, and the fifth-field watersheds within each of them (figure 2-1).

2.1.1 Key Watersheds

The NWFP identifies “key” watersheds that have regional significance for the protection of water quality and aquatic habitat. Tier 1 Key Watersheds are intended to benefit at-risk fish species and stocks by providing refugia for maintaining and recovering habitat. Tier 2 Key Watersheds provide high-quality water. Key Watersheds include areas of both high quality and degraded habitat. Key watersheds with high-quality habitat serve as anchors for the potential recovery of depressed stocks. Those of lower quality habitat have a high potential for restoration and would become areas of high-quality habitat if appropriate restoration measures are implemented. The NWFP designates Key Watersheds as the highest priority for restoration. Table 2-1 identifies Key Watersheds that would be crossed by the PCGP right-of-way.

Specific effects of the Pacific Connector project in Key Watersheds are addressed in the watershed descriptions in this section.

Figure 2-1. PCGP Right-of-Way with Aquatic Provinces and Fifth Field Watersheds

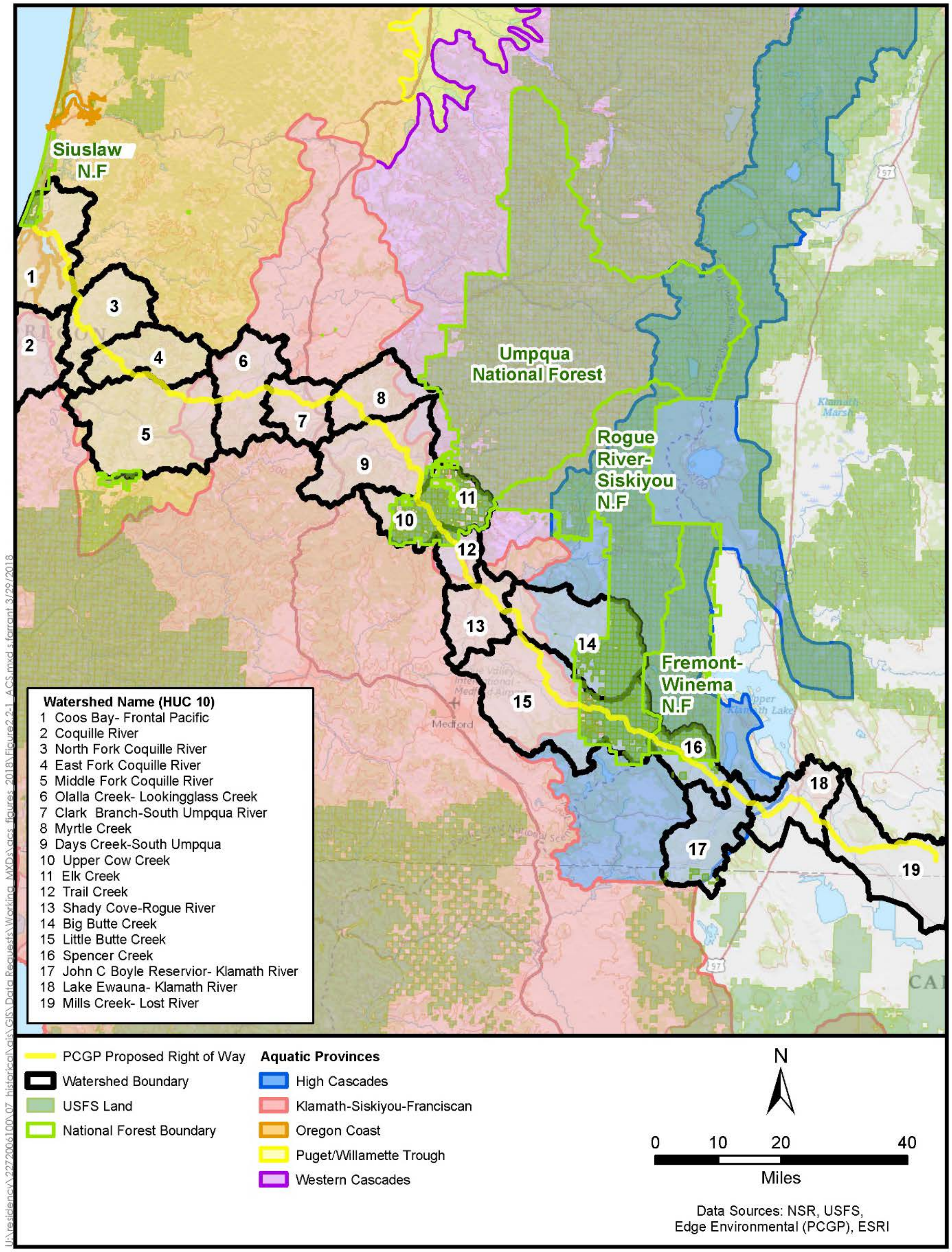


TABLE 2-1 **Miles of PCGP Project Right-of-Way in Key Watersheds by Administrative Unit**				
Watershed	**Umpqua NF Miles**	**Rogue River NF Miles**	**Winema NF Miles**	**Total NF Miles**
Elk Cr.-South Umpqua	2.66	—	—	2.66
Days Cr. South Umpqua (Tier 1) (These 5th field watersheds are both part of the South Umpqua Key Watershed)	1.56	—	—	1.56
North and South Forks Subwatersheds, Little Butte Cr. (Tier 1)	—	8.44	—	8.44
Spencer Cr. (Tier 1)	—	—	6.05	6.05
Clover Cr. Subwatershed, Spencer Cr.(Tier 2)				
Total	**4.22**	**8.44**	**6.05**	**18.71**
Source: Resource Report 2, Table 2.2-4				

2.1.2 Historical Disturbance Processes and Patterns in the Pacific Northwest

A critical aspect of the Pacific Northwest riverine and riparian environment is the widespread occurrence of steep, unstable hillslopes. Recent geologic uplift, weathered rocks and soil, and heavy rainfall all contribute to high landslide frequency and to high sediment loads in many of the region's rivers. Hillslope steepness is one of the simplest indicators of areas prone to mass wasting (e.g., rapid mass movements of soil and organic material down hillslopes and stream channels). The response of these steep hillslopes to disturbance processes shaped the evolution of aquatic environments in the region.

In the Pacific Northwest, fire historically was the dominant watershed disturbance process (Everest and Reeves 2007). Synergy between fire and subsequent intense rainstorms and flood events may be the sequence of disturbances with the greatest effect on riparian ecosystems in the Pacific Northwest (Benda et al. 1998, cited in Everest and Reeves 2007). Wildfires temporarily increase the supply of water and sediment to fluvial systems (Malmon et al. 2007). Runoff-initiated erosion events tend to peak during the first year after a forest fire but these effects are typically short-lived (i.e., 2 to 4 years) due to vegetative recovery, decreased soil hydrophobicity, and changes in surface coarseness (Legleiter et al. 2003). During that period, affected drainages may produce visibly turbid water during each heavy storm or snowmelt event. Landslides, however, may occur several years after a severe fire (Wondzell and King 2003). The lag is largely due to the relatively slow decay of roots of fire-killed trees and shrubs. Once these anchors are lost, the soil is more likely to slough from steep slopes when saturated with rainfall or snowmelt.

Mass wasting (i.e., debris torrents, landslides, and movement of unstable earthflow terrains) following a fire can transport tremendous amounts of sediment and wood debris to stream channels. Reeves (1996, cited in the Catching-Beaver Watershed Assessment) observed that mass wasting following fire can deposit so much material that 2 or 3 m of accumulated sediment and coarse debris can still remain in the channel 100 years after the deposition event. Many terrace-like features next to mountain streams in the Pacific Northwest are relic depositions of debris avalanche–transported material through which streams subsequently cut down. Small, third- to fifth-order forested streams are in close proximity to sediment sources (adjacent hillslopes and channel banks). Large woody debris and boulders form persistent structures that trap significant volumes of sediment in these channels, reducing sediment transport in the short term and substantially increasing channel stability. External sediment inputs such as mass wasting and bank collapse along with wood accumulation tend to dominate channel morphology of smaller streams, while larger streams are primarily influenced by downstream fluvial sediment transport and bank erosion. Bed material transport occurs under relatively high flow conditions for a very short period of time. Since major erosional events are almost always associated with excessive amounts of precipitation, their occurrence depends on these storms occurring during periods of increased susceptibility to surface erosion and mass wasting following intense wildfire (Wondzell and King 2003).

The effects of these disturbance pulses can range from increases in sediment transport in streams to mass wasting events that impact riparian stands at the site to subwatershed scale and deposit large amounts of sediment and large woody debris in and adjacent to stream channels. These pulse disturbances of sediment occurred infrequently at any given site or subwatershed and affected a relatively small portion of the watershed at any one time, although at the watershed or regional scale, disturbance processes were (and are) a constant factor in Pacific Northwest landscapes. Pulse disturbances generally allow ecosystems to remain within their normal historical range of states and conditions since there is sufficient time between disturbances to enable ecosystems to recover to predisturbance conditions (Everest and Reeves 2007, p. 19).

The large-scale ecological structure, function, and processes that shaped Pacific Northwest watersheds have been substantially altered by anthropogenic factors. Fire suppression has altered the historical frequency and intensity of fire events in the Pacific Northwest. As result of fire suppression and timber harvest, there has been a general shift in vegetation patterns, structures, and ecological processes from relatively larger patches of late-successional and old-growth forest with frequent low-intensity fires to more fragmented landscapes that are dominated by early and mid seral plant communities. Large, high-intensity fires do occur (e.g., the Biscuit Fire in 2003), possibly with increasing frequency and intensity. In the past, forest practices (timber harvest) in the Pacific Northwest increased mass wasting events and sediment yields. Road-related mass wasting is a major source of sediment (Hassan et al. 2005). Land use patterns and, in particular, forest roads have altered sediment regimes in many stream networks, replacing episodic pulses of coarse sediments with chronic deposition of fine sediments.

2.1.3 Klamath-Siskiyou Province, MP 47-105, 118-153

The Klamath-Siskiyou Province encompasses the Klamath and Siskiyou Mountains and lies between the Coast Range and Cascades, south of the Willamette Valley. The PCGP project would traverse the northeast corner of the Klamath-Siskiyou Province for approximately 93 miles (figure 2-1). It includes parts of the Umpqua and Rogue River–Siskiyou National Forests and is typified by deeply dissected valleys and jutting ridges and foothills. Much of this province lies within a rain shadow, sheltered from the Pacific maritime influences by the Coast Range.. The region has a rugged landscape, with high peaks and deep canyons. Elevations range from about 1,000 to 5,000 feet above mean sea level (msl). Portions of the South Umpqua, Elk Creek–South Umpqua, Upper Cow Creek, Trail Creek, Shady Cove, Rogue River, Big Butte, and Little Butte Creek fifth-field watersheds are in the Klamath-Siskiyou Province.

2.1.3.1 Landform and Erosional Processes

The Klamath-Siskiyou province is rugged and deeply dissected. Tributary streams generally follow the northeast-southwest orientation of rock structure created by accretion of rocks onto the continent. Variable materials juxtapose steep slopes subject to debris flows and gentle slopes subject to earthflows. Scattered granitic rocks are subject to debris flows and severe surface erosion. High rates of uplift have created steep streamside hillslopes known as inner gorges, especially near the coast.

The Klamath-Siskiyou Province is known for its highly complex geology. Most of the area is composed of highly deformed volcanic and marine sedimentary rocks with some metamorphic terranes. It also includes deformed pieces of oceanic crust and granitic intrusive bodies. Bedrock is often intensely metamorphosed and fractured. Well-developed floodplains and terraces near major rivers give way to highly dissected mountains with high-gradient streams. Many streams in this province have intermittent flows because of high gradients and low summer precipitation.

In this province, erosional processes are dominated by mass wasting–associated high-intensity rainfall events. Erosional processes would be accelerated where these rainfall events overlap with large, stand-replacement fires. Precipitation gradients decrease from west to east, so landslide frequency decreases with decreased precipitation. Hydraulic mining that occurred in the 19th century dramatically altered landscapes and downstream channels where this activity occurred.

2.1.3.2 Climate

The valleys and foothills of the Klamath-Siskiyou Province experience a Mediterranean-type climate, while higher-elevations demonstrate more montane effects. Precipitation in the lowlands ranges from 25 to 50 inches a year, while higher elevations may receive up to 130 inches per year. Areas outside the Coast Range rain shadow receive considerably more precipitation. Most precipitation falls as rain and snow during the winter, though summer thunderstorms may produce measureable amounts.

2.1.3.3 Vegetation

This area is dominated by mixed-conifer and mixed-conifer/hardwood forests. Land ownerships include a mixture of BLM, NFS, state, and private lands. Forests are highly fragmented by natural factors (e.g., poor soils, dry climate, and wildfires) and human-induced factors (e.g., harvest and roads). Much of the historical harvest in this area has been selective cutting rather than clearcutting. As a result, many stands that were logged in the early 1900s include a mixture of old trees left after harvest and younger trees that regenerated after harvest. Much of the area within the province is characterized by high fire frequencies and stand-replacing fires. Any plan to protect LSOG forests in these areas must include careful consideration of fire management.

2.1.4 Cascades Province MP 105-113

Approximately 13 miles of the pipeline corridor that crosses the Umpqua Nationa Forest is within the north-south trending Western Cascades Province (figure 2-1). This province, which drains westward to the Pacific Ocean, reaches elevations of 5,800 feet above msl. Portions of the Upper Cow Creek and Trail Creek fifth-field watersheds are in the Cascades Province.

2.1.4.1 Landform and Erosional Processes

The landforms in the Western Cascades Province are distinguished from the High Cascades Province by older volcanic activity and longer glacial history. Ridge crests at generally similar elevations are separated by steep, deeply dissected valleys. Complex volcanoclastic formations juxtapose relatively stable volcanic deposits that weather to thick soils and are subject to earthflows. Unconsolidated alluvial and glacial deposits are subject to streambank erosion and landslides. Tributary channels flow at large angles into wide, glaciated valleys. Stream gradients are typically moderate to high (2 to 30%).

2.1.4.2 Climate

Lowland areas may receive as little as 60 inches of precipitation per year, while higher elevations may receive up to 120 inches annually. Much of the precipitation that falls above 4,000 feet msl is snow. Average January temperatures range from 26°F to 41°F, while average July temperatures range from 44°F to 78°F.

2.1.4.3 Vegetation

Forests of this province consist primarily of Douglas-fir and western hemlock at lower to middle elevations. Land ownership includes a mixture of private, state, NFS, and BLM lands. The Forest Service administers extensive areas in this province. Private and state lands in this area are managed intensively for timber production under the forest practice and water quality laws of the State of Oregon and are primarily early and mid seral forests whereas federally administered lands still include significant areas (albeit highly fragmented) of LSOG forest. Forests at the southern section of the province are largely replaced by mixed-conifer forests of Douglas-fir, grand fir, and incense-cedar. A large proportion of the known northern spotted owl population in Washington and Oregon occurs in the Western Cascades.

2.1.5 High Cascades Province MP 153-180

Approximately 23 miles of the proposed PCGP corridor would be located in the High Cascades Province (figure 2-1), crossing portions of the Rogue River-Siskyou National Forest (RRNF) and the Klamath Falls Resource Area of the BLM Lakeview District. This province is associated with a north-south trending mountain chain that drains both westward to the Pacific Ocean and eastward into the Klamath and Columbia basins (figure 2-1). The High Cascades Province reaches a peak elevation of 9,493 feet msl at the summit of Mt. McLoughlin. Portions of the Little Butte Creek, Spencer Creek, and Mills Creek–Lost River fifth-field watersheds are in this province.

2.1.5.1 Landform and Erosional Processes

The province consists of volcanic landforms with varying degrees of glaciation. Lava flows form relatively stable plateaus, capped by the recent Cascades volcanoes. Drainages are generally not yet well-developed or otherwise disperse into highly permeable volcanic deposits. Geologically recent volcanic deposits are subject to large debris flows when saturated by snowmelt. This province is composed primarily of approximately 3 million-year-old volcanic material, primarily andesite and basalt, that was subsequently glaciated. Mountains in this province are moderately dissected. Headwater streams have medium to high gradients and are often associated with large meadow-spring complexes such as Buck Lake in the Spencer Creek drainage. Expansive pumice plateaus associated with the eruption of Mt. Mazama about 5,000 years ago (Dead Indian Plateau, Clover Creek) with droughty soils characterized by high snowmelt infiltration and low summer water retention fill valley floors adjacent to volcanic peaks.

2.1.5.2 Climate

The High Cascades Province is climatically diverse, with mild valleys, snowy mountains, and alpine conditions at the highest elevations. Precipitation ranges from 45 to 100 inches per year and is largely associated with orographic influences of the mountains in this province. In the lowlands, average January temperatures range from 30 to 45°F while average July temperatures range from 49 to 85°F. At higher elevations, average January temperatures range from 23 to 37°F while average July temperatures range from 44 to 74°F.

2.1.5.3 Vegetation

This province is dominated by mixed-conifer and ponderosa pine forests at mid to lower elevations and by true fir forests at higher elevations. The higher elevations of the High Cascades Province support forests of silver fir and mountain hemlock. Some national parks and wilderness areas within this province include significant areas of mid-elevation LSOG forest. Land ownership patterns include a mixture of Forest Service, private, state, American Indian, National Park Service, and BLM lands. Forests in this region are highly fragmented due to a variety of natural factors (e.g., poor soils, high fire frequencies, and high elevations) and human-induced factors (i.e., clearcutting and selective harvest). Before the advent of fire suppression in the early 1900s, wildfires played a major role in shaping the forests of this region. Intensive fire suppression efforts in the last 60 years have resulted in significant fuel accumulations in some areas and shifts in tree species composition. These changes may have made forests more susceptible to large high-severity fires and to epidemic attacks of insects and diseases. Any plan to protect LSOG forests in this area must include considerable attention to fire management and to the resilience of forest stands.

2.2 NATIONAL FOREST SYSTEM BASINS AND WATERSHEDS CROSSED BY THE PROJECT

The proposed PCGP project crosses 19 fifth-field watersheds in four river basins that lie in portions of the Coast Range, Klamath-Siskiyou, Western Cascades, and High Cascades aquatic provinces. Watersheds and river basins may lie in one or more aquatic provinces. A total of nine fifth-field watersheds that contain NFS lands are crossed by the project;the proposed pipeline crosses NFS lands in six of these. The ACS applies to this project only to these six fifth-field watersheds (table 2-2 and figure 2-1).

Of the total 231.72 miles of the proposed corridor, 30.62 miles (13.21%) would be on NFS lands. Three National Forests (Umpqua, Rogue River-Siskiyou, and Winema) would be crossed by the project along with a combination of BLM administrative units and private land. Watersheds in which the proposed pipeline does not cross NFS lands are not subject to the conditions of the ACS and are therefore not dicussed in detail in this report. Table 2-2 summarizes the NFS administrative units crossed by the project by fifth-field watershed:

- In 11 watersheds, generally west of the South Umpqua River, BLM lands would be crossed, but no NFS lands would be affected by the project. These watersheds are not analyzed in this report.

- NFS lands would be crossed in the Days Creek–South Umpqua, Elk Creek–South Umpqua, Upper Cow Creek, Little Butte Creek, and Spencer Creek Key Watersheds. The Trail Creek watershed also has NFS lands that would be crossed by the project, but Trail Creek is not designated as a key watershed.

TABLE 2-2

Provinces, River Basins and Watersheds on NFS Lands Subject to the ACS

Province	River Basin	Fifth field Watershed	Hydrologic Unit Code	Key Water-shed	Total Miles All Owners	Umpqua NF Miles	Rogue River NF Miles	Winema NF Miles	Total Forest Service Miles
Klamath Siskiyou	Umpqua	Days Cr. — S. Umpqua	1710030205	Yes	19.15	1.56	0.00	0.00	1.56
Klamath Siskiyou — Western Cascades	Umpqua	Elk Cr. — S. Umpqua	1710030204	Yes	3.26	2.67	0.00	0.00	2.67
Klamath Siskiyou — Western Cascades	Umpqua	Upper Cow Cr.	1710030206	No	5.27	4.50	0.00	0.00	4.50
Western Cascades	Upper Rogue	Trail Cr.	1710030706	No	10.68	2.09	0.00	0.00	2.09
Western Cascades — High Cascades	Upper Rogue	Little Butte Cr.	1710030708	Yes	32.93	0.00	13.75	0.00	13.75
High Cascades	Upper Klamath	Spencer Cr.	1801020601	Yes	15.13	0.00	0.00	6.05	6.05
Total Project Miles where the ACS Applies					**—**	**9.82**	**13.75**	**6.05**	**30.62**

Table 2-3 summarizes the acres affected by the project right-of-way on NFS lands by land allocation. Approximately 608 acres of NFS land are within the project right-of-way. On NFS lands, all Late Successional Reserves (LSR) in the project right-of-way (365.64 acres) are in designated (mapped) LSRs.

TABLE 2-3

Fifth-Field Watersheds and Land Allocations Crossed by the Pacific Connector Gas Pipeline Corridor ROW on NFS Lands

	LSR				Matrix				Riparian Reserves			
	Project Area (acres)		% of Total LSR in Unit		Project Area (acres)		% of Total Matrix in Unit		Project Area (acres)		% of Total Riparian Reserves in Unit	
Unit	Cleared	Modified	Cleared	Modified	Cleared	Modified	Cleared	Modified	Cleared	Modified	Cleared	Modified
Days Cr.-S. Umpqua	9.81	18.55	0.35	0.66	11.01	13.03	2.84	3.36	0.15	1.56	0.02	0.16
Elk Cr.-South Umpqua	21.23	0.00	0.15	0.00	7.43	1.20	0.04	0.01	0.00	0.00	<0.01	0.00
Upper Cow Creek	36.58	0.00	1.56	0.00	37.07	0.00	0.19	0.00	10836	0.00	0.13	0.00
Trail Creek	0.00	0.00	0.00	0.00	41.28	8.99	1.05	0.23	<0.01	0.00	<0.01	0.00
Little Butte Creek	205.26	69.50	0.45	0.15	0.00	0.00	0.00	0.00	7.66	2.56	0.09	0.03
Spencer Creek	0.05	0.02	<0.01	<0.01	71.06	10.05	0.70	0.10	8.63	1.35	0.52	0.08
Total	**272.93**	**1,924.5**	**0.39**	**2.76**	**167.85**	**33.72**	**0.30**	**0.06**	**27.27**	**5.47**	**0.09**	**0.02**

Late Successional Reserves are an important component of the ACS because the standards and guidelines under which LSRs are managed provide additional protection for aquatic resources

(Forest Service and BLM, 1994b: B-12). The South Umpqua watershed is a Key Watershed. On NFS lands, five of the fifth-field watersheds have mapped LSRs crossed by the project right-of-way. Of these five, by far the most affected is the Little Butte Creek watershed (274.76 acres), followed by the Upper Cow Creek watershed (36.58 acres), the Days Creek–South Umpqua River watershed (28.36 acres), and the Elk Creek–South Umpqua River watershed (21.23 acres). Unmapped LSRs associated with known owl activity centers (KOACs) are crossed only in the Upper Cow Creek watershed.

Matrix land would be affected in five fifth-field watersheds where the ACS applies. The most affected watershed is the Spencer Creek watershed (81.11 acres affected); the watershed with the least affected Matrix land is the Elk Creek South Umpqua River watershed (8.63 acres affected). Riparian Reserves would be affected in five fifth-field watersheds where the ACS applies, the Elk Creek South Umpqua River, Days Creek South Umpqua River, Upper Cow Creek, Little Butte Creek, and Spencer Creek watersheds (table 2-3). Acreages of affected Riparian Reserves on these watersheds range from 0.54 acres in Elk Creek South Umpqua to 10.22 acres in Upper Cow Creek.

2.2.1 Umpqua River Basin

2.2.1.1 Geographic Setting

The Umpqua River Basin is flanked to the north by the Siuslaw and Willamette River basins, to the east by the Deschutes and Klamath River drainages, and to the south by the Rogue and Coquille River basins. The basin has its headwaters in the Cascades Range, is bounded on the south by the Klamath Mountains, and transects the Coast Range before entering the Pacific Ocean (figure 2-1). The estuary of the Umpqua River is one of largest on the Oregon coast, with tidewater extending as far inland as Scottsburg, Oregon, at river mile 27.9.

The Umpqua River drains approximately 4,670 square miles of western Oregon, with headwaters in the Cascades Range and Klamath Mountains before traversing the Coast Range and entering the Pacific Ocean through Winchester Bay at Reedsport. The mainstem Umpqua River begins about 110 miles from its mouth at the confluence of the North and South Umpqua rivers near the city of Roseburg.

The North Umpqua River drains 1,359 square miles, with headwaters in the High Cascades. The South Umpqua River drains part of the northern Klamath Mountains Province and part of the Cascades Province. At its confluence with the North Umpqua River, the South Umpqua River has a drainage area of about 1,800 square miles. All the watersheds crossed by the project in the Umpqua Basin lie in the South Umpqua Subbasin, which is within the Klamath-Siskiyou and Western Cascades provinces. The Pacific Connector pipeline crosses on to NFS lands where the ACS applies in the Days Creek-South Umpqua 5th-field watershed at approximately milepost 100. From there, the Pacific Connector route travels generally south, primarily along ridgetops across the Elk Creek- South Umpqua and Upper Cow Creek 5th field watersheds, crossing in to Trail Creek watershed in the Upper Rogue River Basin at MP 111.1.

2.2.1.2 Climate and Hydrology

The Umpqua River Basin is characterized by a temperate, maritime climate with wet, mild winters and moderately dry, warm summers. Because the Umpqua River begins at high elevations in the Cascades Range, it receives a heavier snowpack than coastal rivers with lower elevation headwaters. Most precipitation falls in the winter and varies from around 30 inches in interior valleys to over 80 inches per year in upper elevations of the basin.

Both the North and South Umpqua rivers subbasins are characterized by rugged topography, with steep canyons and rapid elevation changes with associated with volcanic activity, combined with periodic glacial episodes. Shallower and rockier soils, which characterize the South Umpqua River subbasin, release runoff quickly. Consequently, winter runoff dominates the hydrology in the South Umpqua subbasin. High winter runoff results in scouring and flash winter floods like those in 1955 and 1964, which occurred when warm rains and condensation melted a deep snowpack. In the South Umpqua River subbasin, Galesville Reservoir was constructed in the upper Cow Creek drainage in 1985 to reduce flooding along the lower reaches of Cow Creek. Although Galesville Reservoir has a pronounced effect on peak flows in Cow Creek downstream, peak flows farther downstream on the South Umpqua River near Brockway have not shown a marked decline since dam construction.

Total Maximum Daily Load (TMDL) thresholds and a Water Quality Restoration Plan (WQRP) were established for temperature and other pollutants for the Umpqua River Basin in 2006 (https://www.oregon.gov/deq/FilterDocs/umpexecsumm.pdf).

2.2.1.3 Days Creek–South Umpqua River Fifth-Field Watershed, HUC 1710030205

Overview

The portion of the Days Creek–South Umpqua River watershed crossed by the project is a Tier 1 Key Watershed (see Section 1.1.3). Key Watersheds contribute directly to conservation of at-risk anadromous salmonids and resident fish species by providing high-quality habitat. A network of Tier 1 Key Watersheds ensures that refugia for at-risk species are widely distributed across a landscape to provide requisite connectivity.

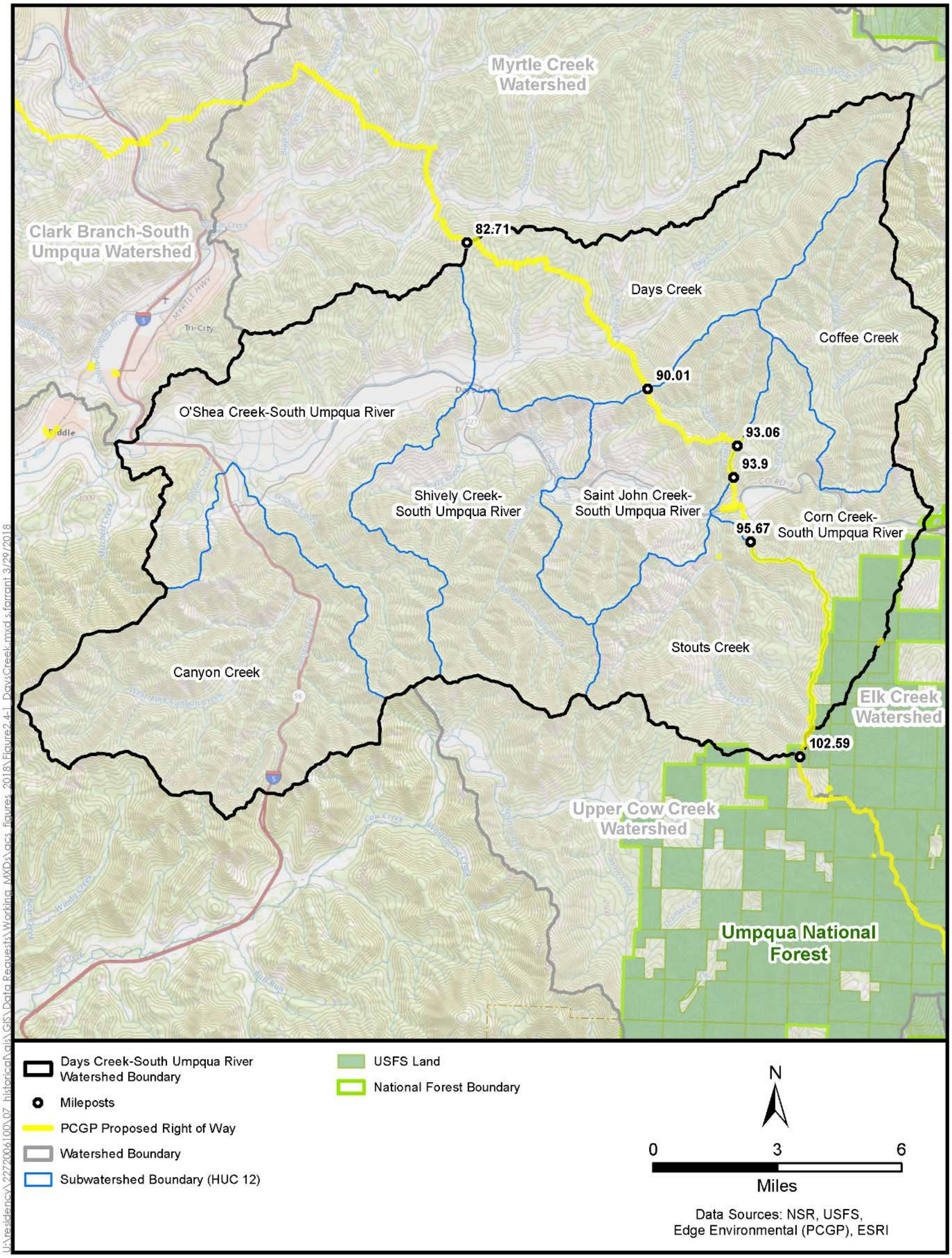
Originating in the Cascades Range, the 221.2-square-mile (141,569-acre) Days Creek–South Umpqua River watershed is one of 13 fifth-field watersheds comprising the South Umpqua Subbasin, which drains about 1,800 square miles of southern Oregon. Located about 20 miles southeast of Roseburg in the southeast portion of the Umpqua National Forest (UNF) (Tiller Ranger District), the watershed is bordered on the north by the Myrtle Creek fifth-field watershed and on the south by the Upper Cow Creek and Elk Creek–South Umpqua River fifth-field watersheds, all of which are partly traversed by the project (figure 2-2). At Roseburg, Oregon, the South and North Umpqua Rivers join to form the Umpqua River, which flows northwest through the Oregon Coast Range and empties into the Pacific Ocean at Winchester Bay. See figure 1-1 for the regional setting of this watershed and its relationship to the other fifth-field watersheds traversed by the project.

Logging, agriculture, mining, transportation, and residential areas dominate human land use in the watershed. The communities of Canyonville, Days Creek, Milo, and Tiller are located in the watershed, and Interstate 5 runs north-south through the watershed.

The geology of the Days Creek–South Umpqua River watershed includes sedimentary, igneous, metamorphic, and volcanic rocks of the Western Cascades and Klamath-Siskiyou provinces[1]. Soils from metamorphic parent materials cover about 57% of the watershed (metamorphic rock is mapped a 44% of the watershed, and mica schist, a type of metamorphic rock, is mapped as 13%), while granodiorite parent material, an igneous type of rock, covers 23% of the watershed. The remaining 20% is composed of sedimentary rock (i.e., siltstone to conglomerate). Both the granodiorite and mica schist soils have high erosion potential when bare.

[1] Provinces discussed in this document are based on both ecological and geological conditions and therefore do not match those recognized by the Oregon Department of Geology and Mineral Industries and the Oregon State Board of Professional Geologists and Geophysicists. The Klamath-Siskiyou Province is known by professional geologists as the Klamath Mountains Province and the Western Cascades and the High Cascades are two mountain ranges within the Cascades Mountains Province. See https://www.oregongeology.org/learnmore/geologicsightseeing.htm

Figure2-2 PCGP Routing and Subwatershed Boundaries, Days Creek–South Umpqua River Watershed



Elevations in the watershed range from about 640 feet where Cow Creek flows into the South Umpqua River in the northwest part of the watershed to about 4,040 feet at theheadwaters of Days Creek in the northeast part of the watershed. Fifty-two percent of the watershed lies at elevations lower than 2,000 feet amsl.

The Days Creek–South Umpqua River watershed has a Mediterranean-type climate, with cool, wet winters and hot, dry summers. Annual precipitation ranges from about 30 inches at Canyonville in the lower part of the watershed to more than 60 inches at the highest elevations. About 85% of the precipitation falls from October through April. At the highest elevations, a substantial portion of the precipitation falls as snow. Summer rainfall is typically less than 5 inches and is typically associated with high-intensity summer thunderstorms.

The Days Creek–South Umpqua River watershed includes eight subwatersheds, four of which (Days Creek, Saint John Creek, Corn Creek, and Stouts Creek) are crossed by the project (figure 2-2). Approximately 2% (2,807 acres or 4.4 square miles) of the land in the watershed lies in the UNF and is managed by the Tiller Ranger District, 41% (57,997 acres or 90.6 square miles) of the land in the watershed is managed by the BLM Roseburg District (South River Resource Area), and the rest of the land in the watershed (57.0%) is in non-federal ownership. The timberland on the private holdings are characterized by early- and mid seral stages. Only 3% of these holdings are covered by timberland with stands in excess of 80 years old. NFS land is found only in the Corn Creek and Stouts Creek subwatersheds (figure 2-2, table 2-4).

Fire severity is low for the Interior Valleys and Foothills Zone, low to moderate for the Douglas-fir/Chinkapin Zone, moderate for the Grand Fir zone, and high for the Cool Douglas-fir/Hemlock and Western Hemlock zones (BLM 2001). High-severity regimes have infrequent fires but when they do occur, they are often intense and stand replacing.

The watershed contains approximately 1,407 miles of streams. Headwater areas, characteristic of much of the NFS land in the watershed, are dominated by dendritic drainage patterns with 1st and 2nd order streams comprising most of the stream miles in the watershed. The term dendritic represents a drainage pattern similar to the pattern made by the veins (i.e., dendritic) on deciduous tree leaves. This type of drainage pattern is found when a common rock type dominates the drainage (e.g., metamorphic rock). Stream drainage densities in the entire watershed average about 6 miles/square mile. These relatively high densities indicate that streamflow responds relatively quickly to rainfall, possibly contributing to high flows and channel erosion.

Closely following rainfall amounts, the vast majority of the streamflow occurs from November through May, with a maximum in January. Small upland intermittent tributaries characteristic of the areas through which the project passes are typically dry in the mid-summer period. About 14% of the watershed is in the transient snow zone (TSZ). Drainages with high road densities, high stream crossing densities, >25% in the TSZ, and a large percentage of land covered by early-seral forests may be susceptible to increased peak flows.

Winter steelhead and resident rainbow trout, fall and spring Chinook salmon, coho salmon, and sea-run cutthroat and resident cutthroat trout have historically used streams in the watershed. Several of these species are listed by the National Marine Fisheries Service (NMFS) under the Endangered Species Act of 1973. Approximately 145 miles of streams in the watershed are considered to be fish-bearing, and 93 miles are considered to be anadromous fish-bearing streams.

Poorly designed or damaged culverts as well as dams without functional fish passage structures prevent upstream fish migration in numerous streams.

NFS lands make up 2% of the total land within the Days Creek–South Umpqua River watershed, 86% (2,417 acres or 3.8 square miles) of these lands are mapped as LSR[2] (RO223). There are approximately 981 acres of Riparian Reserves on NFS lands. NFS lands occurs primarily in the upper reaches of the watershed.

Location and Routing

The project enters the Days Creek–South Umpqua River watershed at MP 82.71 and travels in a south-southeasterly direction through the Days Creek, Saint John Creek, Corn Creek, and Stouts Creek subwatersheds. Between MP 101.77 and MP 102.59, the project right-of-way switches between crossing the Days Creek–South Umpqua River watershed and the Elk Creek watershed before entering the Upper Cow Creek watershed (figure 2-2, table 2-5). The project right-of-way runs predominantly along ridge tops, particularly in the last segment, where it straddles the divide between the Corn Creek and Stouts Creek subwatersheds. In all, the project right-of-way traverses 19.15 miles of the Days Creek–South Umpqua River watershed, including 6.88 miles in the Days Creek subwatershed, 3.31 miles in the Saint John Creek subwatershed, 5.53 miles in the Corn Creek subwatershed, and 3.43 miles in the Stouts Creek subwatershed.

Within the watershed, 1.56 miles of NFS land are crossed by the project right-of-way. The only NFS lands crossed by the project are in the Corn Creek and Stouts Creek subwatersheds (figure 2-2 , table 2-5). Approximately 28.35 acres of LSR on NFS lands (9.81 acres cleared and 18.54 acres modified) (see table 2-6 would be in the project right-of-way in the Days Creek–South Umpqua watershed. All these designated LSR effects would be in the Corn and Stouts Creek subwatersheds, and account for about 1% of the total LSR lands in the watershed. Approximately 24.04 acres of Matrix[3] land would be affected by project construction, including 11.01 acres cleared and 13.03 acres modified (table 2-6).

Project effects on Riparian Reserves and associated aquatic and riparian-dependent resources are minimal considering the number of miles of the project right-of-way in the watershed. There are no stream channel crossings on NFS lands in the Days Creek–South Umpqua River watershed. Two ridge top wetland seeps (CW056 and CW057) would be crossed at MP 102.18 and 102.24, respectively. Total construction effects to Riparian Reserves in the Days Creek–South Umpqua River watershed are approximately 1.71 acres: 0.15 acres cleared and 1.56 acres modified (table 2-6).

[2] Late Successional Reserves (LSR) values apply only to NFS lands.
[3] Matrix is a NFS land allocation.

TABLE 2-4

Land Ownership and Forest Service Land Allocations (acres) in Days Creek–South Umpqua River Fifth-Field Watershed (HUC 1710030205)

	Land Ownership (acres)					Forest Service Land Allocation (acres)		
Sixth-Field Watershed	**Sixth-Field Watershed (acres) a/**	**NFS Land**	**BLM**	**Total NFS and BLM**	**Other**	**LSR**	**Riparian Reserves b/**	**Matrix**
Canyon Creek	24,173.64	0.00	13,395.08	13,395.08	10,778.56	0.00	0.00	0.00
Coffee Creek	11,335.74	0.00	6,709.57	6,709.57	4,626.17	0.00	0.00	0.00
Corn Creek-South Umpqua River	12,014.87	2,624.04	3,837.63	6,461.67	5,553.20	2,385.98	939.25	232.23
Days Creek	22,024.29	0.00	7,983.00	7,983.00	14,041.29	0.00	0.00	0.00
O'Shea Creek-South Umpqua River	26,490.27	0.00	5,342.13	5,342.13	21,148.14	0.00	0.00	0.00
Saint John Creek-South Umpqua River	13,835.72	0.00	6,046.98	6,046.98	7,788.74	0.00	0.00	0.00
Shively Creek-South Umpqua River	17,328.30	0.00	7,008.79	7,008.79	10,319.51	0.00	0.00	0.00
Stouts Creek	14,366.06	182.86	7,673.90	7,856.76	6,509.30	31.35	42.11	149.20
Watershed Total	**141,568.89**	**2,806.90**	**57,997.08**	**60,803.98**	**80,764.91**	**2,417.33**	**981.36**	**387.67**

a/ All data derived from Stantec-based GIS layers.
b/ May occur within other NFS land allocations.

TABLE 2-5

Project Corridor (miles) and Project Area (acres) in Days Creek–South Umpqua River Fifth-Field Watershed (HUC 1710030205) by Land Ownership

	Land Ownership							
	NFS Lands				Entire Sixth Field Watershed			
		Project Area (acres)				Project Area (ares) b/		
Sixth-Field Watershed a/	**Corridor Length (miles)**	**Cleared**	**Modified**	**% of NFS Land Impacted**	**Corridor Length (miles)**	**Cleared**	**Modified**	**% of Sixth-Field Watershed Impacted**
Canyon Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coffee Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corn Creek-South Umpqua River	0.93	7.60	16.09	0.84	5.53	78. 32	41.68	1.00
Days Creek	0.00	0.00	0.00	0.00	6.88	109.07	123.16	0.01
O'Shea Creek-South Umpqua River	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Saint John Creek-South Umpqua River	0.00	0.00	0.00	0.00	3.31	67.48	22.41	0.65
Shively Creek-South Umpqua River	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stouts Creek	0.63	13.39	15.76	1.04	3.43	67.20	39.46	0.74
Watershed Total	**1.56**	**20.99**	**31.85**	**1.13**	**19.15**	**322.07**	**226.71**	**0.39**

a/ All data derived from Stantec-based GIS layers
b/ Includes NFS, BLM, and other ownerships

TABLE 2-6

Project Area (acres) on NFS Lands in the Days Creek–South Umpqua River Fifth-Field Watershed (HUC 1710030205)) by Land Allocation

Sixth-Field Watershed a/	Designated LSR b/				Matrix				Riparian Reserves b/			
	Project Area (acres)		% of Total LSR on NFS Land		Project Area (acres)		% of Total Matrix on NFS Land		Project Area (acres)		% of Total Riparian Reserves on NFS lands c/	
	Cleared	**Modified**	**Cleared**	**Modified**	**Cleared**	**Modified**	**Cleared**	**Modified**	**Cleared**	**Modified**	**Cleared**	**Modified**
Canyon Creek	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coffee Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corn Creek-South Umpqua River	3.48	10.53	0.14	0.43	4.10	5.48	1.77	2.36	0.00	0.20	0.00	0.02
Days Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O'Shea Creek-South Umpqua River	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Saint John Creek-South Umpqua River	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shively Creek-South Umpqua River	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stouts Creek	6.33	8.02	0.26	0.33	6.91	7.55	4.63	5.06	0.15	1.36	0.02	0.14
Watershed Total	**9.81**	**18.55**	**0.35**	**0.66**	**11.01**	**13.03**	**2.84**	**3.36**	**0.15**	**1.56**	**0.02**	**0.16**

a/ All data derived from Stantec-based GIS layers.
b/ Includes mapped and unmapped LSR on NFS lands.
c/ Riparian Reserve acres overlap with LSR and Matrix land allocations.

Existing Conditions Days Creek–South Umpqua River, HUC 1710030205

Original Watershed Assessment Findings

The BLM in consultation with the UNF completed the Second Iteration Watershed Assessment for the Days Creek–South Umpqua River watershed in 2001 (BLM 2001). Subsequent review and assessment of the 2015 Stouts Fire has been included in this document with respect to NFS lands. Watershed conditions are summarized as follows:

- Timber harvesting and road construction over the past 60 years have had major effects in the watershed, including increased peak flows, accelerated sediment transport to streams, increase of landslide hazards, higher stream temperatures, reductions in aquatic habitat complexity and connectivity, and debilitating alterations to stream channel morphology (Beschta 1978, Harr and McCorison 1979, Jones and Grant 1996, Wemple et al. 1996, all cited in BLM 2001).
- Based on data from 2000 Operations Inventory Vegetation Data, 13% of the watershed was nonforested (mainly agriculture and pasture land with emphasis on livestock production), 18% was early seral (30 years old or less), 39% was mid seral (31-80 years old), and 27% was late seral (80 years old or older). About 84% was conifer forest and 3% was covered in hardwood-

dominated forest. For BLM-administered lands[4], 1% was nonforest, 25% was early seral forest, 16% was mid seral forest, and 57% was LSOG forest (BLM 2001).

- On NFS lands, there are approximately 455 acres of Riparian Reserves associated with LSOG (older than 120 years) forest. Regardless, there are Riparian Reserves associated with streams throughout the watershed that have insufficient riparian growth and stream cover, ongoing bank erosion and channel instability, insufficient LWD, and elevated stream temperatures. This is particulary relevant to those Riparian Reserves and upland forest areas that were subjected to the Stouts Fire. The watershed assessment and subsequent recommendations for post-fire recovery after the Stouts Fire support the recommendations to manage fuel loading and reestablish native vegetation.

- Wildfires have had a major impact on the vegetation patterns in the watershed, creating a mosaic of types of varying sizes. The 1987 Canyon Mountain and Bland Mountain fires burned approximately 15,000 acres of the watershed, furthering the shift to early seral forest that resulted largely from logging (BLM 2001). The 2015 Stouts Fire burned an additional 26,452 acres of the watershed, complicating this shift to early seral forest. The Forest Service assigned a BAER team to assess risk to resource conditions and identify the appropriate methods and costs for emergency two-year funding of the burned area rehabilitation. Prescribed burns have been used extensively to prevent major fires and prepare the site for reforestation. The potential exists for additional large-scale fires in this watershed where fuel loads are excessive.

- On steeper slopes throughout the watershed, there are substantial areas susceptible to landslides when burned, cleared, or affected by road construction. Landslides associated with roads are a major source of sediment transport to downstream aquatic habitats in the watershed. This is due to road construction methods and maintenance. Road construction prior to 1970 used sidecast construction methods that commonly contained organic materials in the fill and the fill materials were not compacted at optimum density and moisture conditions. These older roads are usually the areas where watershed maintenance has been focused in the past due to their unstable construction.

- Road densities averaged 4.56 miles/square mile throughout the watershed, with most drainages having densities of less than 5.0 miles/square mile. Many of these roads are in need of maintenance and are a major source of elevated peak flows and sediment transport in the watershed (BLM 2001). They serve to extend the stream network substantially, thereby increasing peak flows and modifyint sediment fluxin the stream channels. This has, in turn, resulted in bank and channel erosion. Between 1997 and 2001, about 12 miles of roads in the watershed had been improved and about another 4 miles had been decommissioned; the recommendation is to improve and preferably decommission roads wherever possible. During and following the Stouts Fire, the BLM and Forest Service did conduct road maintenance and repair on a number of roads throughout the watershed; however, subsequent storms impacted a number of these roads and the associated watershed conditions.

[4] Percentages of forest cover types on NFS lands are not presented due to the relatively small amount of NFS lands within the watershed.

- Timber clearing in the TSZ could result in elevated peak flows during warm rain-on-snow events. Forty-eight percent of the watershed lies above 2,000 feet amsl.
- The South Umpqua River from its mouth to the headwaters is on Oregon's Final 1998 Water Quality Limited Streams 303(d) list for temperature. Tributaries, including Beals Creek, Days Creek, and Shivley Creek, were on the water-quality limited list for habitat modification (including lack of LWD and pool frequency), while Fate Creek, Stouts Creek, and the East Fork of Stouts Creek were listed for temperature. The South Umpqua River was listed for toxics, flow modification, aquatic weeds or algae, bacteria, dissolved oxygen, sediment, pH, and temperature.
- Based on an ODFW Aquatic Habitat Inventory of 82 stream reaches in the watershed, only three were in good condition, 57 were rated as fair, and 22 were in poor condition. None were rated as being in excellent condition (BLM 2001, p. 169).
- Past removal of LWD and boulders from streams in the watershed as part of area logging operations has resulted in decreased habitat complexity, reduced sediment holding capacity, and higher flood peaks. It is recommended that restoration efforts be undertaken to address this issue throughout the watershed.
- Numerous culverts are faulty or are inadequate to handle large floods, resulting in blockage of passage of fish and other aquatic organisms through the area. It is recommended that these culverts be identified and repaired/replaced and that locations for other poorly designed or damaged culverts be identified.

Changes in Watershed Condition

Through July 2015, there were no large-scale disturbance events that would change the general conditions in the Days Creek–South Umpqua River watershed from those described in the applicable watershed assessment. A lightning storm caused the Stouts Fire to begin near the confluence of Stouts Creek and the South Umpqua River on July 30, 2015. This fire grew very fast over the first several days and was not contained until early September 2015. Overall, the fire burned 26,452 acres of BLM, NFS, and private land and impacted resources associated with LSRs and Riparian Reserves. The fire burned across three subwatersheds that would be crossed by the project; Saint John Creek, Corn Creek, and Stouts Creek. Within these affected subwatersheds, 2,612 acres were burned on NFS land and 5,518 acres were burned on BLM land. The Forest Service BAER team identified issues from the fire involving seedling planting, noxious weeds, soil stabilization, road/trail water diversion, tree hazard removal, and monitoring. In November 2015, Stantec biologists, foresters, and geomorphologists conducted a field review of the burned area and surrounding watersheds. In conjunction with the data from the BAER reports, it was determined that the burn severity was moderate (25-50% of canopy cover mortality). The Stouts Fire Supplement to Appendix J of the 2015 Final EIS contains more details on the Stouts BAER report, as well the post-fire watershed projects that were implemented.

Prior to the Stouts Fire, the Forest Service and BLM had instituted a restoration program throughout the watershed based on recommendations from the 2001 watershed assessment in an attempt to improve conditions in specific stream reaches and subwatersheds. A wide array of restoration projects were completed between 2001 and 2015, including:

- Removal and modification of an old irrigation dam to enhance aquatic connectivity in Fate Creek.
- Streambank stabilization in Days Creek to reduce fine sediment and improve aquatic habitat.
- Replacement of stream crossings in several subwatersheds to improve water quality and enhance aquatic connectivity.
- Road decommissioning to reduce hydrologic connectivity and sediment delivery to streams.
- Placement of large wood in fish-bearing streams throughout the watershed to increase channel complexity and improve aquatic habitat.

Current Watershed Conditions

Watershed conditions have improved in the Days Creek–South Umpqua River watershed through accomplishment of restoration projects and implementation of the NWFP. BLM and Forest Service monitoring efforts indicated a trend in improvement of conditions in the Stouts Creek, Days Creek, and St. John's Creek subwatersheds prior to the 2015 Stouts Fire. Insufficent information is available subsequent to the fire to assess what adverseconditions persist in these subwatersheds; however, the 2015 BAER team report suggests that the high-intensity fire, coupled with extensive increases in sediment supply, was expected to degrade watershed conditions. Conversations with BLM and Forest Service hydrologists after the 2017 winter storms confirm that stream crossings failed and high volumes of sediment were delivered to channels throughout the watershed.

Natural Disturbance Processes

Natural disturbance processes in the Days Creek–South Umpqua River watershed are typically associated with wildfires started by lightning strikes (e.g., 2015 Stouts Fire) and flood events (e.g., 2016 rain-on-snow floods). The severity of catastrophic fire hazards varies with the nature of the forest community, and the Days Creek–South Umpqua River watershed includes some areas of adverse consequences for severe, stand-replacing fires. In areas where fires have recently occurred, soils on steep slopes can become unstable from root loss and soil hydrophobicity and increasing landslide instability during heavy precipitation events. As a result of wildfires, a vegetation mosaic characterized by large blocks of vegetation of the same age class predominated under natural conditions, resulting in high connectivity in the terrestrial ecosystem. Under natural conditions, the peak flow conditions resulting from heavy rainfall would be ameliorated to a substantial degree by infiltration of much of the fallen water into the soil system. The subsequent slow release to the drainage system would not only dampen peak flows but also support base flow during the long dry season. The effects of peak flow events to the aquatic habitat under natural conditions were also mitigated by the complexity and hydraulic stability of the drainage network. Under natural conditions, LWD and boulders in the streams and active floodplain dynamics helped reduce peak flows and their effects on the aquatic ecosystem. In-stream structure created pool habitats and substrate conditions conducive to spawning by anadromous and resident fish populations, and the absence of man-made obstructions (culverts and dams) facilitated access of fish populations to upstream habitats.

Project Effects and Range of Natural Variability

Table 2-7 describes the natural range of variability of five key ecological processes and project effects on these processes relative to the ranges of variability resulting from past and ongoing natural and human disturbances in the watershed. All processes have been affected to some degree by human activity.

Current watershed conditions do not reflect natural ranges of variability of key ecological processes in the Days Creek–South Umpqua River watershed. The South Umpqua watershed assessment documented that, historically, the watershed was about 85% LSOG forest (BLM 2001, p. 76). At the time of the 2001 watershed assessment, approximately 58% (35,540 acres out of 60,812 acres) of the federally administered land in the South Umpqua River watershed was in forest stands at least 80 years old (late successional) (BLM 2001, p. 76). The project affects approximately 2.2% of NFS lands, 0.31% of BLM lands, and 0.51% of all ownerships within the watershed. This small impact area is well within the scale of natural disturbance processes described by Everest and Reeves (2007) and Agee (1993) for the Coast Range and Klamath-Siskiyou Province as well as the South Umpqua watershed assessment and is unlikely to change the watershed condition.

The historical condition of the riparian zone along the upper South Umpqua River favored conditions typical of old-growth forests found in the Pacific Northwest (Roth 1937, cited in BLM 2001). Roth noted the shade component that existed along the surveyed stream reaches. The majority of the stream reaches surveyed were "arboreal" in nature, meaning "tall timber along the banks, shading most of the stream." The river and its tributaries were well shaded by the canopy closure associated with mature trees. Streambanks were provided protection by the massive root systems of these trees (Roth 1937, cited in BLM 2001: 164).

Effects to Riparian Reserves are minor. Two forested wetlands in a ridge top swale on the hydrologic divide with the Elk Creek–South Umpqua would be crossed. About 1.71 acres of Riparian Reserves, located adjacent to two isolated forested wetlands that would likely be dry during construction, would be impacted. Approximately 0.37 acre of affected Riparian Reserves would be LSOG and 1.34 acres would be mid seral. Crossings on BLM and private lands would use BMPs that are expected to be effective at minimizing sediment entrainment the transport. Off-site mitigation measures, which include road upgrades/stabilization and culvert replacement, would help bring erosion processes, stream flow, and aquatic connectivity closer to the natural ranges of variability.

TABLE 2-7

Project Effects and Relevant Ecological Processes Described in the Days Creek–South Umpqua River Fifth-Field Watershed Assessment

Ecological Processes Relevant to the Project	Historic Range of Variability	Pacific Connector Effects
Erosional Processes	Landslides are a dominant sediment delivery geomorphic process to stream systems in the watershed under natural conditions. Historically, shallow landslides were associated with high-intensity rainfall events that overlapped with infrequent high-intensity fires. Slope movement of deep-seated landslides are climate driven except on toes where debris flows and slides occur in response to fluvial undercutting. These events resulted in large depositions of coarse wood and coarse sediments to stream systems. Agricultural development on private lands and high road densities throughout the watershed have resulted in chronic fine-grained sediment becoming the primary sediment source. Roads, some affected by landslides, can be a chronic source of sediment transport to waterbodies. In some cases, culverts are undersized and plugged. Roads in the watershed have extended the drainage system substantially during storms, resulting in increased sediment transport and peak flows. Many exposed soils in the watershed are subject to rapid surface erosion during storm events, resulting in increased sediment loads in streams.	Landslide prone areas have been avoided in routing of the project right-of-way. All areas crossed by the project are classified as having a very low to low risk due to the low probability of mass wasting movement and having no significant consequences (Geoengineers 2009). The project right-of-way is generally located on ridge tops. Erosion control measures and BMPs would be implemented to minimize sediment transport off the project right-of-way and thereby reduce the landslide risk consequences. Rapid revegetation of disturbed areas, encouraged by replanting with native species, is anticipated. As a result, sediment effects are expected to be minor, short-term, and well within the range of natural variability for the watershed. Road drainage, surface enhancement, and storm-proofing mitigation projects would likely reduce significant sources of sediments. Offsite fire suppression and fuels reduction mitigation projects in the watershed would help reduce the risk and probability of high-intensity, stand-replacing fire and associated sediment.
Ecological Succession/ Vegetative Condition	The watershed has been heavily affected by both aboriginal and contemporary human use. Before Euro-American settlement, the dominant factor affecting overall landscape patterns was wildfire, which created a complex mosaic of large, even-age stands with large numbers of snags and fire-maintained natural openings. Logging has greatly modified the seral composition of forests in the watershed, with increases in early and mid seral forests and extensive fragmentation of the forest stands.	The project would have minimal impact on vegetation in Riparian Reserves. A small amount of Riparian Reserves (1.71 acres), all located in ridge top areas and bordering intermittent streams, would be impacted.
Flow Regime	Surface and ground water flow regimes are directly related to topography and to the precipitation regime, which in this watershed largely involves rainfall. Under natural conditions, most of the rain falling in the watershed percolates into the soils, where its movement toward aquatic habitats may be delayed, depending on the ground water regime. Large, high-intensity fires may create conditions that significantly increase flows, especially for steep terrain with shallow soils. Improperly designed roads may extend the drainage system and accelerate the transport of runoff to stream channels if proper drainage facilities are not constructed. Clearing of the TSZ in past and ongoing logging and road construction operations have likely contributed to increased peak flows during warm rain-on-snow events. Absence of LWD and boulders in streams also fosters increased peak flows.	Vegetative conditions may contribute to peak flows when more than 25% of a watershed is in the TSZ and less than 30 years old, or where there has been extensive vegetation loss after a stand-replacing fire. The South Umpqua watershed assessment estimated that 94% of the NFS lands in the watershed are hydrologically recovered and unlikely to contribute to increases in peak flows (BLM 2001, p. C-3). The project affects less than 1% of the watershed and therefore would not cause conditions likely to increase peak flows. The limited scale of vegetative impact, project location on or near ridge tops, and limited connectivity to aquatic systems make it unlikely that the project would contribute to an increase in peak flows. Improvements to access roads identified in the TMP along with several off-site road improvement mitigation projects are intended to reduce road-related effects to flow regimes in the watershed and mitigate any project effects. The amount of project-related clearing in TSZ lands is small and should not contribute to elevated peak flows during warm rain-on-snow events. See EIS Chapter 4.3.

TABLE 2-7 **Project Effects and Relevant Ecological Processes Described in the Days Creek–South Umpqua River Fifth-Field Watershed Assessment**		
Ecological Processes Relevant to the Project	**Historic Range of Variability**	**Pacific Connector Effects**
Stream Temperature	In the absence of disturbance, pre-settlement water temperatures were likely below those currently experienced by streams in the watershed. Stand-replacing wildfires and human disturbance (mainly logging, particularly in riparian areas, and road construction) have increased exposure of watershed streams to sunlight, resulting in elevated water temperatures outside the natural range in a number of drainages (e.g., Fate Creek, Stouts Creek, and the East Fork of Stouts Creek). Absence of LWD in streams has also likely contributed to higher stream temperatures by reducing pool frequency and size and allowing streams to widen.	The small acreage of riparian vegetation to be cleared and modified during project construction is unlikely to have any effect on stream temperatures since no stream channels would be crossed or exposed to solar radiation. All riparian areas cleared in the watershed are at near-ridge top positions, and the intermittent streams draining them are dry during the critical summer period when elevated stream temperatures are a concern. Therefore, clearing of the isolated riparian areas near the top of ridge should have no effect on temperatures on water bodies downstream.
Aquatic Habitat and Stream Channel Complexity and Connectivity	Prior to human impact, beaver dams and high densities of LWD in log jams created complex channels and maintained pools in streams of the watershed. Water was stored in the channel and in the streambanks and floodplains as perched aquifers or as parts of deeper unconfined aquifers. Significant amounts of this water were slowly released during the summer, thereby sustaining flows. A combination of LWD and riparian vegetation indicated stable streambanks and channels that were relatively resilient during floods. Removal of LWD and inadequate sources of replenishment of LWD to the creek channels and riparian zones have substantially reduced the complexity of the stream channels, rendering them less suitable as aquatic habitat. The presence of poorly designed and faulty culverts restrict access of anadromous and resident fish populations to upstream habitat.	No LWD or boulders would be removed from streams during construction because there are no channel crossings in the watershed. The very limited effects to Riparian Reserves in the watershed would be mitigated by replanting with native vegetation. Therefore, no long-term effects to aquatic habitat are expected.

Compliance with Land Management Plans

Table 2-8 provides NWFP Standards and Guidelines relevant to the ACS that are applicable to NFS lands in the Days Creek–South Umpqua River watershed.

TABLE 2-8 **Consistency of Project Effects on Days Creek–South Umpqua River Watershed with Umpqua National Forest ACS-Related Management Direction**	
UNF/NWFP Standard/Guideline	**Project Compliance**
Riparian Reserves - Lands; LH-4	Terms and conditions to ensure compliance with ACS objectives in the Days Creek–South Umpqua River watershed have been incorporated into the POD prepared by the applicant in conjunction with the Forest Service and submitted as part of the right-of-way application. The POD includes 28 exhibits, including the Wetland and Waterbody Crossing Plan, the Erosion Control and Revegetation Plan, the Hydrostatic Test Plan, the Right-of-Way Clearing Plan, and the TMP, etc.

TABLE 2-8 **Consistency of Project Effects on Days Creek–South Umpqua River Watershed with Umpqua National Forest ACS-Related Management Direction**	
UNF/NWFP Standard/Guideline	**Project Compliance**
Riparian Reserves General Riparian Area Management; RA-4	Hydrostatic test and dust abatement water withdrawals would not compromise aquatic habitats during low-flow conditions in the Days Creek–South Umpqua River watershed because all such needs would be provided by municipal sources.
Riparian Reserves - Road Management; RF-2	No new project roads intersect Riparian Reserves in the Days Creek–South Umpqua River watershed.
Riparian Reserves - Road Management; RF-4	No new project-related road crossings of streams are proposed in the Days Creek–South Umpqua River watershed. Several existing crossings would be upgraded to minimize erosion potential and facilitate fish passage through the reach. Specific specifications in the TMP (see Section 2.2.3 and Exhibit F, Section F.9.e) require culvert and bridge replacements to meet agency standards and agency approval of plans.
Riparian Reserves - Road Management; RF-5	Road maintenance specifications in the TMP require implementation of T-831, T-842, T-811 and T-834, which are maintenance specifications designed to minimize sediment delivery to aquatic habitats, would be implemented during project construction in the Days Creek–South Umpqua River watershed.
Riparian Reserves - Road Management; RF-7	The TMP submitted by the applicant and accepted by the Forest Service meets all the requirements of RF-7 in the Days Creek–South Umpqua River watershed.
Riparian Reserves - watershed and Habitat Restoration; WR-3	Application of BMPs and other aggressive erosion control measures, restricted construction windows, and numerous other impact minimization measures have been incorporated into several exhibits to the POD to prevent habitat degradation in the Days Creek–South Umpqua River watershed. These measures are not being used as a substitute for otherwise preventable habitat degradation or as surrogates for habitat protection.
Management direction for Survey and Manage Species in the NWFP ROD was replaced by the 2001 ROD and Standards and Guidelines for Amendments to the Survey and Manage, Protection Buffer, and other Mitigation Measures Standards and Guidelines as Modified by the 2011 Settlement Agreement in Conservation Northwest v. Sherman, Case No. 08-CV-1067-JCC (W.D. Wash.)	The project affects Survey and Manage species within the Days Creek–South Umpqua River watershed. This is not consistent with Management Recommendations in the 2001 Survey and Manage ROD; however, the project does not threaten the persistence of any Survey and Manage species (see appendix F). Waiving application of Management Recommendations for Survey and Manage species in the watershed would not prevent attainment of any ACS objective.
Retain late-successional forest patches in landscape areas where little late-successional forest persists. This management action/direction will be applied in fifth-field watersheds (20 to 200 square miles) in which federal forest lands are currently comprised of 15% or less late-successional forest. (The assessment of 15% will include all federal land allocations in a watershed.) Within such an area, protect all remaining late-successional forest stands. Protection of these stands could be modified in the future, when other portions of the watershed have recovered to the point where they could replace the ecological roles of these stands.	NFS lands in the Days Creek–South Umpqua River watershed are currently above this threshold.

The Days Creek–South Umpqua River watershed is a Key Watershed where special standards and guidelines apply on NFS lands. These are described in table 2-9.

TABLE 2-9 **Project Consistency with Standards and Guidelines for Key Watersheds, Days Creek–South Umpqua RIver Watershed**		
Standard and Guideline	**Project Consistency**	**Mitigation**
Reduce existing system and nonsystem road mileage with no net increase in road miles.	No new roads would be constructed by the project. The construction road in the project right-of-way would be obliterated after construction.	None
No new roads would be constructed in inventoried Roadless Areas.	No part of the project is in an inventoried Roadless Area.	None
Watershed analysis must be completed prior to management activities	Watershed analysis has been completed for all watersheds crossed by the project right-of-way on Forest Service lands.	Off-site mitigations are consistent with watershed analysis recommendations.

Relationship of Proposed Forest Plan Amendment UNF-3 to the ACS

UNF LRMP IV-67-1, Forest-Wide Soils Standard and Guideline, states:

> The combined total amount of unacceptable soil condition (detrimental compaction, displacement, puddling or severely burned) in an activity area (e.g., cutting unit, range allotment, site preparation area) should not exceed 20%. All roads and landings, unless rehabilitated to natural conditions, are considered to be in detrimental condition and are included as part of this 20%.

Degraded soil conditions may occur in the cleared project areas. On NFS lands in the Days Creek–South Umpqua River watershed, approximately 38% (21 acres) of the project right-of-way would be cleared. Degraded soil conditions may result from displacement and compaction following completion of corridor construction and rehabilitation. Compaction can largely be addressed by subsoil ripping, but displacement would be unavoidable because of the nature of the project. Existing Forest Plan Standards and Guidelines allow up to 20% of the project right-of-way or 11 acres to result in a degraded soil condition on completion of a project. Thus, the proposed amendment allows an estimated 10 acres or 0.36% of NFS lands in watershed to be in a degraded soil condition on completion of the project.

Severe disturbances such as soil mixing or displacement would reduce long-term site productivity by displacing the duff layer and soil surface (A horizon), thus reducing the soil's ability to capture and retain water and nutrients. As a result, sites with long-term detrimental soil conditions would have interrupted hydrologic function and poor site productivity. Compacted and/or displaced soils may increase runoff and sediment transport and have lower rates of vegetative recovery. Sites with long-term detrimental soil conditions would have interrupted hydrologic function and poor site productivity. Without mitigation, bare soil surfaces in granitic or serpentine soils can persist more than 50 years following a severe disturbance.

Environmental consequences associated with 10 acres of additional detrimental soil conditions over the project right-of-way in the Elk Creek–South Umpqua River watershed include:

- **A potential localized increase in sediment mobilization.** Pacific Connector selected the project route to avoid areas with a high likelihood of geologic hazards. No landslides have been identified that pose a threat to the project. The project does not cross earthflow (a type of landslide) terrains in the watershed. Effective erosion control measures and BMPs are required, as shown in the ECRP. Additionally, the project would comply with the UNF Forest Plan Standards and Guidelines for maintenance of effective ground cover. As a result of the dispersal of effects by the linear nature of the project, maintenance of effective ground cover, the required application of BMPs, lack of stream crossings, minimal effects to Riparian Reserves, and implementation of erosion control methods, it is highly unlikely that amending the UNF Forest Plan to exceed the soil disturbance thresholds by 10 acres would result in the mobilization of sediment that would change the existing equilibrium described in the South Umpqua watershed analysis.

- **A potential localized increase in peak flows.** The project would remove canopy on about 33.9 acres or about 0.9% of NFS lands in the Days Creek–South Umpqua River watershed. Analysis by FERC showed that the project was highly unlikely to contribute to increases in peak flows because of the small area affected by the project as a proportion of the watershed (FERC 2009). Additionally, the project has minimal impacts to Riparian Reserves; it crosses two small forested wetlands but no streams or rivers are crossed in the watershed on NFS lands. As a result, it is highly improbable that the project would change flow regimes from current conditions or from those described in the watershed analysis. See also EIS Chapter 4.3 for a discussion of peak flows.

    - **A potential loss of site productivity, which may slow vegetative recovery.** Approximately 13% of the watershed contains mica schist and 23% contains granodiorite; both rock types have high erosion potential when bare. Mechanically decompacting the soil to a minimum depth of 20 inches and reestablishing soil organic matter would be a critical first step in rehabilitating the soil toward a more natural condition. Soil rehabilitation would also require recovery of the soil biology, which requires restoration of the soil organic matter and time. Pacific Connector would decompact the right-of-way, fertilize disturbed areas, reestablish native vegetation (limiting the area directly over the pipe to grasses and shrubs), and scatter slash and LWD across the site to provide for long-term nutrient cycling as required in the ECRP. Additionally, the Forest Service would require soil remediation with biosolids or other organic materials as necessary to restore biotic capacity. The use of biosolids mixed with wood chips has demonstrated significant increases in vegetative recovery on disturbed sites on the UNF (Orton 2007).

Off-Site Mitigation

Off-site mitigation is intended to provide supplemental actions for project effects that cannot be completely mitigated onsite. All proposed off-site projects related to effects in the Days Creek–South Umpqua River watershed are located in the watershed (table 2-10).

Offsite mitigation efforts in Days Creek–South Umpqua River watershed are focused on:

1. Snag creation to increase habitat within LSRs for northern spotted owl.
2. Lupine meadow restoration
3. Fuels reduction and other fire suppression actions (table 2-10).

TABLE 2-10

Proposed Off-Site Mitigation Projects for Days Creek–South Umpqua Watershed in the Umpqua National Forest

Mitigation Group	Project Type	Project Name	Project Rationale	Quantity
Terrestrial Habitat Improvement	Snag Creation	Days Cr. South Umpqua Matrix Snag Creation	Mitigate immediate and future impacts to snag habitat from the clearing of the pipeline right-of-way. The project prevents development of large snags during the life of the project and for decades afterward. Corridor construction will result in loss of snag habitat on approximately 775 acres of corridor construction (includes safety zone buffer). This project will add to those cumulative impacts. As snags are a critical component of LSR spotted owl habitat, replacement is needed. Snag requirements are specifically outlined in the Forests' LRMPs and the NWFP. Forests require analysis and mitigation under most management activities. Replacement would be immediate, although there would be a 10-year delay as snag decay develops. Snag management is discussed in the NWFP for LSRs on pages C-14 and 15 of the ROD (items 4 and 7). Snag management levels are based on the Forest's Plant Association Guidelines. Snags are also discussed in the South Cascades LSR Assessment (Chap. 3).	14 Acres
Terrestrial Habitat Improvement	Snag Creation	Days Cr. South Umpqua LSR Snag Creation		32 Acres
Terrestrial Habitat Improvement	Lupine Meadow Restoration	Upper Cow Cr. Lupine Meadow Restoration	Mitigate impacts to unique habitats impacted by the project. There will be a loss of forest habitat buffering the unique habitats and disruption to soil horizons, enhancing the opportunities for nonnative plant species. These impacts cannot be fully mitigated on site; therefore, restoration activities such burning, removal of encroaching conifers, and noxious weed control would be applied to a 23-acre meadow located in LSR 223.	23 Acres
Stand Density Fuel Break	Fuels Reduction	Days Cr. South Umpqua LSR Integrated Fuels Reduction	High-intensity fire has been identified as the single factor most impacting late successional and old growth forest habitats on federal lands in the area of the NWFP. Construction of the pipeline and associated activities remove both mature and developing stands and will increase fire suppression complexity. However, the corridor will also provide a fuel break, and fuels reduction adjacent to the corridor will increase the effectiveness of the fuel break. Fuels reduction will lower the risk of loss of developing and existing mature stands and other valuable habitats to high-intensity fire.	254 Acres
Stand Density Fuel Break	Fuels Reduction	Days Cr. South Umpqua Matrix Integrated Fuels Reduction		194 Acres

Snag Creation: Snag creation projects are described in table 2-10; these projects are intended to mitigate for the loss of snag habitats within and adjacent to the project right-of-way. The creation of snags is important in providing habitat for northern spotted owl and other snag-dependent species. Over time, snags also provide LWD on the forest floor and lead to an increase soil productivity. Snag management and creation as they relate to LSRs are discussed in the NWFP on pages C-14 and C-15 (Forest Service and BLM 1994b: C-14,15). Approximately 46 acres of snag creation would occur within the UNF.

Lupin Meadow Restoration: Lupin Meadow will be restored and future impacts will be mitigated to protect the unique habitats impacted by the project. There will be loss of forest habitat buffering unique habitats and disruption to soil horizons, enhancing the opportunities for nonnative plant species. These impacts cannot be fully mitigated on site; therefore, restoration activities such as burning, removal of encroaching conifers, and noxious weed control would be applied to a 23-acre meadow located in LSR 223.

Fire Suppression: High-intensity fire has been identified as the single factor most impacting late successional and old growth forest habitats on federal lands in the area of the NWFP. Construction of the pipeline and associated activities remove both mature and developing stands and will increase fire suppression complexity. However, the corridor will also provide a fuel break, and fuels reduction adjacent to the corridor will increase the effectiveness of the fuel break. Fuels reduction will lower the risk of loss of developing and existing mature stands and other valuable habitats to high-intensity fire. Approximately 448 acres of fuel reduction projects on both LSR and Matrix lands in the UNF have been proposed.

Cumulative Effects

Activities on NFS Lands

The Forest Service manages approximately 2% of the Days Creek–South Umpqua River watershed. There are currently no projects proposed on NFS lands in the watershed that would contribute to cumulative effects.

Activities on BLM land and Private Lands

The BLM manages approximately 41%, and private lands comprise about 57% of the Days Creek–South Umpqua River watershed. There are no projects proposed on BLM lands that might contribute to cumulative effects due to the project's miniscule foot print (0.31% of the basin). Private lands in the watershed are expected to be managed according to current land use patterns, consistent with the County General Plan and existing federal and state statutes, including the Oregon Forest Practices Act and the Clean Water Act. Industrial forest ownerships comprise the majority of the forested landscapes on private lands in the watershed.

Cumulative Effects

The project comprises about 2.2% of NFS lands, 0.31% of BLM lands, and 0.51% of private lands in the Days Creek–South Umpqua River watershed (table 2-5). The small proportion of the watershed affected by the project; ongoing land management on private lands; the regulatory framework between BLM, ODEQ, and ACOE applicable to the project; and project location and routing make it highly unlikely that the portion of the project on federal lands, when considered with other past, present and reasonably foreseeable future actions, would change watershed conditions in the Days Creek–South Umpqua River watershed in any significant, discernable, or measureable way. See also EIS Chapter 4.14, Cumulative Effects.

Project Effects by ACS Objective

Table 2-11 compares the project effects against the objectives of the ACS. The project does not cross any stream channels and affects approximately 1.71 acres of the Riparian Reserves in the Days Creek–South Umpqua River watershed. All affected Riparian Reserves are near ridge tops. The intermittent streams associated with them would likely be dry during construction. The two wetlands are ridge top swales that have no apparent surface connection to drainages.

TABLE 2-11

Compliance of the Project with ACS Objectives, Days Creek–South Umpqua River Watershed

ACS Objective	Project Impacts
Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.	Riparian Reserves are landscape-scale features that would be affected by the project. The project right-of-way would impact 2.2% of the NFS land in the Days Creek–South Umpqua River watershed. Approximately 0.15 acre of Riparian Reserves would be cleared. All of the vegetation cleared would be mid seral. While the cutting of trees where the project right-of-way intersects two localized Riparian Reserves would result in a long-term change in vegetation condition, it would be minor in scale and well within the range of natural variability for vegetative change, given the fire history of the Days Creek–South Umpqua River watershed. The application of BMPs and erosion control measures, use of native vegetation, and the anticipated rapid revegetation of disturbed areas would likely further reduce project impacts. The level of impacts is well within the range of natural variability for disturbance processes described by Everest and Reeves (2007) and Agee (1993) and as documented in the South Umpqua Watershed Assessment (BLM 2001). The NFS lands in the Days Creek–South Umpqua River watershed are approximately 32% LSOG.
Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life-history requirements of aquatic and riparian-dependent species.	The project is not expected to affect spatial or temporal connectivity on NFS lands in the Days Creek–South Umpqua River watershed. No streams would be crossed and impacts in Riparian Reserves would be minimal. Any residual levels of disturbance are anticipated to be well within the range of natural variability.
Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.	The project would have no discernible impact on streambanks or bottoms in the Days Creek–South Umpqua River watershed because no stream channels would be crossed. The few impacts in Riparian Reserves are associated with near ridge-top intermittent streams or ridge top (wetland) swales that have no apparent surface connectivity to the drainage system. Therefore, there would be little influence on the physical integrity of the aquatic system.
Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.	Sediment impacts are expected to be as described in Section 1.4.1. Minor amounts of sediment would be mobilized during construction, but these impacts are expected to be short term and limited to the immediate project area. Connectivity to aquatic systems is limited since no stream channels would be crossed. With application of the ECRP and BMPs, no long-term impacts associated with sediment transport are anticipated. No impacts on water temperature are expected because the two waterbodies that would be crossed are isolated and not connected to an intermittent or perennial stream and no effective shade would be removed.
Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.	Areas of unstable soils have been avoided in project routing. There would be no stream channels crossed in the watershed because the route lies on a ridge top and connections to aquatic systems that would transport sediment do not exist. Sediment fluxes are expected to be minor, short-term, and well within the range of natural variability for the Klamath-Siskiyou Province with implementation of the erosion control measures in ECRP and BMPs as well as the anticipated rapid revegetation that is characteristic of the province. Erosional impacts are, therefore, expected to be consistent with those described in Section 1.4.1.
Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.	It is highly unlikely that the project would affect flows because there is no connectivity between the two isolated wetlands to any drainage system. The project routing is on a ridge top in the watershed and would not cross any stream channels. The watershed is hydrologically recovered (BLM 2001:143) and the project would affect less than 0.5% of the watershed (table 2-6) so changes in peak flows as a result of construction are highly unlikely.

TABLE 2-11 **Compliance of the Project with ACS Objectives, Days Creek–South Umpqua River Watershed**	
ACS Objective	**Project Impacts**
Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.	Two small forested wetlands would be crossed in or near a ridge top swale in the Stouts Creek subwatershed at MP 102.1 and 102.2. Trench plugs would be installed on each side of these wetlands to block subsurface flows and maintain water table elevations, as required by FERC's Wetland and Waterbody Construction and Mitigation Procedures. By restricting crossings to the dry season (July 1 to Sept. 15), possible impacts on water tables of these wetland areas are expected to be minor and short-term. These features appear to have no surface connectivity with the Stouts Creek drainage network.
Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation; nutrient filtering; and appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse, woody debris sufficient to sustain physical complexity and stability.	Approximately 0.15 acre or less than 0.01% of Riparian Reserves in the watershed would be cleared by the project. All affected Riparian Reserves are located at or near ridge tops and contribute little to the thermal regulation, nutrient filtering, bank erosion, and channel stability of the drainage networks in the watershed. Existing herbaceous and brush cover would be maintained in Riparian Reserves to the extent practicable. Replanting with native species would facilitate recovery of vegetation communities. These restoration and off-site mitigation efforts would contribute to the maintenance and restoration and physical functions of the Riparian Reserves in the watershed.
Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.	Impacts to Riparian Reserves would be minimal. All of the Riparian Reserves are located at or near ridge tops. To maintain riparian habitat, construction BMPs would be implemented. Revegetation would be encouraged by planting of native riparian species. The persistence of riparian-dependent Survey and Manage species would not be threatened by project construction and operation in the watershed (see appendix F5).

Summary

It is highly unlikely that contruction and operation of the project would prevent attainment of ACS objectives due to the relatively small portion of NFS lands affected, the relative lack of intersections with waterbodies, and the small acreage of Riparian Reserves affected in the Days Creek–South Umpqua River watershed. No project impacts relevant to the ACS have been identified that are outside the range of natural variability for disturbance processes in the watershed (see table 2-17). The proposed amendment to the UNF LRMP to waive protection measures for Survey and Manage species would not prevent attainment of ACS objectives because the project does not threaten the persistence of any riparian-dependent Survey and Manage species. Mitigation measures associated with the project are responsive to watershed assessment recommendations and would improve watershed conditions where they are applied (see table 2-10).

2.2.1.4 Elk Creek–South Umpqua River Fifth-Field Watershed, HUC 1710030204

Overview

Originating in the Cascades Range, the Elk Creek–South Umpqua River watershed is one of 13 fifth-field watersheds comprising the South Umpqua Subbasin, which drains about 1,800 square miles of southern Oregon. Located about 30 miles southeast of Roseburg in the UNF (Tiller Ranger District), most of the watershed lies in Douglas County but a small portion along the southwest border lies in Jackson County (figure 2-1). The watershed was designated a Tier 1 Key watershed in the NWFP.

This watershed straddles the Western Cascades and the Klamath-Siskiyou provinces. Bedrock in the upper reaches are volcanic materials including lava and pyroclastic flows typical of the Cascades Province, whereas the bedrock in a majority of the watershed is primarily the granite, granodiorite, schist, and serpentinite found in the Klamath-Siskiyou Province.[5]

The Elk Creek–South Umpqua River watershed is bordered on the north by the Tier 1 Days Creek–South Umpqua River watershed, on the northeast by the Middle South Umpqua River-Dumont Creek and Jackson Creek watersheds, on the southwest by the Upper Cow Creek watershed (also in the South Umpqua River system), and on the south and east by the Trail Creek and Elk Creek–South Umpqua River watersheds of the Upper Rogue River drainage system.

In the Elk Creek–South Umpqua River watershed, the drainage network flows northwest, with Elk Creek crossing the northwest watershed boundary within the Days Creek–South Umpqua River watershed and discharging into the South Umpqua River. At Roseburg, the South and North Umpqua Rivers join to form the Umpqua River, which flows northwest through the Oregon Coast Range and empties into the Pacific Ocean at Winchester Bay. See figure 1-1 for the regional setting of this watershed and its relationship to the other fifth-field watersheds traversed by the project.

The 84.9-square-mile (54,356-acre) Elk Creek–South Umpqua River watershed includes four subwatersheds: Upper Elk Creek, Middle Elk Creek, Drew Creek, and Lower Elk Creek (figure 2-3). Land ownership in the watershed is primarily within the UNF (62.9%) managed by the Tiller Ranger District (table 2-12). NFS land is found in all four subwatersheds, with holdings ranging from 6,334 acres in the Middle Elk Creek subwatershed to 10,584 acres in the Upper Elk Creek subwatershed (table 2-12). BLM lands constitute 0.7% of the watershed, and private lands constitute 36.4% of the watershed.

Elevations in the watershed range from about 640 feet where Elk Creek leaves the northwestern part of the watershed and flows into the South Umpqua River to about 4,040 feet at the head of Days Creek in the northeastern part of the watershed. Over 82% of the land in the watershed is in the TSZ. Removal of canopy cover in the TSZ can influence peak flows during warm rain-on-snow events.

The Elk Creek–South Umpqua River watershed has a Mediterranean-type climate, with cool, wet winters and hot, dry summers, during which the fire threat is greatest. Annual precipitation ranges from about 30 inches at Canyonville in the lower part of the watershed to more than 60 inches at the highest elevations. About 85% of the precipitation falls from October through April. At the highest elevations, a substantial portion of the precipitation falls as snow. Summer rainfall is typically less than 5 inches and is typically associated with high-intensity summer thunderstorms.

About 14,271 acres (41.74%) of the NFS land is allocated as LSR. Most of the LSR land in the watershed is in the South Umpqua River/Galesville LSR. Land allocated as Matrix constitutes

[5]Provinces discussed in this document are based on both ecological and geological conditions and therefore do not match those recognized by the Oregon Department of Geology and Mineral Industries and the Oregon State Board of Professional Geologists and Geophysicists. The Klamath-Siskiyou Province is known by professional geologists as the Klamath Mountains Province and the Western Cascades and the High Cascades are two mountain ranges within the Cascades Mountains Province. See https://www.oregongeology.org/learnmore/geologicsightseeing.htm

55.23% of the NFS lands in the watershed. Approximately 9,397 acres or 27.49 acres of NFS lands in the watershed are in Riparian Reserves.

Location and Routing

Leaving the Days Creek–South Umpqua River fifth-field watershed on high ground, the project first enters the Elk Creek–South Umpqua River watershed at MP 101.8 (figure 2-3). The project then skirts the southwest divide separating the Lower Elk and Drew Creek subwatersheds from the Days Creek–South Umpqua River and Upper Cow Creek fifth-field watersheds. Along this segment, the project right-of-way runs alternately on the two sides of these divides. On leaving the watershed at MP 109, the project right-of-way drops down into the South Fork Cow Creek subwatershed of the Upper Cow Creek fifth-field watershed.

In all, approximately 3.26 miles of the project right-of-way are in the Elk Creek–South Umpqua River watershed, with 2.67 miles on NFS land (table 2-13 . NFS land is crossed in the Drew Creek and Lower Elk Creek subwatersheds (figure 2-3). In addition, 0.1 mile of BLM land and 0.49 mile of private land are crossed in the Lower Elk Creek subwatershed. Most of the traversed land is in the TSZ, where clearing could contribute to elevated peak flow conditions during warm rain-on-snow events.

Project effects in the Elk Creek–South Umpqua River watershed total 36.51 acres, due primarily to clearing (table 2-13). These affected acreages include 29.91 acres of NFS land (28.67 acres cleared and 1.24 acres modified and constituting 0.09% of the NFS lands in the watershed). Over all land ownerships, 0.07% of the land in the watershed would be affected by project construction.

Effects to LSRs on NFS lands in the Elk Creek–South Umpqua River watershed total 21.23 acres, which accounts for 0.15% of the LSR on NFS lands. Most of these effects are due to clearing (table 2-14). About 8.63 acres of Matrix land on NFS lands would also be affected by project construction. Approximately 0.54 acre of Riparian Reserves would be affected on NFS lands in the Elk Creek–South Umpqua River watershed. Over all allocations, 0.09% of the NFS land in the watershed would be affected by project construction (table 2-15).

Figure 2-3 PCGP Routing and Subwatershed Boundaries, Elk Creek–South Umpqua River Watershed

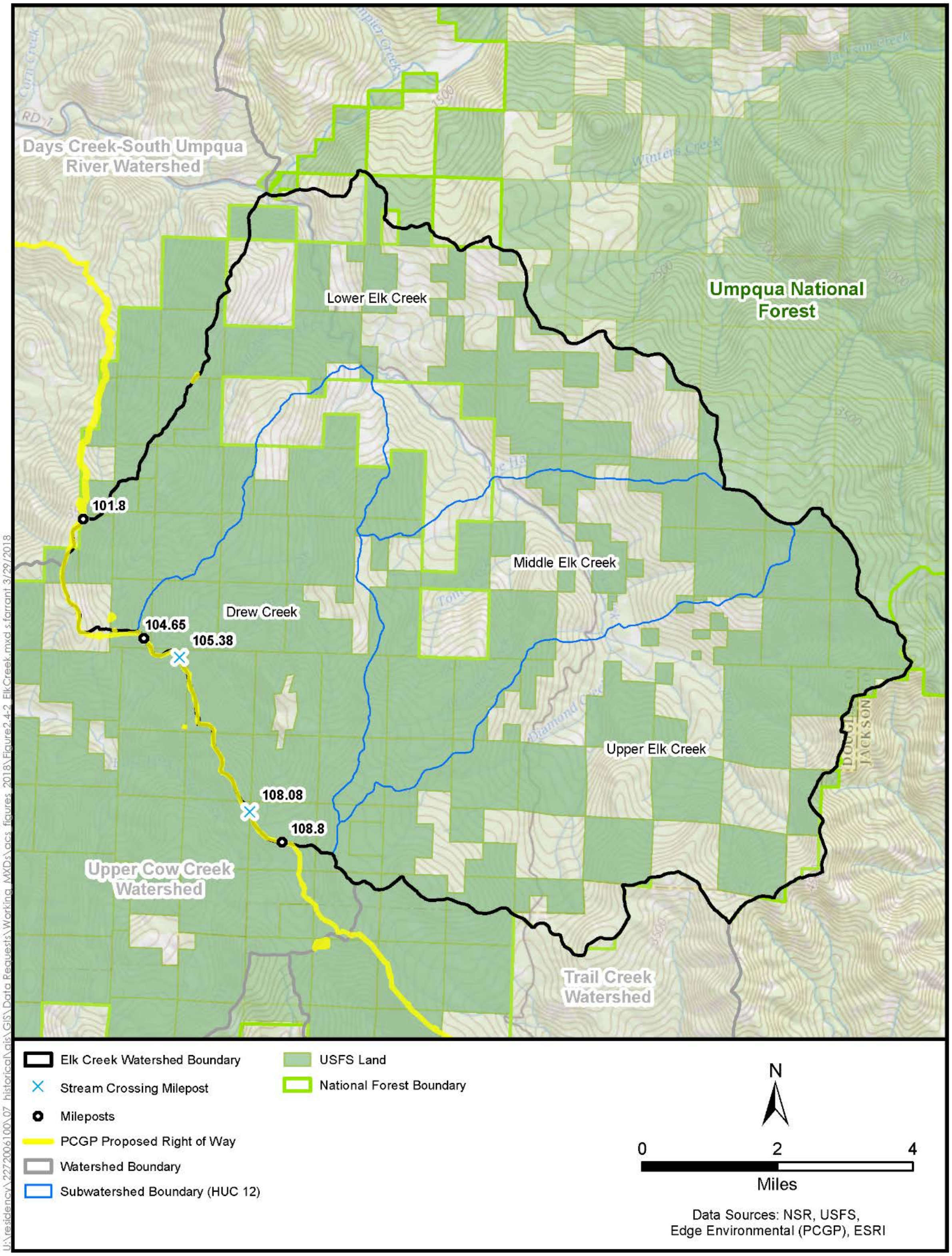


TABLE 2-12

Land Ownership and Forest Service Land Allocations (acres) in Elk Creek–South Umpqua River Fifth-Field Watershed (HUC 1710030204)

	Land Ownership (acres)					Forest Service Land Allocation (acres)		
Sixth-Field Watershed	**Sixth-Field Watershed (acres) a/**	**NFS Land**	**BLM**	**Total NFS and BLM**	**Other**	**LSR**	**Riparian Reserves b/**	**Matrix**
Drew Creek	9,621.17	8,050.35	0.00	8,050.35	1,570.82	5,293.49	2,372.51	2,526.09
Lower Elk Creek	16,881.51	9,209.06	140.01	9,349.07	7,532.44	3,021.36	2,656.99	5,993.16
Middle Elk Creek	10,271.53	6,337.49	0.00	6,337.49	3,934.04	2,425.35	1,611.48	3,659.79
Upper Elk Creek	17,581.71	10,590.46	230.23	10,820.69	6,761.02	3,530.90	2,755.53	6,701.48
Watershed Total	**54,355.92**	**34,187.36**	**370.24**	**34,557.60**	**19,798.32**	**14,271.10**	**9,396.51**	**18,880.52**

a/ All data derived from Stantec-based GIS layers.
b/ May occur within other NFS land allocations.

TABLE 2-13

Project Corridor (miles) and Project Area (acres) in Elk Creek–South Umpqua River Fifth-Field Watershed (HUC 1710030204) by Land Ownership

	Land Ownership							
	NFS Lands				Entire Sixth Field Watershed			
		Project Area (acres)				Project Area (ares) b/		
Sixth-Field Watershed a/	**Corridor Length (miles)**	**Cleared**	**Modified**	**% of NFS Land Impacted**	**Corridor Length (miles)**	**Cleared**	**Modified**	**% of Sixth-Field Watershed Impacted**
Drew Creek	2.45	26.05	0.00	0.08	2.45	26.05	0.00	0.27
Lower Elk Creek	0.22	2.62	1.24	0.01	0.81	8.73	1.73	0.06
Middle Elk Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upper Elk Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Watershed Total	**2.67**	**28.67**	**1.24**	**0.09**	**3.26**	**34.78**	**1.73**	**0.07**

a/ All data derived from Stantec-based GIS layers
b/ Includes NFS, BLM, and other ownerships

TABLE 2-14

Project Area (acres) on NFS Lands in the Elk Creek–South Umpqua River Fifth-Field Watershed (HUC 1710030204) by Land Allocation

	Designated LSR b/				Matrix				Riparian Reserves b/			
	Project Area (acres)		% of Total LSR on NFS Land		Project Area (acres)		% of Total Matrix on NFS Land		Project Area (acres)		% of Total Riparian Reserves on NFS lands c/	
Sixth-Field Watershed a/	**Cleared**	**Modified**	**Cleared**	**Modified**	**Cleared**	**Modified**	**Cleared**	**Modified**	**Cleared**	**Modified**	**Cleared**	**Modified**
Drew Creek	20.94	0.00	0.40	0.00	5.11	0.00	0.20	0.00	0.51	0.00	0.00	0.00
Lower Elk Creek	0.29	0.00	0.01	0.00	2.32	1.20	0.04	0.02	0.03	0.00	<0.01	0.00
Middle Elk Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upper Elk Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Watershed Total	**21.23**	**0.00**	**0.15**	**0.00**	**7.43**	**1.20**	**0.04**	**0.01**	**0.54**	**0.00**	**<0.01**	**0.00**

a/ All data derived from Stantec-based GIS layers.
b/ Includes mapped and unmapped LSR on NFS lands.
c/ Riparian Reserve acres overlap with LSR and Matrix land allocations.

TABLE 2-15

Riparian Reserve Effects Elk Creek–South Umpqua RIver Fifth-Field Watershed HUC 1710030204

										Riparian Reserve Vegetation Cleared in Construction Corridor and TEWAs by Age Class (Acres) c/, f/																			
Jurisdiction	**MP**	**Waterbody**	**Description**		**Waterbody Type**	**Crossed**	**Width of Crossing (feet)**	**Wetland Acres Crossed**	**Clipped**	**RR_Conifer_LSOG**	**RR_Hardwood_LSOG**	**RR_Mixed_Conifer_Hardwood_LSOG**	**Total_LSOG (80+)**	**RR_Conifer_MS**	**RR_Hardwood_MS**	**RR_Mixed Conifer Hardwood MS**	**Total Mid-Seral (40-80)**	**RR_Conifer_ES**	**RR_Shrub_ES**	**RR_Grasslands**	**Total Early Seral (0-40)**	**Stream Channel or Wetland Area**	**Net Riparian Reserve Cleared**	**Uncleared Storage Area in RR**	**Total Direct Impact in RR (Cleared plus**	**Roads and Other Altered Habitats**	**Gross Riparian Reserves**	**fish bearing**	**Anadromy**
Drew creek Subwatershed HUC 171003020403																													
UMP NFS	105.38	D	Ditch		D	Yes			No																		0	No	No
UMP NFS	108.08	D	Ditch		D	Yes			No																		0	No	No
Subtotal Drew Creek			**Crossed: 2 Ditches**	**Clipped: None**	**2**	**0**			**1**																		**0**	**No**	**No**
Total Elk Creek			**Crossed: 2 isolated features**		**3**	**2**			**1**																		**0.54**	**No**	**No**

a/ "Crossed" indicates that the pipeline trench crosses the waterbody or wetland.
b/ "Clipped" indicates that the pipeline corridor crosses a portion of the Riparian Reserve, but the pipeline trench does not cross the associated waterbody. Acre values shown as "0.00" are GIS slivers that are less than 0.01 acre.
c/ Wetland Riparian Reserves often overlap with associated or nearby Riparian Reserves for streams. Where this occurs, the Riparian Reserve component of the wetland is counted with the stream channels to avoid double counting.
d/ Roads and other altered habitats such as rock pits sometimes occur within Riparian Reserves. These features do not have riparian features and are not considered part of the Riparian Reserve vegetated area.
e/ "Anadromy" means that a stream contains anadromous fish or that it is a tributary that directly influences an anadromous stream.
f/ Ditches do not create Riparian Reserves and are shown as 0 acres. They are NOT included in tallies of water body crossings.

Existing Conditions

Original Watershed Analysis Findings

The Forest Service completed the Elk Creek watershed analysis in 1996. Watershed conditions are summarized as follows:

- In the Elk Creek–South Umpqua River watershed, soils within the project right-of-way originate on landscapes underlain by granite and schist terrains. The Elk Creek Watershed Assessment documents that the granitic terrain in the Elk Creek–South Umpqua River watershed has the lowest rate of natural landslides. Landslides related to management activity are primarily associated with timber sales.

- The TSZ in the Tiller Ranger District occurs between 2,000 and 5,000 feet elevation (Forest Service 1990b). In the Elk Creek–South Umpqua River watershed, 44,924 acres or 82% of the watershed is in this transient zone. Since the majority of the watershed is influenced by the TSZ, projects that remove canopy cover should consider the effect on peak flows.

- Channel extension from high road densities (and hence effects on peak flows and increased sediment transport) is greatest on paved and aggregate surfaced roads with ditch lines and culverts.

- The road density within each basin ranges from 1.83 to 5.67 miles per square mile. An estimated 66.2 miles of increased channel extension to the stream network is attributable to the road system. The majority of roads (77%) were constructed prior to 1980. Roads constructed prior to the mid-1970s, depending on road grade, were built using balance cut and fill construction on moderate grade slopes using side-casting excavation and installing culverts at perennial stream crossings and cross drains in the road design inconsistent with todays standards.

- Native surface and non-system roads were found to contribute less to channel extension (and hence to peak flows and sediment routing) because such roads are shorter, steeper, and higher on the hill slope and tend to be narrow and out-sloped. As such, these roads tend not to accumulate water but rather to shed it quickly. The low contribution of surface runoff and erosion of the native-surfaced and non-system roads to the stream network indicate that they may not be as large a factor in increased stream sedimentation as the surfaced roads because the sediment deposition occurs quickly near the source.

- Modern forest management has disrupted historic disturbance processes. Thus, many fundamental ecosystem processes have been disrupted, including plant succession, nutrient cycling, and other processes that rely on the ecosystem patterns historically created by fire. Timber harvest has occurred in 37% of the lands managed by the Forest Service within the watershed. Approximately 20% of the harvest has been by regeneration methods and 17% by selection methods. Fire suppression has nearly eliminated disturbance from the rest of the landscape. The result of this changed disturbance regime is a fragmented landscape low in late-successional vegetation, with unusually high conifer density. Conifer species, specifically pines, are being killed directly as a result of high tree density and indirectly by insect attack. The habitat formerly provided by frequent, low-severity fires is completely absent from the landscape. Wildfire hazard has increased with the accumulation of live and dead fuel and landscape homogenization. These conditions suggest that sustainability, as affected by diversity and health, has declined.

- Terrestrial vegetation has changed dramatically since 1939. The establishment stage increased only 4%, stem exclusion increased 33%, and late-successional growth decreased 31% in the watershed. Wildlife populations that use late-successional habitat for survival have likely decreased in response to loss of habitat. The northern spotted owl, a federally listed threatened species, currently inhabits the watershed and is tied to late-seral habitat for life history requisites. Other sensitive species and species of concern to the Forest Service that rely on a variety of plant communities in the watershed include red-tree vole, great gray owl, red-legged frog, and the Umpqua mariposa lily, a serpentine endemic. Unique habitats that have persisted over time such as Savage Bluffs, Hamlin Prairie, Callahan Meadow, Drew Meadow, and the oak woodlands provide habitat that is key to the survival of several sensitive and rare plants and animals. Some of these species are the ball-head phacelia, Waldo rock cress, Thompson's mistmaiden, and California mountain kingsnake. These habitats have decreased in size due to conifer encroachment, exclusion of fire, road building, and firewood use. Negative effects that have altered native species composition include grazing and introduction of non-native plants.

Management recommendations from the watershed assessment that are pertinent to the PCPG in the Elk Creek–South Umpqua River watershed are summarized below. The congruence of the project with each recommendation is noted. [6]

Landscape Recommendation 1: Concentrate activities in watersheds that have already had heavy impacts from roads and harvesting to restore the landscape-level vegetation and aquatic conditions. Minimize sediment production and inputs to streams, minimize erosional processes, and reduce road densities throughout the watershed. Use Knutsen Vandenberg funding and road reconstruction packages from proposed activities to pay for restoration projects.

- **Project:** The project accomplishes these recommendations primarily by route location, application of the ECRP, and use of BMPs in the construction right-of-way. In the Elk Creek–South Umpqua River watershed, the project right-of-way lies entirely on ridge tops. Where the route leaves the ridge top in the East Fork of Cow Creek, it does so to avoid high-quality spotted owl habitat in Elk Creek. By leaving the ridge top and passing into the East Fork of Cow Creek, the project avoids fragmenting high-quality late-successional forest.

Landscape Recommendation 3: Defer harvest in existing interior late-successional patches and their buffers until existing stem exclusion stands have developed into replacement habitat. Currently, late-successional interior habitat occurs sporadically throughout the watershed as patches embedded in a sea of stem exclusion vegetation. Vegetation manipulation that promotes diversity to the stem exclusion stands and expedites the development of late-successional habitat is encouraged.

- **Project:** The project accomplishes this recommendation by route location and proposed mitigation measures. To minimize impacts in late-successional stands, the route is located on major ridge tops. Where the route leaves the ridge top and turns into the East Fork of Cow

6 Elk Creek Watershed Assessment, p. 156.

Creek, it does so in part to avoid high-quality spotted owl habitat. The East Fork of Cow Creek is already heavily roaded so the project is not fragmenting high-quality late-successional forest.

Landscape Recommendation 22: Channel extension occurs across the landscape in the Elk Creek–South Umpqua River watershed. Channel extension can be reduced by adding culverts, drain dips, and other drainage structures to existing roads, which help interrupt direct stream extension by dispersing the water on the hillside at desired locations rather than channeling it into existing streams. Obliterating roads would reduce road densities and decrease channel extension.

- **Project**: Consistent with this recommendation, roads used by Pacific Connector to access the project would be upgraded and maintained as needed.

Project Recommendation 10: When aggregating harvest units, consider the effect on peak flows. Canopy removal in snow zones may increase streamflow. The cumulative effects of canopy removal and added road ditches on peak flows and aquatic habitat should be examined at the project level.

- **Project:** The FERC conducted a project-level peak flow assessment for the project and concluded that the project was highly unlikely to contribute to an increase in peak flows.

Specific Recommendations for Drew Creek and Callahan Creek Subwatersheds

Most of these subwatersheds are part of the South Umpqua River/Galesville LSR. Any management activities in these subwatersheds should meet the objectives and follow the guidelines in the South Umpqua River/Galesville LSR.

- **Project:** Although this LSR is in the Klamath-Siskiyou Province where harvest of trees over 80 years old to accomplish fuels objectives is permitted, the Late Successional Reserve Assessment (LSRA) recommends that trees over 80 years old not be cut. It is likely that a small percentage of the trees in the shaded fuel break proposal would be over 80 years old. In this circumstance, trees greater than 80 years old would be removed only where necessary to achieve the fuel break objectives. This is permissible under the standards and guidelines applicable to the Klamath-Siskiyou Province (Forest Service and BLM 1994b; C-13). The project would also remove an estimated 65 acres of trees older than 80 years from LSR 223 (includes both Elk Creek–South Umpqua River and Cow Creek watersheds) in the UNF (FERC 2010). Standards and guidelines for new developments in LSRs make provisions for utility corridors in LSRs.

Most of the Drew and Lower Elk Creek subwatersheds are composed of granite or schist soil types. All management activities in these subwatersheds should follow the guidelines in the 1995 Tiller Ranger District granite and schist policy.

- **Project:** The project is consistent with the Tiller Ranger District granite and schist policy. Callahan Creek in the Lower Elk Creek subwatershed has been identified as a major contributor of sediment inputs to the South Umpqua River. Debris flows and landslide frequencies related to timber harvest and road construction are very high in this watershed; however, the natural landslide rate is the lowest in the Elk Creek–South Umpqua River watershed. Restoration of upland processes should be considered a priority in the Lower Elk

Creek subwatershed. Road obliteration and rehabilitation projects would likely reduce sediment inputs.

- **Project**: The project lies entirely on ridge tops in these subwatersheds to avoid side-hill areas prone to management-caused landslides. The mitigation plan filed by Pacific Connector includes approximately 5.9 miles of road decommissioning in the Lower Elk Creek subwatershed. Shaded fuel breaks with underburning, meadow restoration, off-site pine removal, and precommercial thinning in LSRs all serve to restore upland processes.[7]

Changed Watershed Conditions

There were no large-scale disturbances that would change the conditions described in the watershed analysis prior to summer 2015. In July 2015, the Stouts Fire began in the adjoining watershed and rapidly spread into several other watersheds, including the Elk Creek–South Umpqua River watershed. The fire was fully contained by early September 2015. Overall, the fire burned 26,452 acres of BLM, NFS, and private land and impacted resources associated with LSRs and Riparian Reserves. The fire affected the Drew Creek, Lower Elk Creek, and Middle Elk Creek subwatersheds. A total of 13,481 acres were burned within these subwatersheds, with 11,482 acres on NFS land and 17 acres on BLM land. The Forest Service BAER team identified issues from the fire involving seedling planting, noxious weeds, soil stabilization, road/trail water diversion, tree hazard removal, and monitoring. In November 2015, Stantec biologists, foresters, and geomorphologists conducted a field review of the burned area and surrounding watersheds. In conjunction with the data from the BAER reports, it was determined that the burn severity was moderate (25 to 50% of canopy cover mortality). The Stouts Fire Supplement to Appendix J of the 2015 Final EIS contains more details on the Stouts BAER report, as well as the post-fire watershed projects that were implemented.

Prior to this fire, the Forest Service and BLM had conducted a number of management activities in the watershed based on the recommendations in the watershed analysis (table 2-16).

TABLE 2-16

Activities in Elk Creek Since Publication of the Elk Creek Watershed Analysis, October 1996

Name	Activity Type	Dates	Total Acres/Miles	Location
Joe Hall Cr. Bridge Construction	Replace culvert with bridge	2012	1 ac	Lower Elk (6th)
Elk Cr. Instream Restoration	Add rock and large wood	2012	0.1 mi	Elk (5th)
Eight County Hazardous Fuels Reduction	Pile burning	2009	341	Elk (5th)
Eight County Hazardous Fuels Reduction	Precommercial thin	2009	393	Elk (5th)
Drew Vegetation	Pile burning	2009-2012	68 ac	Low and Middle Elk (6th)
Drew Vegetation	Commercial thin	2008-2012	340 ac	Low and Middle Elk (6th)
Drew Vegetation	Precommercial thin	2007	53 ac	Low and Middle Elk (6th)

7 Ibid.

TABLE 2-16 **Activities in Elk Creek Since Publication of the Elk Creek Watershed Analysis, October 1996**				
Name	**Activity Type**	**Dates**	**Total Acres/Miles**	**Location**
Diamond Cr. Bridge Construction	Tree removal, bridge construction	2008	1 ac	Upper Elk (6th)
Joe Hall Instream	Add rock and large wood	2006	2 mi	Lower Elk (6th)
Joe Hall Instream Phase 2	Add large wood	2007	1 mi	Lower Elk (6th)
Joe Hall Landslide Stabilization	Riparian shrub planting	2008	2 ac	Lower Elk (6th)
Joe Hall Logs	Blowdown log removal	2006	80 ac	Lower Elk (6th)
Brownie Instream	Add large wood	2007	2 mi	Upper Elk (6)
Brownie Instream Logs	Blowdown log removal	2007	14 ac	Elk headwater (6th)
Devils Knob Fuelbreak	Precommercial thin	2012	268 ac	Lower Elk (6th)
Devils Knob Fuelbreak	Pile burning	2012	268 ac	Lower Elk (6th)
Cattle Grazing	Cattle grazing	1996-2006	43,140 ac	Elk (SU -5th)
Cattle Grazing	Cattle grazing	2007-2012	32,860 ac	Elk (SU -5th)
Drew 1 (Calochortus)	Precommercial thin	2001	15 ac	Lower Elk (6th)
Drew 1 (Calochortus)	Prescribed burn	2001	15 ac	Lower Elk (6th)
Drew 2 (Calochortus)	Precommercial thin	2005	120 ac	Drew (6th)
Drew 2 (Calochortus)	Prescribed burn	2005	120ac	Drew (6th)
Wildfire	Wildfire	1991-2012	41 ac	Lower and Middle Elk (6th)
Summit Mdw. Restoration	Prescribed burn, snag creation	2001	98 ac	Lower Elk (6th)
Weed Treatment	Hand pull/cut	1997-2012	2400 ac	Elk (SU -5th)
Reforestation	Tree planting	1997-2003	467 ac	Elk (SU -5th)
Clearcutting on Private Land within District Boundary	Clearcut	1996-2006	249 ac	Lower Elk (6th)
Clearcutting on Private Land within District Boundary	Clearcut	1996-2012	2,934 ac	Upper Elk (6th)
Commercial Thinning on Private Land within District Boundary	Commercial thin	2006	6 ac	Lower Elk (6th)
ERFO Road Repair	Road repair	1996-2006	10 ac	Elk (5th)
Road Maintenance	Brushing, grading, resurfacing	2010-2012	53 mi.	Elk (5th)

Current Watershed Conditions

Watershed conditions have improved in the Elk Creek–South Umpqua River watershed with accomplishment of restoration projects and implementation of the NWFP; however, most of the issues identified in the watershed assessment remain. NWFP monitoring showed improving watershed condition trends in the Drew Creek and Lower, Middle, and Upper Elk Creek subwatersheds. Drew Creek showed a slight negative trend on roads while the other subwatersheds were neutral to improving. Forest Service Watershed Condition Class evaluation rated the Drew Creek subwatershed as "functioning at risk" with at-risk impacts from water quality issues, fire risk, and roads.

Natural Disturbance Processes

Disturbance processes in the Elk Creek–South Umpqua River watershed are consistent with those described for the Klamath-Siskiyou and Western Cascades provinces. Prior to modern management, fire was the dominant process affecting upslope and riparian vegetation above the floodplain. The fire regime for this watershed is characterized by Agee (1993) as moderate. A diverse combination of fires with variable intensity, frequency, and size created an equally diverse pattern of landscape and stand vegetation. With the onset of modern management, that disturbance process has been altered. Fire suppression has excluded all but small gap disturbances outside of areas where timber harvest has occurred, fragmenting the landscape. Fire exclusion and timber harvest have increased homogeneity in mid seral plant communities while decreasing early and late seral vegetation. Shade- and density-tolerant white-fir has increased at the expense of intolerant fire-adapted Douglas-fir and yellow pines and most hardwoods. Fire hazard and magnitude of insect and disease activity is likely higher than before modern management (Forest Service 1996: 8).

Project Effects and Range of Natural Variability

Table 2-17 addresses relevant ecological processes and the historic range of variability in the Elk Creek–South Umpqua River watershed.

TABLE 2-17

Project Effects and Relevant Ecological Processes Described in the Elk Creek–South Umpqua River Fifth-Field Watershed Assessment

Ecological Processes Relevant to the Project	Historic Range of Variability	Pacific Connector Effects
Erosional Processes	Landslides are a dominant geomorphic process for sediment delivery to stream systems in the watershed under natural conditions. Historically, shallow landslides were associated with high-intensity rainfall events that overlapped with infrequent high-intensity fires. These events resulted in large depositions of coarse wood and coarse sediments to stream systems. Agricultural development on private lands and high road densities throughout the watershed have resulted in chronic fine-grained sediment becoming the primary sediment source. Roads, some affected by landslides, can be a chronic source of sediment transport to waterbodies. In some cases, culverts are undersized and plugged. Roads in the watershed have extended the drainage system substantially during storms, resulting in increased sediment transport and peak flows. Many exposed soils in the watershed are subject to rapid surface erosion during storm events, resulting in increased sediment loads in streams.	Landslide-prone areas have been avoided in routing of the project. All areas crossed by the project right-of-way are classified as a very low to low risk due to the low probability of mass wasting movement and no significant consequences (Geoengineers 2009). The project within the Elk Creek–South Umpqua River watershed is located entirely on ridge tops. Erosion control measures and BMPs would be implemented to minimize sediment transport off the project right-of-way and thereby reduce the landslide hazard and consequences. Rapid revegetation of disturbed areas, encouraged by replanting with native species, is anticipated. As a result, sediment effects are expected to be minor, short-term, and well within the range of natural variability for the watershed. Road decommissioning and storm-proofing mitigation projects would likely reduce significant sources of sediments. Off-site fuel hazard reduction mitigation projects in the watershed would help reduce the risk and probability of high-intensity, stand-replacing fire and associated sediment.

TABLE 2-17

Project Effects and Relevant Ecological Processes Described in the Elk Creek–South Umpqua River Fifth-Field Watershed Assessment

Ecological Processes Relevant to the Project	Historic Range of Variability	Pacific Connector Effects
Ecological Succession/Vegetative Condition	The watershed has been heavily affected by both aboriginal and contemporary human use. Before Euro-American settlement, the dominant factor affecting overall landscape patterns was wildfire, which created a complex mosaic of large, even age stands with large numbers of snags and fire-maintained natural openings. Logging and fire suppression have greatly modified the seral composition of forests in the watershed, with increases in early and mid seral forests and extensive fragmentation of late seral forest stands.	The project would have minimal impact on vegetation in Riparian Reserves. A small amount of Riparian Reserves (0.54 acre), all located in ridge top areas, would be impacted. Approximately 0.28 acre of the affected Riparian Reserves is LSOG and 0.26 acre is mid seral.
Flow Regime	Surface and shallow ground water flow regimes are directly related to the precipitation regime, which in this watershed largely involves rainfall. Under natural conditions, most of the rain falling in the watershed percolates into the soils, where its movement toward aquatic habitats is delayed. Large, high-intensity fires may create conditions that significantly increase flows. Roads can extend the drainage system and accelerate the transport of runoff to stream channels. Clearing of the TSZ in past and ongoing logging and road construction operations has likely contributed to increased peak flows during warm rain-on-snow events. The absence of LWD and boulders in streams also fosters increased peak flows.	Vegetative conditions may contribute to peak flows when more than 25% of a watershed is in the TSZ and less than 30 years old or where there has been extensive vegetation loss after a stand-replacing fire. The project affects 0.07% of the watershed. The limited scale of vegetative impact, project location on ridge tops, and limited connectivity to aquatic systems make it unlikely that the project would contribute to an increase in peak flows. Improvements to access roads identified in the TMP along with several off-site road improvement mitigation projects are intended to reduce road-related effects to flow regimes in the watershed and mitigate any project effects. The amount of project-related clearing on TSZ lands is small and should not contribute to elevated peak flows during warm rain-on-snow events. See EIS Chapter 4.3 for additional discussion.
Stream Temperature	In the absence of disturbance, pre-settlement water temperatures were likely below those currently experienced on streams in the watershed. Stand-replacing wildfires and human disturbance (mainly logging, particularly in riparian areas, and road construction) have increased exposure of watershed streams to sunlight, resulting in elevated water temperatures outside the natural range. Absence of LWD in streams has also likely contributed to higher stream temperatures by reducing pool frequency and size and allowing streams to widen.	There are two ditch crossings on NFS lands in the watershed and a small amount of riparian vegetation would be cleared during project construction. These two crossings have intermittent flow and are unlikely to have any effect on stream temperatures. Therefore, they should have no effect on temperatures on water bodies downstream.
Aquatic Habitat and Stream Channel Complexity	Prior to human impact, beaver dams and high densities of LWD in log jams created complex channels and maintained pools in streams of the watershed. Water was stored in the channel and as shallow ground water as perched aquifers or unconfined aquifers in the streambanks and floodplains. Significant amounts of this water were slowly released during the summer, thereby sustaining flows. A combination of LWD and riparian vegetation indicated stable streambanks and channels that were relatively resilient during floods. Removal of LWD and inadequate sources of replenishment of LWD to the creek channels and riparian zones has substantially reduced the complexity of the stream channels, rendering them less suitable as aquatic habitat. Presence of poorly designed and faulty culverts restrict access of anadromous and resident fish populations to upstream habitat.	Since there are no stream crossings in this watershed (only two intermittent wetted ditches), no LWD or boulders would be removed from streams during construction. The very limited effects to Riparian Reserves in the watershed would be mitigated by replanting with native vegetation. Therefore, no long-term effects to aquatic habitat and channel complexity are anticipated.

Compliance with Land Management Plans

Table 2-18 provides NWFP Standards and Guidelines relevant to the ACS that are applicable to NFS lands in the Elk Creek–South Umpqua River watershed.

TABLE 2-18

Umpqua National Forest Standards and Guidelines Applicable to the ACS

UNF/NWFP Standard/Guideline	Project Compliance
Riparian Reserves - Lands; LH-4	Terms and conditions to ensure compliance with ACS objectives in the Elk Creek–South Umpqua River watershed have been incorporated into the POD prepared by the applicant in conjunction with the Forest Service and submitted as part of the righ-of-way application. The POD includes 28 exhibits, including the Wetland and Waterbody Crossing Plan, the Erosion Control and Revegetation Plan, the Hydrostatic Test Plan, the Right-of-way Clearing Plan, eand the TMP, etc.
Riparian Reserves - General Riparian Area Management; RA-4	Hydrostatic test and dust abatement water withdrawals would not compromise aquatic habitats during low-flow conditions in the Elk Creek–South Umpqua River watershed because all such needs would be provided by municipal sources.
Riparian Reserves - Road Management; RF-2	No new project roads intersect Riparian Reserves in the Elk Creek–South Umpqua River watershed.
Riparian Reserves - Road Management; RF-4	No new project-related road crossings of streams are proposed in the Elk Creek–South Umpqua River watershed. Several existing crossings would be upgraded to minimize erosion potential and facilitate fish passage through the reach. Specific specifications in TMP Section 2.2.3 and Exhibit F, Section F.9.e require culvert and bridge replacements to meet agency standards and agency approval of plans.
Riparian Reserves - Road Management; RF-5	Road maintenance specifications in the TMP require implementation of T-831, T-842, T-811, and T-834, which are maintenance specifications designed to minimize sediment delivery to aquatic habitats. These specifications would be implemented during project construction in the Elk Creek–South Umpqua River watershed. In addition, off-site mitigations (culvert replacements) would improve road conditions, further minimizing sediment transport to adjacent aquatic habitats.
Riparian Reserves - Road Management; RF-6	Fish passage would be maintained at all road crossings where project-related road repairs are implemented in the Elk Creek–South Umpqua River watershed. Some existing crossings would be upgraded. In addition, off-site mitigations (culvert replacement) would be implemented to expand fish migration in the watershed.
Riparian Reserves - Road Management; RF-7	The TMP submitted by the applicant and accepted by the Forest Service meets all the requirements of RF-7 in the Elk Creek–South Umpqua River watershed.
Riparian Reserves - watershed and Habitat Restoration; WR-3	Application of BMPs and other aggressive erosion control measures, restricted construction windows, and numerous other impact minimization measures have been incorporated into several exhibits to the POD to prevent habitat degradation in the Elk Creek–South Umpqua River watershed. These measures are not being used as a substitute for otherwise preventable habitat degradation or as surrogates for habitat protection.
Management direction for Survey and Manage species in the NWFP ROD was replaced by the 2001 ROD and Standards and Guidelines for Amendments to the Survey and Manage, Protection Buffer, and other Mitigation Measures Standards and Guidelines as Modified by the 2011 Settlement Agreement in Conservation Northwest v. Sherman, Case No. 08-CV-1067-JCC (W.D. Wash.)	The project affects Survey and Manage species within the Elk Creek–South Umpqua River watershed. Such effects are inconsistent with management recommendations for Survey and Manage Species in the 2001 ROD for Survey and Manage Species. However, the project does not threaten the persistence of any Survey and Manage species (see appendix j). Waiving application of Management Recommendations for Survey and Manage species in the watershed would not prevent attainment of any ACS objective.

TABLE 2-18 **Umpqua National Forest Standards and Guidelines Applicable to the ACS**	
UNF/NWFP Standard/Guideline	**Project Compliance**
Retain late-successional forest patches in landscape areas where little late-successional forest persists. This management action/direction will be applied in fifth-field watersheds (20 to 200 square miles) in which federal forest lands are currently comprised of 15% or less late-successional forest. (The assessment of 15% will include all federal land allocations in a watershed.) Within such an area, protect all remaining late-successional forest stands. Protection of these stands could be modified in the future, when other portions of the watershed have recovered to the point where they could replace the ecological roles of these stands.	Federal lands in the Elk Creek–South Umpqua River watershed are currently 45% LSOG and exceed this threshold.

The Elk Creek–South Umpqua River watershed is a Key Watershed where special standards and guidelines apply. These are described in table 2-19.

TABLE 2-19 **Project Consistency with Standards and Guidelines for Key Watersheds, Elk Creek–South Umpqua RIver Watershed**		
Standard and Guideline	**Project Consistency**	**Mitigation**
Reduce existing system and nonsystem road mileage with no net increase in road miles.	No new roads would be constructed by Pacific Connector. The construction road in the project right-of-way would be obliterated after construction.	Decommissioning of 5.9 miles of road would result in a net decrease of road miles.
No new roads would be constructed in inventoried Roadless Areas.	No part of the project is in an inventoried Roadless Area.	None needed
Watershed analysis must be completed prior to management activities.	Watershed analysis has been completed for all watersheds crossed by the project on Forest Service lands.	Off-site mitigations are consistent with watershed analysis recommendations.

Relationship of Proposed Forest Plan Amendment UNF-3 to the ACS

UNF LRMP IV-67-1, Forest-Wide Soils Standard and Guideline, states:

> The combined total amount of unacceptable soil condition (detrimental compaction, displacement, puddling or severely burned) in an activity area (e.g., cutting unit, range allotment, site preparation area) should not exceed 20 percent. All roads and landings, unless rehabilitated to natural conditions, are considered to be in detrimental condition and are included as part of this 20 percent.

Degraded soil conditions may occur in the cleared project areas. On NFS lands in the Elk Creek–South Umpqua watershed, approximately 90% (29 acres) of the project right-of-way would be cleared. Degraded soil conditions may result from displacement and compaction following completion of project construction and rehabilitation. Compaction can largely be addressed by subsoil ripping, but displacement would be unavoidable because of the nature of the project. Existing Forest Plan Standards and Guidelines allow up to 20% of the project right-of-way, or 7 acres, to result in a degraded soil condition on completion of a project. Thus, the proposed amendment allows an estimated 22 acres, or 0.06%, of NFS lands in the watershed to be in a degraded soil condition on completion of the project.

Severe disturbances such as soil mixing or displacement would reduce long-term site productivity by displacing the duff layer and soil surface (A horizon), thus reducing the soil's ability to capture and retain water and nutrients. As a result, sites with long-term detrimental soil conditions would have interrupted hydrologic function and poor site productivity. Compacted and/or displaced soils may increase runoff and sediment transport and have lower rates of vegetative recovery. Without mitigation, bare soil surfaces in granitic or serpentine soils can persist more than 50 years following a severe disturbance.

Environmental consequences associated with 22 acres of additional detrimental soil conditions over the project right-of-way in the Elk Creek–South Umpqua River watershed include:

- **A potential localized increase in sediment mobilization.** Pacific Connector selected the project route to avoid areas with a high likelihood of geologic hazards. No landslides have been identified that pose a threat to the project. The project right-of-way does not cross earthflow (a type of landslide) terrains in the watershed. Effective erosion control measures and BMPs are required, as shown in the ECRP. Additionally, the project would comply with UNF Forest Plan Standards and Guidelines for maintenance of effective ground cover. As a result of the dispersal of effects by the linear nature of the project, maintenance of effective ground cover, required application of BMPs, ridge-top location, lack of stream crossings, minimal effects to Riparian Reserves, and implementation of erosion control methods, it is highly unlikely that amending the UNF Forest Plan to exceed the soil disturbance thresholds by 22 acres would result in the mobilization of sediment that would change the existing equilibrium described in the Elk Creek watershed analysis.

- **A potential localized increase in peak flows.** The Elk Creek watershed analysis recommended site-specific evaluation of the potential for peak flows as a result of canopy removal. The project would remove canopy on about 33 acres or about 0.9% of NFS lands in the Elk Creek–South Umpqua River watershed. Analysis by FERC showed that the project was highly unlikely to contribute to increases in peak flows because of the small area affected by the project as a proportion of the watershed (FERC 2009). Additionally, the entire project right-of-way in the watershed lies on ridge-top locations that have minimal, if any, interactions with aquatic systems since no stream intersects with the project right-of-way in the watershed. As a result, it is highly improbable that the project would change flow regimes from current conditions or from those described in the watershed analysis. See also EIS Chapter 4.4 for a discussion of peak flows.

- **A potential loss of site productivity, which may slow vegetative recovery.** Granitic and schist soils such as those found in the watershed are typically low in productivity. Without mitigation, these soils can remain barren for 50 years when severely disturbed. Mechanically decompacting the soil to a minimum depth of 20 inches and reestablishing soil organic matter would be a critical first step in rehabilitating the soil toward a more natural condition. Soil rehabilitation would also require recovery of the soil biology, which requires restoration of the soil organic matter and time. Pacific Connector would decompact the right-of-way, fertilize disturbed areas, reestablish native vegetation (limiting the area directly over the pipe to grasses and shrubs), and scatter slash and LWD across the site to provide for long-term nutrient cycling, as required in the ECRP. Additionally, the Forest Service would require soil remediation with biosolids or other organic materials as necessary to restore biotic capacity. Biosolids mixed with wood chips have demonstrated significant increases in vegetative recovery on disturbed sites on the UNF (Orton 2007).

Off-site mitigation measures contribute to further reducing these watershed effects. Road decommissioning is planned on 5.95 miles (approximately 35 acres) in the watershed as part of the mitigation plan for the project. Storm-proofing is recommended for 9.21 miles. Decommissioning and storm-proofing roads reduces sediment by reestablishing effective ground cover, increasing infiltration on decommissioned roads, and increasing the road prism drainage capacity while lowering erosion on storm-proofed roads. Decommissioning and storm-proofing roads also contributes to reducing peak flow effects by reducing road-stream interactions, increasing infiltration, and reestablishing natural drainage. It also reduces compaction and helps offset the estimated 10 to 12 acres of the project right-of-way in the watershed that may be in a degraded soil condition on completion of the project.

Off-Site Mitigations

Management recommendations that are pertinent to the project from the Elk Creek watershed analysis are summarized below. The congruence of the project with each recommendation is noted. Numbering coincides with that in the watershed analysis.

Landscape Recommendation 5. Reduce fragmentation across the landscape.

- **Project:** The project proposes to fund mitigation measures designed by the Forest Service that would reduce fragmentation at a landscape scale. In Elk Creek, these include:
  - **Commercial thinning of approximately 91 acres.** This has the effect of moving stands past the stem-exclusion stage by removing excess stems. This reduces fragmentation by effectively aggregating stands, creating more uniform age class distribution, maintaining stands in a healthy condition, and reducing the probability of stand-replacing fire.
  - **Off-site pine removal of approximately 300 acres**. Stand-density management is proposed in pine plantations that were planted with off-site seedlings. The purpose of this mitigation action is to restore stand density, species diversity, and structural diversity to those considered characteristic under a natural disturbance regime by enhancing and accelerating the physical and biological services for associated flora and fauna within LSR 223.
  - **Fuels reduction of approximately 176 acres.** Both mature stands and developing stands will be removed during pipeline construction. Impacts to mature and developing stands will exceed the life of this project by many decades. Density management will increase longevity of existing mature stands by reducing losses from disease, insects, and fire. Density management in younger stands will accelerate development of LSOG. Associated fuel reductions reduce risk of loss to fire and reduce potential fire size and intensity. Biological resources are not compensated for by land allocation change. Removal of LSOG is essentially a permanent loss. Young stands will take 70 years to develop into LSOG so this is not a one-to-one replacement. LSR Assessments have

identified the importance of density management to control losses to stand-replacing fire. In order to effectively offset permanent loss, entire stands need to be treated so habitat over time becomes contiguous and is in proximity to the project. The proposed ridge-line pipeline route intersects an area that has had reoccurring lighting strikes and has a potential for stand-replacing fires. This mitigation will assist in protection and restoration of the late seral forest values. This mitigation provides multiple resources values for the LSR, Forest, adjacent private landowners, and public.

- **Decommissioning approximately 5.9 miles of roads.** Decommissioning roads reduces fragmentation by returning the road corridor to a forested condition.

- **Storm-proofing approximately 9.21 miles of roads.** Storm-proofing will increase the drainage capacity of the road prism while decreasing erosion.

Landscape Recommendation 8. Retain higher levels of LWD during regeneration harvest than have been left historically to favor long-term site productivity, aquatic resources, wildlife, and vegetation processes. Historically, temporal and spatial variability has been extreme. That variability should be perpetuated.

- **Project:** Placement of LWD back on the project right-of-way according to Forest Service standards when construction is completed is part of the ECRP POD filed with FERC.

Landscape Recommendation 22. Channel extension occurs across the landscape in the Elk Creek–South Umpqua River watershed. Channel extension can be reduced by adding culverts, drain dips, and other drainage structures to existing roads, which help interrupt the direct stream extension by dispersing the water on the hillside at desired locations rather than channeling it into existing streams. Obliterating roads would reduce road densities and decrease channel extension.

- **Project**: Consistent with this recommendation, roads used by the project to access the project right-of-way and components would be upgraded and maintained as needed. Pacific Connector has also committed to fund decommissioning of 5.95 miles of roads in the Elk Creek–South Umpqua River watershed.

Landscape Recommendation 24. Roads that remain open in the watershed should be "storm-proofed" to reduce road failures and the sedimentation produced by them. Drainage structures should be upgraded to pass the 100-year flood events.

- **Project:** In response to this recommendation, Pacific Connector has committed to fund 9.21 miles of road storm-proofing in Elk Creek.

Landscape Recommendation 26. Prescribed fire should be used, alone or with tree cutting, to restore nutrient cycles, reduce non-sustainable fuel accumulations, and create conditions that are favorable to the establishment and recruitment of non-conifers and conifers. Considering that the native plant community has already been altered, the objective should be to favor development of a new one that replicates the function of the premanagement community. The forests in the Elk Creek–South Umpqua River watershed evolved with fire as a fundamental process and, with proper management, fire can be the best tool for restoring ecosystem functions.

- **Project**: Prescribed fire is proposed in the Elk Creek–South Umpqua River watershed as part of the fuels reduction in the mitigation plan adopted by Pacific Connector.

Project Recommendation 2. Silvicultural prescriptions should meet management objectives in the context of site conditions and historic fire processes. However, deviation from this generality is acceptable to retain the stand- and landscape-level complexity. Generally, stands should be restored to a species composition and structure that are more sustainable and typical of native forests prior to fire suppression.

Project Recommendation 3. Second-growth stands, plantations, and selectively harvested stands are overrepresented in the landscape. These features have a narrow window of silvicultural treatment and should be treated to meet stand structure and composition objectives and avoid undesirable mortality. However, some dense stands and patches in stands should be retained across the landscape to retain diverse habitats.

Project Recommendation 4. Non-commercial thinning should be accomplished with KV collections whenever possible.

Project Recommendation 5. Stand density management has a much greater benefit to tree growth and stand differentiation, species composition, and forest health than does fertilization. Overly dense stands are abundant and appropriated. Timber stand improvement money is limited. This money should be spent on thinning rather than fertilization.

Project Recommendation 6. Reforestation prescriptions and stocking objectives should be tailored to meet site-specific objectives. If soil and watershed conditions require rapid recovery of conifer canopy and root-site occupancy, then high initial stocking is appropriate. If large trees, structural diversity, and species diversity throughout the life of the stand are required, then high initial stocking is not appropriate. Precommercial thinning can effect changes in stand structure and development, but adequate funding is unlikely.

Project Recommendation 7. Reduce stand density to retain old ponderosa and sugar pines and recruit young ones, ideally at the stand rather than at the individual tree level.

- **Project:** Proposed mitigations for fuels reduction (176 acres), commercial thinning (91 acres), removal of off-site pine (300 acres), and reforestation of the project right-of-way are all responsive to recommendations 3, 4, 5, 6, and 7 above. Fuel reduction with periodic underburns reduces stand density and helps to restore fire-dependent ecosystems while reducing the probability of a landscape-level stand-replacing fire. Removal of off-site pine (pine plantations that are not adapted to the site where they were planted) provides a mechanism to restore ponderosa and sugar pines that are adapted to the site. Reforestation of the project right-of-way would follow these recommendations.

Specific Recommendations for Drew Creek and Upper and Lower Elk Creek Subwatersheds

Most of these subwatersheds are part of the South Umpqua River/Galesville LSR. Any management activities in these subwatersheds should meet the objectives and follow the guidelines in the South Umpqua River/Galesville LSR.

- **Project:** Proposed mitigations for the project in Elk Creek–South Umpqua River include fuel reduction, commercial thinning, meadow restoration, road decommissioning, noxious weed treatment, and off-site pine removal. These actions are all consistent with the recommendations in the South Umpqua River/Galesville LSR.

  - This LSRA also recommends that trees over 80 years old not be cut. It is likely that a small percentage of the trees in the shaded fuel break proposal would be over 80 years old. In this circumstance, trees greater than 80 years old would be removed only where necessary to achieve the fuel break objectives. The project would also remove an estimated 65 acres of trees older than 80 years from LSR 223 (includes both Elk Creek–South Umpqua River and Cow Creek watersheds) on the UNF. In this case, it is not possible to build the project without removing trees older than 80 years. Standards and guidelines for new developments in LSRs make provisions for utility corridors in LSRs.

  - The natural meadows in these two subwatersheds, in particular Drew Meadows and Callahan Meadows, provide significant habitat for many wildlife and plant species. Impacts on these natural meadows have included harvesting, road construction, grazing, and the establishment of non-native species. Restoration of these natural meadows can include burning, reseeding with native species, and reducing encroachment by conifers.

- **Project:** The mitigation plan filed by Pacific Connector includes approximately 101 acres of meadow restoration in Callahan Meadows and in the Lower Elk Creek sixth-field watershed.

  - The noxious weed eradication program should be continued on a regular basis. St. John's wort is of particular concern in Callahan Meadows.

- **Project**: The project right-of-way lies entirely on ridge tops in these subwatersheds to avoid side-hill areas prone to management-caused landslides. The mitigation plan filed by Pacific Connector includes approximately 1.75 miles of road storm-proofing in the Lower Elk Creek subwatershed and 2.7 miles in the Upper Elk Creek subwatershed. Shaded fuel breaks with underburning, meadow restoration, off-site pine removal, and precommercial thinning in LSRs all serve to restore upland processes.

Summary of Mitigation Actions. The applicant-filed mitigation plan includes the following activities in the Elk Creek–South Umpqua River watershed that are consistent with recommendations in the Elk Creek watershed analysis (see Section 2.2.3.2 for a more complete description of these mitigation measures).

- 5.9 miles of road decommissioning. Decommissioning and planting selected roads in conjunction with precommercial thinning treatments (see other mitigations) would block up forested habitat and reduce edge effects and fragmentation in a period of about 40 years. Removal of culverts and roadbeds in Riparian Reserves reduces sedimentation of the waters.

- 9.2 miles of storm proofing. Storm proofing improvement of existing roads restores hydrologic connectivity and reduces sediment by managing drainage and restoring surfacing where needed.

- 176 acres of fuel reduction primarily along the ridge top between Elk Creek and Cow Creek. Fuel breaks help reduce the potential for large-scale stand-replacing fire. At the landscape scale, this contributes to the maintenance of the canopy.
- Two sites for water source improvement projects. Construction of the pipeline and associated activities will increase fire suppression complexity. Pump chances increase the capacity for agency response and help reduce potential fire losses to valuable habitats by providing readily available water sources.
- 91 acres of commercial thinning. Commercial thinning has the effect of regulating stand density, accelerating the development of larger trees, and reducing the stand-replacing fire hazard by regulating stand density and ladder fuels.
- 99 acres of log placement in upland units. This measure restores CWD in old harvest units that are currently devoid of this habitat element. CWD also contributes to long-term soil productivity.
- 68 acres of snag creation. Snags are a critical component of LSR spotted owl habitat, and replacement is needed. Snag requirements are specifically outlined in the Forests' LRMPs and the NWFP. Forests require analysis and mitigation under most management activities.
- 101 acres of meadow restoration at Callahan Meadows. This measure has the effect of restoring native plant communities and controlling invasive weeds.
- 6.7 miles of noxious weed treatment. Mitigation of impacts to unique habitats.
- 300 acres of off-site pine removal. This measure removes trees that are not genetically adapted to the site where they are located and provides a mechanism to restore ponderosa pine and sugar pines that are adapted to the site.
- Replacement or improvement of fish passage at five culverts. Restoring stream crossings reconnects aquatic habitats by allowing the passage of aquatic biota and restoring riparian vegetation.
- 99 acres of upland placement of LWD. Mitigate for the loss of recruitment of large down wood to adjacent stands and within the construction clearing zone. Downed wood is a critical component of mature forest ecosystems.

Cumulative Effects

Activities on NFS Lands

The Forest Service manages 63% of the Elk Creek–South Umpqua River watershed. Along with the project, other projects on NFS lands that would contribute to cumulative effects are shown in table 2-20.

TABLE 2-20 **Umpqua National Forest Projects That Contribute to Cumulative Effects with the Project in the Elk Creek–South Umpqua River Watershed**					
Unit	**Fifth-Field Watershed**	**Sixth-Field Watershed**	**Project Name**	**Project Description**	**Resource**
UNF	Elk Creek–South Umpqua	Lower Elk Creek	Proposed Elk Creek Collaborative Watershed Restoration Project. Published in program of work 2012. Implementation in 2015.	900 ac. commercial thin, 500 ac. fuels reduction, 250 ac. prescribed burn, 100 ac. pre-commercial thin, 50 ac. weed treatment, 50 ac. planting, 4 culvert replacements, 5 miles road decommission	Upland and riparian vegetation, road network, fisheries/aquatic habitat, water quality
UNF	Elk Creek–South Umpqua	Lower Elk Creek	Current grazing	4,963 ac. cattle grazing	Upland and riparian vegetation, fisheries/aquatic habitat, water quality
UNF	Elk Creek–South Umpqua	Lower Elk Creek	Proposed Tiller Aquatic Restoration Project. Published in program of work 2010. NEPA analysis ongoing. Implementation t in 2013.	2 culvert replacements, 5 miles instream habitat improvement, 4 sump maintenance sites, 86 ac. Riparian Reserve thinning	Riparian vegetation, road network, fisheries/aquatic habitat, water quality
UNF	Elk Creek–South Umpqua	Lower Elk Creek	Anticipated clear cutting on private land	150 ac.	Upland and riparian vegetation, road network, fisheries/aquatic habitat, water quality
UNF	Elk Creek–South Umpqua	Drew Creek	Current grazing	5,000 ac. cattle grazing	Upland and riparian vegetation, fisheries/aquatic habitat, water quality
UNF	Elk Creek–South Umpqua	Drew Creek	Proposed Elk Creek Collaborative Watershed Restoration Project. Published in program of work 2010. NEPA analysis ongoing. Implementation in 2015.	200 ac. commercial thin, 500 ac. fuels reduction, 250 ac. prescribed burn, 100 ac. pre-commercial thin, 50 ac. weed treatment, 50 ac. planting, 2 culvert replacements, 5 miles road decommission	Upland and riparian vegetation, road network, fisheries/aquatic habitat, water quality
UNF	Elk Creek–South Umpqua	Drew Creek	Proposed Tiller Aquatic Restoration Project. Published in program of work 2010. NEPA analysis on going. Implementation in 2013.	2 miles instream habitat improvement, 1 sump maintenance site, 58 ac. Riparian Reserve thinning, 1 pond habitat improvement	Riparian vegetation, road network, fisheries/aquatic habitat, water quality

These projects are expected to be consistent with the Standards and Guidelines and land allocation objectives of the UNF LRMP. Collectively, these projects are expected to improve watershed conditions on NFS lands by:

- Reducing road-related surface erosion sediment.
- Improving aquatic habitat conditions.
- Reducing the risk of catastrophic fire and improving stand health by reducing stand density on existing conifer stands.

Activities on Non-Forest Service Lands

BLM lands account for less than 1%, and private lands comprise about 36% of the Elk Creek–South Umpqua River watershed. There are no projects on BLM lands that might contribute to cumulative effects to the watershed. Private lands in the watershed are expected to be managed according to current land use patterns consistent with the Douglas CountyGeneral Plan and existing federal and state statutes, including the Oregon Forest Practices Act and the Clean Water Act.

Cumulative Effects

The project right-of-way comprises about 0.09% of NFS lands, 0.61% of the BLM lands, and 0.02% of private lands in the Elk Creek–South Umpqua River watershed (table 2-12). The small proportion of the landscape affected by the project; ongoing land management on private lands; the regulatory framework between the BLM, ODEQ, and ACOE applicable to the project; and project location and routing make it highly unlikely that the portion of the Pacific Connector project on federal lands, when considered with other past, present, and reasonably foreseeable future actions would change watershed conditions in the Elk Creek–South Umpqua River watershed in any significant, discernable, or measureable way. See also DEIS Chapter 4.14 for a discussion of cumulative effects.

Project Effects Compared by ACS Objective

Table 2-21 shows project effects compared to each of the nine ACS objectives. The project does not cross any stream channels on NFS lands and affects approximately 0.54 acres of Riparian Reserves in the Elk Creek–South Umpqua River watershed. All affected Riparian Reserves are on ridge tops.

TABLE 2-21

Compliance of the Project with ACS Objectives, Elk Creek–South Umpqua River Watershed

ACS Objective	Project Impacts
Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.	Riparian Reserves are landscape-scale features that are affected by the project. The project affects (cleared and modified) 0.09% of the NFS land in the Elk Creek-South Umpqua River watershed (table 2-12). No Riparian Reserves are crossed or clipped in the Elk Creek watershed since the project is routed on a ridgetop. The application of BMPs and erosion control measures, use of native vegetation, and the anticipated rapid revegetation of disturbed areas would likely further reduce project effects. The level of impact is well within the natural range of variability for disturbance processes described by Everest and Reeves (2007) and Agee (1993) and as documented in the South Umpqua Watershed Assessment (Forest Service 1996).
Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life-history requirements of aquatic and riparian-dependent species.	The project is not expected to impact spatial or temporal connectivity on NFS lands in the Elk Creek–South Umpqua River watershed. No streams are crossed and no riparian reserves are clipped. Aquatic system connectivity would be enhanced by replacement of five culverts within the watershed. Any residual levels of disturbance are anticipated to be well within the range of natural variability (table 2-17).
Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.	The project would have no discernible impact on streambanks or bottoms in the Elk Creek–South Umpqua River watershed because no stream channels are crossed. Off-site mitigations involving LWD within Riparian Reserves would help restore physical integrity and complexity (p. 2-47).

TABLE 2-21

Compliance of the Project with ACS Objectives, Elk Creek–South Umpqua River Watershed

ACS Objective	Project Impacts
Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.	Minor amounts of sediment would be mobilized during construction, but these effects are expected to be short-term and limited to the immediate project area. Connectivity to aquatic systems is limited since no stream channels are crossed. With application of the ECRP and BMPs, there should be no long-term effects associated with sediment transport and delivery. No impacts to water temperature are expected because no channels are crossed, and no effective shade is removed. Any sediment transport to aquatic systems that may occur would be offset by off-site road drainage enhancement, surface upgrade, and storm-proofing mitigation projects.
Maintain and restore the sedimentary erosion, transportation and deposition regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.	Areas of unstable soils have been avoided in project routing. There are no stream channels crossed in the watershed and the route lies on a ridge top; therefore, connections to aquatic systems that would transport sediment do not exist. As a result, sediment fluxes are expected to be minor and short-term and well within the range of variability for the Klamath–Siskiyou Province due to implementation of the erosion control measures in ECRP, BMPs, and the anticipated rapid revegetation that is characteristic of the province. As a result, erosional effects are expected to consistent with those described in Section 1.4.1. Road decommissioning and storm proofing would help reduce sediment effects in the watershed and move the sediment regime closer to the desired condition (p. 2-47-51).
Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.	It is highly unlikely that the project would impact flows because of the lack of connectivity to aquatic systems. The project routing is on a ridge top in the watershed and does not cross any stream channels. The watershed is hydrologically recovered, and the project affects 0.07% of the watershed (table 2-13). In addition, analysis by FERC showed that the project was highly unlikely to contribute to increases in peak flows because of the small area affected by the project as a proportion of the watershed (FERC 2009).
Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.	The project would not affect floodplains and water table elevations in meadows because these features are not crossed by the project in the Elk Creek–South Umpqua River watershed.
Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation; nutrient filtering; and appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse, woody debris sufficient to sustain physical complexity and stability.	No vegetation in Riparian Reserves is removed. Existing herbaceous and brush cover would be maintained in Riparian Reserves to the extent practicable. Replanting with native species would facilitate recovery of vegetation communities. LWD placement within 26 acres of Riparian Reserves would help to enhance physical complexity of the aquatic habitats (p. 2-47-51). These restoration efforts, along with the limited effects to which they are directed, would maintain and restore biological and physical functions of the Riparian Reserves in the watershed.
Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.	Existing herbaceous and brush cover would be maintained to the extent practicable. To maintain riparian habitat, construction BMPs would be implemented. LWD placement within 26 acres of Riparian Reserves would help to enhance physical complexity of the aquatic habitats (p. 2-47-51). Revegetation would be encouraged by planting of native riparian species. The project would waive application of Management Recommendations for Survey and Manage species in the watershed but would not threaten the persistence of riparian-dependent Survey and Manage species or prevent attainment of the ACS objectives (see appendix F5).

Summary

It is highly unlikely that project construction and operation would prevent attainment of ACS objectives on NFS land in the Elk Creek–South Umpqua River watershed based on the project's ridge top location and the lack of intersection with waterbodies and the affected Riparian Reserves.

Amendments of the UNF LRMP to waive protection measures for Survey and Manage species would not prevent attainment of ACS objectives because the project does not threaten the persistence of any riparian-dependent survey and manage species (Appendix F5 (See Appendix F5). The relatively small amount of Riparian Reserves affected would not be outside the range of variability for disturbance processes in the watershed (see Table 2-17).

2.2.1.5 Upper Cow Creek Fifth-Field Watershed, HUC 1710030206

Overview

The Upper Cow Creek watershed is located in Douglas County, Oregon, and covers approximately 47,500 acres. The most common land use in the Upper Cow Creek watershed is forestry, with 98.7% of the land base used for public or private forestry. Agriculture constitutes 1.2% of the land use and mostly occurs along lower Cow Creek. Land ownership is primarily federal (67.0%) and is mostly administered by the Forest Service and BLM. Private landholdings constitute 24.9% of the watershed (Geyer 2003). Below Galesville Dam, Cow Creek meanders through the Lower Cow Creek watershed, joining the South Umpqua River at Riddle, Oregon.

The Upper Cow Creek watershed lies within the Klamath-Siskiyou Province, though at its easternmost reach, it has some geologic units typical of the Cascades Province[8], such as igneous rock (granite) and medium-grade metamorphic rock (schist). The elevation of the lowest point in the watershed is 1,780 feet, which is the elevation at the top of the Galesville Dam spillway. The elevation of thee highest point is 5,095 feet at Cedar Springs Mountain. In the Upper Cow Creek watershed, 95.9% of the land base is above 2,000 feet; the TSZ. Rain-on-snow events may occur in these areas.

Figure 2-4 and table 2-22 show the subwatersheds and ownerships of the Upper Cow Creek watershed. On NFS lands, the project traverses 1.74 miles of the Dismal Creek subwatershed and 2.76 miles of the South Fork Cow Creek subwatershed.

The portion of Upper Cow Creek watershed addressed by the Forest Service in a watershed analysis is located in the southwest corner of the Tiller Ranger District on the UNF. The watershed encompasses approximately 47,499 acres, with 24,151 acres (51%) within the Forest Service boundary. On NFS lands within the watershed, there are 2,350 acres of LSR[9], 19,402 acres of Matrix lands[10], and an estimated 7,849 acres of Riparian Reserves. An additional 645 acres are in unmapped LSRs associated with KOACs [11] on the UNF (table 2-22).

The Upper Cow Creek watershed is primarily within the Klamath-Siskiyou Province, with a small area on the southeastern edge that lies within the Western Cascades Province. Eighty-nine percent

[8] Provinces discussed in this document are based on both ecological and geological conditions and therefore do not match those recognized by the Oregon Department of Geology and Mineral Industries and the Oregon State Board of Professional Geologists and Geophysicists. The Klamath-Siskiyou Province is known by professional geologists as the Klamath Mountains Province and the Western Cascades and the High Cascades are two mountain ranges within the Cascades Mountains Province. See https://www.oregongeology.org/learnmore/geologicsightseeing.htm

[9] LSR values apply only to NFS lands.

[10] Matrix is an NFS land allocation,

[11] Known Owl Activity Centers (KOACs) are only relevant on NFS lands.

of the watershed is either granite or schist. These soil types are susceptible to higher erosion and landslide potential (Forest Service 1995a).

There are an estimated 129 miles of streams within the Forest Service boundary. The Upper Cow Creek watershed no longer supports anadromous fisheries due to the construction of the Galesville Dam in 1985. Approximately 38 miles are Class II streams (resident fish), with resident cutthroat and rainbow trout. Canopy coverage in the smaller streams and tributaries to Cow Creek is high, which indicates adequate shade (75 to 100%). In the mainstem of Cow Creek, the canopy opens up and Cow Creek widens downstream as the channel becomes less constricted. Stream temperatures are cool throughout most of the watershed; they begin to rise in the wide, shallow part of the mainstem of Cow Creek. The maximum recorded stream temperature is 75°F in lower Cow Creek (Forest Service 1995a).

Location and Routing

To the maximum extent possible, the project is located on ridge tops to avoid impacting Riparian Reserves. The project right-of-way originally proposed in the East Fork of Cow Creek was located on a large upland feature known as Long Prairie and had no intersections with stream crossings or other Riparian Reserves. After consultation with the Forest Service and The Cow Creek Band of Umpqua Tribe of Indians, the routing was moved away from Long Prairie to avoid sensitive traditional cultural sites. Pacific Connector's proposed alignment to avoid Long Prairie was filed in the September 2007 FERC Certificate application. However, after completion of the 2008 northern spotted owl surveys, it was determined that the proposed 2007 route crossed a northern spotted owl nest area. In consultation with the U.S. Fish and Wildlife Service and the Forest Service, Pacific Connector developed a re-route to avoid the nest area and to minimize effects on suitable northern spotted owl habitat. This re-route developed in cooperation with the Forest Service has been incorporated into the proposed route, as recommended by FERC (FERC 2009). In 2010, at the request of the Forest Service, a minor realignment was also completed between MP 109.71 and MP 109.78 to avoid areas of potential instability. The current project alignment developed by Pacific Connector and the Forest Service in the Upper Cow Creek watershed avoids areas of unstable soils, areas that had potential conflicts under the National Historic Preservation Act and various agreements with The Cow Creek Band of the Umpqua Indians, and habitat for a federally listed species.

The proposed project enters the Upper Cow Creek watershed at MP 102.6 and travels approximately 5.27 miles in a south-southeasterly direction, exiting the watershed at MP 111.1 (figure 2-4). From approximately MP 102.6 to approximately MP 109, the project right-of-way would be located on the ridge top between the Elk Creek and the Upper Cow Creek fifth-field watersheds. In all, approximately 5.27 miles of the PCGP corridor are in the Upper Cow Creek fifth-field watershed (table 2-23), 2.51 miles are in the Dismal Creek subwatershed, and 2.76 miles are in the South Fork Cow Creek subwatershed. On NFS lands, approximately 4.5 miles of the PCGP corridor are in the watershed, with 1.74 miles in the Dismal Creek subwatershed and 2.76 miles in the South Fork Cow Creek subwatershed. Between MP 109 and 110, one small forested wetland and two intermittent and four perennial stream crossings occur. Riparian Reserves associated with one perennial stream and six forested wetlands would be clipped by construction clearing of the corridor and TEWAs but the wetlands would not be crossed by the PCGP trench. The Cow Creek watershed analysis estimated that 49%, or approximately 4,559 acres, of the South

Fork Cow Creek subwatershed are Riparian Reserves, of which approximately 35%, or 1,595 acres, are LSOG (Forest Service 1995a: 94-95).

Currently, there are approximately 9,441.60 acres of LSOG on NFS lands in the Upper Cow Creek watershed. Approximately 10.06 acres, or 0.13%, of the Riparian Reserves on NFS lands in the Upper Cow Creek fifth-field watershed would be cleared. Of the cleared Riparian Reserves, approximately 4.46 acres are LSOG. Early and mid seral forest vegetation constitutes the remainder of the affected Riparian Reserve vegetation (tables 2-22 through 2-25).

Portions of the routing between MP 109 and MP 110 in the South Fork Cow Creek subwatershed cross areas mapped as earthflow terrains. Field investigation by licensed geologists and geotechnical engineers from the Forest Service and PCGP have shown that these areas are dormant and unlikely to be reactivated by PCGP construction (GeoEngineers 2009, Hanek 2011, NSR 2015). Since these earthflow features are not unstable, they are not mapped as additional Riparian Reserves.

Table 2-26 provides the stream crossing and turbidity risk ratings for Upper Cow Creek in the blue, yellow, and green categories.

Figure2-4 PCGP Routing and Subwatershed Boundaries, Upper Cow Creek Watershed

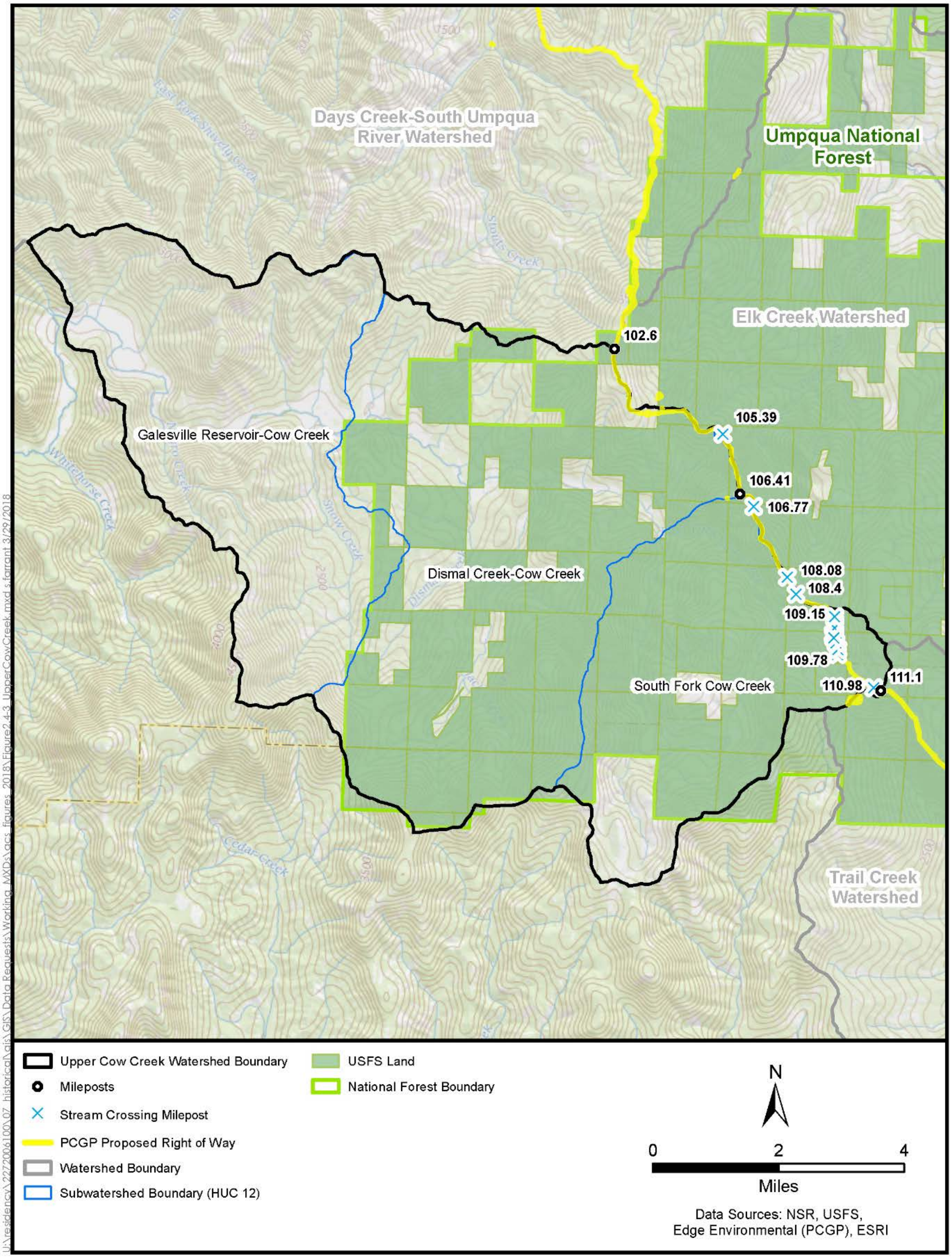


TABLE 2-22

Land Ownership and Forest Service Land Allocations (acres) in Upper Cow Creek Fifth-Field Watershed (HUC 1710030206)

	Land Ownership (acres)					Forest Service Land Allocation (acres)		
Sixth-Field Watershed	**Sixth-Field Watershed (acres) a/**	**NFS Land**	**BLM**	**Total NFS and BLM**	**Other**	**LSR**	**Riparian Reserves b/**	**Matrix**
Dismal Creek-Cow Creek	21,230.73	14,529.21	887.54	15,416.75	5,813.98	1,078.98	4,478.21	12,985.03
Galesville Reservoir-Cow Creek	15,134.85	311.16	8,461.92	8,773.08	6,361.77	0.00	110.65	211.59
South Fork Cow Creek	11,133.85	9,310.97	516.57	9,827.54	1,306.31	1,271.42	3,260.26	6,205.37
Watershed Total	**47,499.43**	**24,151.34**	**9,866.03**	**34,017.37**	**13,482.06**	**2,350.41**	**7,849.12**	**19,401.99**

a/ All data derived from Stantec-based GIS layers.
b/ May occur within other NFS land allocations.

TABLE 2-23

Project Corridor (miles) and Project Area (acres) in Upper Cow Creek Fifth-Field Watershed (HUC 1710030206) by Land Ownership

	Land Ownership							
	NFS Lands				Entire Sixth Field Watershed			
		Project Area (acres)				Project Area (ares) b/		
Sixth-Field Watershed a/	**Corridor Length (miles)**	**Cleared**	**Modified**	**% of NFS Land Impacted**	**Corridor Length (miles)**	**Cleared**	**Modified**	**% of Sixth-Field Watershed Impacted**
Dismal Creek-Cow Creek	1.74	26.22	0.00	0.11	2.51	40.94	0.00	0.09
Galesville Reservoir-Cow Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
South Fork Cow Creek	2.76	47.54	0.00	0.20	2.76	47.54	0.00	1.46
Watershed Total	**4.50**	**73.76**	**0.00**	**0.31**	**5.27**	**88.48**	**0.00**	**0.19**

a/ All data derived from Stantec-based GIS layers
b/ Includes NFS, BLM, and other ownerships

TABLE 2-24

Project Area (acres) on NFS Lands in the Upper Cow Creek Fifth-Field Watershed (HUC 1710030206) by Land Allocation

Sixth-Field Watershed a/	Designated LSR b/				Matrix				Riparian Reserves b/			
	Project Area (acres)		% of Total LSR on NFS Land		Project Area (acres)		% of Total Matrix on NFS Land		Project Area (acres)		% of Total Riparian Reserves on NFS lands c/	
	Cleared	Modified	Cleared	Modified	Cleared	Modified	Cleared	Modified	Cleared	Modified	Cleared	Modified
Dismal Creek-Cow Creek	22.98	0.00	2.13	0.00	3.26	0.00	0.02	0.00	1.59	0.00	0.04	0.00
Galesville Reservoir-Cow Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
South Fork Cow Creek	13.72	0.00	1.08	0.00	33.81	0.00	0.54	0.00	8.47	0.00	0.26	0.00
Watershed Total	**36.70**	**0.00**	**1.56**	**0.00**	**37.07**	**0.00**	**0.19**	**0.00**	**10.06**	**0.00**	**0.13**	**0.00**

a/ All data derived from Stantec-based GIS layers.
b/ Includes mapped and unmapped LSR on NFS lands.
c/ Riparian Reserve acres overlap with LSR and Matrix land allocations.

TABLE 2-25

Riparian Reserve Effects, Upper Cow Creek Fifth-Field Watershed, HUC 1710030206

Jurisdiction	MP	Waterbody	Description	Waterbody Type	Crossed a/	Width of Crossing (feet)	Wetland Acres Crossed	Clipped b/	Riparian Reserve Vegetation Cleared in Construction Corridor and TEWAs by Age Class (acres) c/ f/														Uncleared Storage Area in RR	Total Direct Impact in RR (Cleared plus UCSA)	Roads and Other Altered Habitats c/	Gross Riparian Reserves	fish bearing	Anadromy d/
									RR_Conifer_LSOG	RR_Hardwood_LSOG	RR_Mixed_Conifer_Hardwood_LSOG	Total_LSOG (80 years +)	RR_Conifer_MS	RR_Hardwood_MS	RR_Mixed Conifer Hardwood MS	Total Mid-Seral (40-80 years)	RR_Conifer_ES	RR_Shrub_ES	RR_Grasslands	Total Early Seral (0-40 years)	Stream Channel or Wetland Area	Net Riparian Reserve Cleared						
Dismal Creek Subwatershed HUC 171003020602																												
UNF	105.39	CDX050	1-4' wide roadside ditch, 20% gradient; extends off-site	D	Yes	10.34		No				**0.00**				**0.00**				**0.00**		**0.00**		0.00		0.00	No	No
South Fork Cow Creek HUC 171003020601																												
UNF	106.77	CDX049	1-2' wide ditch, 2-5' bankfull, 5-10% Gradient	D	Yes	10.34		No				**0.00**				**0.00**				**0.00**		**0.00**		0.00		0.00	No	No
UNF	108.08	CDX047	2' wide roadside ditch,5-10% gradient; dissipates in forest	D	Yes	3.19		No				**0.00**				**0.00**				**0.00**		**0.00**		0.00		0.00	No	No
UNF	108.40	CDX048	2' wide roadside ditch;10% gradient	D	Yes	7.12		No				**0.00**				**0.00**				**0.00**		**0.00**		0.00		0.00	No	No
UNF	109.15	GDX 015	Connects to GW014.	W	Yes	8.27	0.09	No				**0.00**				**0.00**				**0.00**		**0.00**		0.00		0.00	No	No
UNF	109.17	GW014/FS-HF-C Trib to East Fork Cow Creek	Seep wetland with shrubs, crosses road and continues. USFS considers this wetland as a perennial stream.	P	Yes	12.02		No				**0.00**	1.54			**1.54**	0.29	0.09		**0.38**	0.03	**1.95**		1.95	0.04	1.99	Yes	No
UNF	109.24	FS-HF-D	Small wetland adjacent to R/W	W	No	0.00		Yes				**0.00**	0.85			**0.85**				**0.00**		**0.85**		0.85		0.85	No	No

TABLE 2-25

Riparian Reserve Effects, Upper Cow Creek Fifth-Field Watershed, HUC 1710030206

									Riparian Reserve Vegetation Cleared in Construction Corridor and TEWAs by Age Class (acres) c/ f/																			
Jurisdiction	**MP**	**Waterbody**	**Description**	**Waterbody Type**	**Crossed a/**	**Width of Crossing (feet)**	**Wetland Acres Crossed**	**Clipped b/**	**RR_Conifer_LSOG**	**RR_Hardwood_LSOG**	**RR_Mixed_Conifer_Hardwood_LSOG**	**Total_LSOG (80 years +)**	**RR_Conifer_MS**	**RR_Hardwood_MS**	**RR_Mixed Conifer Hardwood MS**	**Total Mid-Seral (40-80 years)**	**RR_Conifer_ES**	**RR_Shrub_ES**	**RR_Grasslands**	**Total Early Seral (0-40 years)**	**Stream Channel or Wetland Area**	**Net Riparian Reserve Cleared**	**Uncleared Storage Area in RR**	**Total Direct Impact in RR (Cleared plus UCSA)**	**Roads and Other Altered Habitats c/**	**Gross Riparian Reserves**	**fish bearing**	**Anadromy d/**
			[What does R/W mean—not in acro list; also no slash mark in RW below]																									
UNF	109.29	FS-HF-E	Skunk cabbage seep wetland on FS land adjacent to ROW	W	No	0.00		Yes				**0.00**	0.08			**0.08**				**0.00**		**0.08**		0.08		0.08	No	No
UNF	109.32	GW017	Forested wetland seep	W	No	0.00		Yes				**0.00**				**0.00**				**0.00**		**0.00**		0.00		0.00	No	No
UNF	109.33	GSI016/FS-HF-F Trib. to East Fork Cow Creek	3' wide, intermittent	I	Yes	7.54		No				**0.00**	0.80			**0.80**	0.13			**0.13**		**0.93**		0.93	0.22	1.15	No	No
UNF	109.43	GW018	Wetland seep	W	No	0.00		Yes				**0.00**				**0.00**				**0.00**		**0.00**		0.00		0.00	No	No
UNF	109.47	GW021	Emergent wetland seep, connects to GSP019	W	No	0.00		Yes				**0.00**				**0.00**				**0.00**		**0.00**		0.00		0.00	No	No
UNF	109.47	GSP019/FS-HF-G East Fork Cow Creek	Cow Creek – 28' wide, broad, cobbles, boulders	P	Yes	26.44		No				**0.00**				**0.00**	1.87			**1.87**	0.06	**1.93**		1.93		1.93	Yes	No
UNF	109.49	GW020	Emergent wetland seep	W	No	0.00		Yes				**0.00**				**0.00**				**0.00**		**0.00**		0.00		0.00	No	No
UNF	109.58	East Fork Cow Creek	Riparian Reserve associated with	P	No	0.00		Yes			0.38	**0.38**				**0.00**	0.69			**0.69**		**1.07**		1.07	0.19	1.26	Yes	No

TABLE 2-25

Riparian Reserve Effects, Upper Cow Creek Fifth-Field Watershed, HUC 1710030206

									Riparian Reserve Vegetation Cleared in Construction Corridor and TEWAs by Age Class (acres) c/ f/																			
Jurisdiction	**MP**	**Waterbody**	**Description**	**Waterbody Type**	**Crossed a/**	**Width of Crossing (feet)**	**Wetland Acres Crossed**	**Clipped b/**	**RR_Conifer_LSOG**	**RR_Hardwood_LSOG**	**RR_Mixed_Conifer_Hardwood_LSOG**	**Total_LSOG (80 years +)**	**RR_Conifer_MS**	**RR_Hardwood_MS**	**RR_Mixed Conifer Hardwood MS**	**Total Mid-Seral (40-80 years)**	**RR_Conifer_ES**	**RR_Shrub_ES**	**RR_Grasslands**	**Total Early Seral (0-40 years)**	**Stream Channel or Wetland Area**	**Net Riparian Reserve Cleared**	**Uncleared Storage Area in RR**	**Total Direct Impact in RR (Cleared plus UCSA)**	**Roads and Other Altered Habitats c/**	**Gross Riparian Reserves**	**fish bearing**	**Anadromy d/**
			EF of Cow Creek, clipped.																									
UNF	109.69	AW298/ FS-HF-J Trib. to East Fork Cow Creek	Perennial stream on FS land, extension of AW298 - willow-dominated wetland	P	Yes	10.20		No	1.16			**1.16**				**0.00**				**0.00**	0.03	**1.19**		1.19	0.27	1.46	Yes	No
UNF	109.78	GSP019/ FS-HF-K Trib. to East Fork Cow Creek	Intermittent stream on FS land, extension of AW299 - willow-dominated wetland (INCORRECTLY ID AS INT)	P	Yes	5.16		No	1.27			**1.27**				**0.00**	0.43			**0.43**		**1.70**		1.70		1.70	No	No
UNF	110.98	ESI068/FS-HF-N East Fork Cow Creek	EF Cow Creek ephemeral drainage, U-shaped, cobble, 1-2' wide	I	Yes	16.41		No				**0.00**	1.10			**1.10**				**0.00**	0.03	**1.13**		1.13		1.13	No	No

TABLE 2-25

Riparian Reserve Effects, Upper Cow Creek Fifth-Field Watershed, HUC 1710030206

Jurisdiction	MP	Waterbody	Description	Waterbody Type	Crossed a/	Width of Crossing (feet)	Wetland Acres Crossed	Clipped b/	Riparian Reserve Vegetation Cleared in Construction Corridor and TEWAs by Age Class (acres) c/ f/														Uncleared Storage Area in RR	Total Direct Impact in RR (Cleared plus UCSA)	Roads and Other Altered Habitats c/	Gross Riparian Reserves	fish bearing	Anadromy d/
									RR_Conifer_LSOG	RR_Hardwood_LSOG	RR_Mixed_Conifer_Hardwood_LSOG	Total_LSOG (80 years +)	RR_Conifer_MS	RR_Hardwood_MS	RR_Mixed Conifer Hardwood MS	Total Mid-Seral (40-80 years)	RR_Conifer_ES	RR_Shrub_ES	RR_Grasslands	Total Early Seral (0-40 years)	Stream Channel or Wetland Area	Net Riparian Reserve Cleared						
Subtotal South Fork Cow Creek		**Crossed:** 3 Ditches f/ 4 Perennial Streams 2 Int. Streams 1 Wetland	**Clipped:** 6 Wetland RR 1 Perennial RR		**7**		**0.09**	**7**	**2.43**	**0.00**	**0.38**	**2.81**	**4.37**	**0.00**	**0.00**	**4.37**	**3.41**	**0.09**	**0.00**	**3.50**	**0.15**	**10.83**	**0.00**	**10.83**	**0.72**	**11.55**	**4**	**0**
Total Upper Cow Creek		**Crossed:** 4 Ditches 4 Perennial Streams 2 Int. Streams 1 Wetland	**Clipped:** 6 Wetland RR 1 Perennial RR		**7**		**0.09**	**7**	**2.43**	**0.00**	**0.38**	**2.81**	**4.37**	**0.00**	**0.00**	**4.37**	**3.41**	**0.09**	**0.00**	**3.50**	**0.15**	**10.83**	**0.00**	**10.83**	**0.72**	**11.55**	**4**	**0**

a/ "Crossed" indicates that the pipeline trench crosses the waterbody or wetland.
b/ "Clipped" indicates that the pipeline corridor crosses a portion of the Riparian Reserve, but the pipeline trench does not cross the associated waterbody.
c/ Roads and other altered habitats such as rock pits sometimes occur within Riparian Reserves. These features do not have riparian features, and are not considered as part of the Riparian Reserve vegetated area.
d/ "Anadromy" means that a stream contains anadromous fish, or that it is a tributary that directly influences an anadromous stream.
e/ Ditches do not create Riparian Reserves and are shown as 0 acres. They are not included in tallies of water body crossings in the body of the table.

TABLE 2-26

Stream Crossing Turbidity and Risk Rating, Upper Cow Creek Fifth-Field Watershed

Fifth-Field Watershed	Sixth-Field Subwatershed	MP	Type a/	Description a/	Bankfull Width (ft) b/	Width of Crossing (ft) a/	Channel Gradient (%) b/	Channel Incision (ft) b/	Bank Character b/	Streambed Material b/	Turbidity Rating c/	Site Response Rating d/	Construction Impact Rating d/	Overall Rating e/
Upper Cow Creek	SF Cow Cr.	109.17	P	HF-C Perennial stream with associated seep wetland with shrubs	5	12.02	18.6		Erodible	Sand	M	M	M	YELLOW
Upper Cow Creek	SF Cow Cr.	109.33	I	HF-F 3' wide, intermittent		7.54					M	M	M	YELLOW
Upper Cow Creek	SF Cow Cr.	109.47	P	HF-G Cow Creek – 28' wide, broad, cobbles, boulders,	12	26.44	3.32	3.5	Erosion resistant	Cobble/boulders	M	M	H	GREEN
Upper Cow Creek	SF Cow Cr.	109.69	P	HF-J Perennial extension of AW298 – willow-dominated wetland	12	10.2	13.15		Erosion resistant	Large cobble	M	L	M	BLUE
Upper Cow Creek	SF Cow Cr.	109.78	P	HF-K Perennial, extension of AW299 – willow-dominated wetland	8	5.16	9.61	3	Highly erodible	Cobble	M	M	H	GREEN

Sources:
a/ Table 2A-3a, Resource Report 2, Water Use and Quality, PCGP 2013
b/ Table A-2, Stream Crossing Risk Analysis, GeoEngineers 2011
c/ Table B-1, Turbidity, Nutrients and Water Quality Analysis, GeoEngineers 2011
d/ Table A-1, Stream Crossing Risk Analysis, GeoEngineers 2011
e/ Figure 4, Stream Crossing Risk Analysis, GeoEngineers 2011

Existing Conditions Original Watershed Analysis Findings

The Forest Service completed a watershed analysis for the Upper Cow Creek watershed in 1995 (Forest Service 1995a). The Umpqua Basin Watershed Council completed a second analysis that covered all ownerships in 2003 (Geyer 2003). Watershed conditions are summarized as follows:

- The Cow Creek fifth-field watershed is primarily composed of granitic and schistose soils that are highly erosive and susceptible to sliding and scouring. Localized ancient dormant earthflow terrains are also represented on the pipeline route in the East Fork of Cow Creek.
- Timber harvest and roads in steep terrain have significantly increased the rate of landslides in the watershed. The floods in 1964, 1974, and 1980s and the large storm event on January 9, 1995, caused many timber harvest– and road-related slides.
- The erosive nature of the soils in this watershed is reflected in high levels of sediment transport, storage, and delivery to various waterbodies, particularly in those subwatersheds prone to landslides, debris flows, and debris torrents (saturated debris flows). Historically, sediment delivery has probably always been high; however, human activities such as road construction, timber harvesting, mining, and grazing have increased landslide, debris flow, debris torrent, and general sedimentation rates over natural levels (Forest Service 1995a: 8).
- Timber harvest and fire suppression have altered the frequent low-intensity fire disturbance regime that dominated Sierran-Steppe mixed forests of the Klamath-Siskiyou eco-region represented in the Upper Cow Creek watershed. The result of this changed disturbance regime is a fragmented landscape, low in both early and late seral vegetation. The density and dominance of tolerant conifers are high, commonly at the expense of intolerant conifers and most hardwoods. Fire hazard and the magnitude of insect and disease activity may be higher than before modern management (Forest Service 1995: 8, Forest Service et al. 1998).
- The East Fork of Cow Creek appears to have been in equilibrium (neither degrading nor aggrading) at the time the watershed analysis was completed with respect to sediment transport, delivery, and storage. Dismal Creek is aggrading and appears to be out of equilibrium with respect to sediment transport and storage (Forest Service 1995a: pg. 49). The lower parts of Cow Creek, the Applegate drainage, and Dismal Creek are primarily storage systems; fine sediments are stored in pools and behind large woody material, reducing spawning substrate and pool habitat (Forest Service 1995a).
- The watershed analysis documented that shade cover on streams was above 80% for the lower-order reaches (first, second, and third), averaging 88% for the fourth-order reaches and 52% for the fifth-order reaches of Cow Creek. Water temperatures and canopy suggest good stream shading in the watershed (Forest Service 1995: 51). For the watershed analysis, 12 water temperature monitoring stations were established in the streams in the Cow Creek watershedduring summer 1995. Providing one summer's data was not meant to represent a baseline; however, this monitoring data indicated that the maximum water temperature on the East Fork Cow Creek above the confluence with the South Fork Cow Creek was 55 to 60ºF or below. The Umpqua Basin Watershed Council (Geyer 2003) collected temperature data from 89 continuously sampling data loggers from sites throughout the Cow Creek watershed during summer 2000. Data from the East Fork mouth, downstream of the project crossing, indicated

that the maximum temperature was 61.6ºF. There were 74 days where the temperature exceeded 55ºF, but there were no days where the temperature exceeded 64 ºF.

- A portion of the project crosses the East Fork of Cow Creek drainage area in the South Fork Cow Creek subwatershed. The Cow Creek watershed analysis provides the following characterization of the drainage:

    - The watershed is highly roaded with a density of 4.7 road miles/mile. Road densities are likely generating sediment that contributes to winter erosion. Sediment storage is high, but may be in the range of equilibrium for granite-schist landscapes (see Figure 2-5.) Water temperatures in this drainage were low. Continuous temperature monitoring results identified 60ºF as the high recorded for the 1995 summer. Coarse woody debris is limited, possibly as a result of flood flows that reactivated woody debris in the streambanks and from woody debris transported in debris flows and torrents in storms of 1964 and 1974 (Forest Service 1995a: 63).

Figure 2-5 Natural Turbidity and Stored Sediment in the East Fork of Cow Creek

Changes in Watershed Condition

Since the watershed analysis was written in 1995, peak-flow events in 1997 and again in 2003 caused several road crossing failures. A lightning storm caused the Stouts Fire to begin near the confluence of Stouts Creek and the South Umpqua River on July 30, 2015. This fire grew very fast over the first several days and was not contained until early September 2015. Overall, the fire burned 26,452 acres of BLM, NFS, and private land and impacted resources associated with LSRs and Riparian Reserves. A total of 1.56 miles are crossed by the PCGP corridor within the burned area of the Upper Cow Creek watershed. The fire burned 147 acres of the Dismal Creek and South Fork Cow Creek subwatersheds. The Forest Service BAER team identified issues from the fire involving seedling planting, noxious weeds, soil stabilization, road/trail water diversion, tree hazard removal, and monitoring. In November 2015, Stantec biologists, foresters, and geomorphologists conducted a field review of the burned area and surrounding watersheds. In conjunction with the data from the BAER reports, it was determined that the burn severity was moderate (25-50% of canopy cover mortality). The Stouts Fire Supplement to Appendix J of the 2015 Final EIS contains more details on the Stouts BAER report, as well as the post-fire watershed projects that were implemented. Prior to this fire, the Forest Service and BLM had completed restoration projects between 1995 and 2015, which are shown in table 2-27.

TABLE 2-27

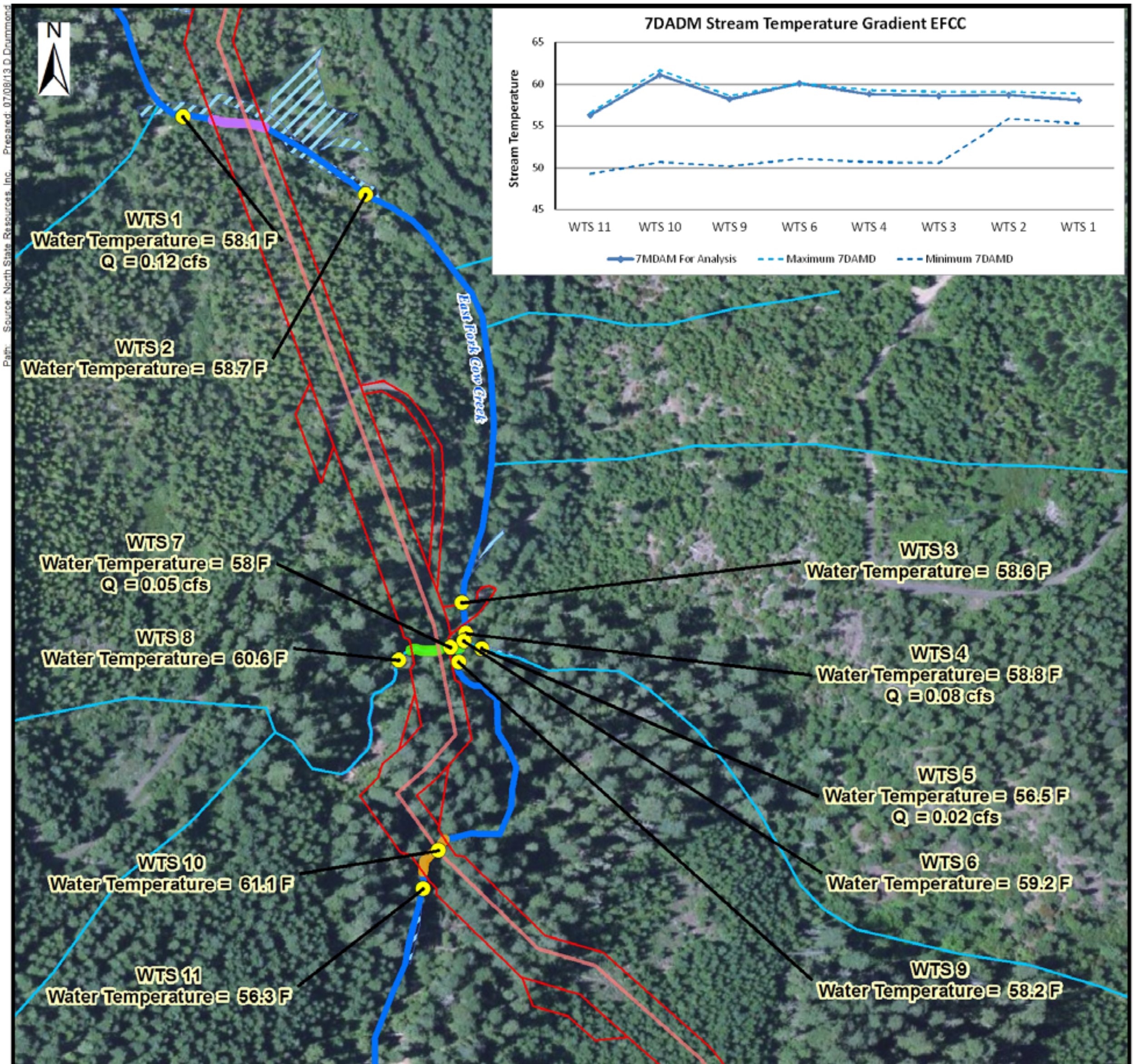
Activities in Cow Creek Since Publication of the Cow Creek Watershed Analysis, September 1995

Name	Activity Type	Dates	Total Acres/Miles	Location
Stouts Fire	Wildfire	2015	26,452	Upper Cow Creek
Eight County Hazardous Fuels Reduction	Pile burning	2010	68	Upper Cow (5th)
Eight County Hazardous Fuels Reduction	Precommercial thin	2009-2010	68	Upper Cow (5th)
Devils Flat Fuelbreak	Precommercial thin	2007	180 ac	Dismal (6th)
Cattle Grazing	Cattle grazing	1995-2012	8,250 ac	South Fk. Cow (6th)
Off-Site Pine	Precommercial thin	?	40 ac	Dismal (6th)
Wildfire	Wildfire	1992-2012	27 ac	Dismal (6th)
Weed Treatment	Hand pull/cut	1997-2012	685 ac	Upper Cow (5th)
Kirby Road	Road construction	2001	<1 ac	South Fk. Cow (6th)
Apple Jack Salvage	Commercial thin	1997	60 ac	Dismal (6th)
Reforestation	Tree planting	1996-2003	450 ac	Upper Cow (5th)
Skeleton Salvage	Commercial thin	1997	20 ac	Dismal (6th)
ERFO Road Repair	Road repair	1995-2006	3 ac	Upper Cow (5th)
Clearcutting on Private Land within District Boundary	Clearcut	1995-2012	889 ac	Dismal (6th)
Commercial Thinning on Private Land within District Boundary	Commercial thin	1999-2006	258 ac	Dismal (6th)
Road Maintenance	Brushing, grading, resurfacing	2010-2012	70 mi	Upper Cow (5th)

Current Watershed Conditions

Generally, conditions described in the 1995 Cow Creek watershed analysis are were still applicable prior to the 2015 Stouts Fire. In 2010, the Forest Service rated the watershed Condition Class of Upper Cow Creek watershed as “Functioning at Risk,” noting positive attributes for water quality and quantity and riparian vegetation and “Functioning at Risk” or “Not Properly Functioning” ratings for aquatic habitat, aquatic biota, and road density (see attachments: Section 3.3.1). Road-related sediments and culvert blockages have negatively affected aquatic habitats in the Upper Cow Creek watershed. Forest Service LRMP monitoring data showed positive trends for overall watershed condition (see attachments: Section 3.3.2). Figure 2-6 shows current (2013 water year) seven-day averages of maximum water temperatures (NSR 2015). The 2015 BAER team suggested that high-intensity fire coupled with extensive increases in sediment supply was expected to degrade watershed conditions.

Figure 2-6 Current Seven-Day Average Maximum Temperatures, East Fork Cow Creek Perennial Streams



Site ID	Location	Hydrofeature	7-Day Average of Maximum Daily Water Temperature (7DAMD) (7/25)	Range of 7-Day Average of Maximum Daily Water Temperature (6/20 - 8/31)	Measured Streamflow (cfs)	Exisiting Conditons: Measured Difference in Water Temperature (7DAMD) Across Hydrofeature	Exisiting Conditons: Modeled Difference in Water Temperature (7DAMD) Across Hydrofeature	Exisiting Conditons: Modeled Water Temperature (F) After Crossing Hydrofeature
WTS 11	EFCC Mainstem	K	56.3	56.6 - 49.3	*Not measured*			
WTS 10	EFCC Mainstem	K	61.1	61.7 - 50.7	*Not measured*	4.8	0.8	62.5
WTS 9	EFCC Mainstem	*None*	58.2	58.6 - 50.2	*Not measured*			
WTS 8	Tributary	J	60.6	61 - 51.2	*Not measured*			
WTS 7	Tributary	J	58.0	58.9 - 50.6	0.05	2.6	1.8	60.7
WTS 6	EFCC Mainstem	*None*	60.1	60.1 - 51.1	*Not measured*			
WTS 5	Tributary	*None*	56.5	56.7 - 49.2	0.02			
WTS 4	EFCC Mainstem	*None*	58.8	59.3 - 50.7	0.08			
WTS 3	EFCC Mainstem	*None*	58.6	59.1 - 50.6	*Not measured*			
WTS 2	EFCC Mainstem	G	58.7	59.1 - 55.9	*Not measured*			
WTS 1	EFCC Mainstem	G	58.1	58.9 - 55.3	0.12	0.6	1.9	60.8

Monitoring Location
Proposed Pipeline Alignment
Construction Right of Way
Hydrofeature G
Hydrofeature J
Hydrofeature K
EFCC Mainstem
Stream
Wetlands
Feet
0 150 300
1:3,600

Natural Disturbance Processes

Natural disturbance processes for the Upper Cow Creek watershed are consistent with those described for the Klamath and Western Cascades provinces. Prior to the advent of successful fire suppression, fire was the dominant process affecting upslope and riparian vegetation above the floodplain. Fire visited many sites as often as every 15 years and rarely missed a site for more than 100 years. The Upper Cow Creek watershed's complex fire regime created an equally complex and diverse landscape and stand-level vegetation (Forest Service 1995a: ES-V). Higher intensity,stand-replacing fires occurred on average about every 150 to 200 years in the western Oregon Cascades (Everest and Reeves 2007). Granitic, dioritic, quartz dioritic, and schistose soils in the watershed are susceptible to high rates of surface erosion and mass wasting, particularly on earthflow[12] terrains and slopes over 60% and likely demonstrated high erosion rates when stand-replacing fires and high-intensity rainfall events overlapped.

Project Effects and Natural Range of Variability

The Upper Cow Creek watershed is an active landscape with respect to erosional processes. The Cow Creek watershed analysis clearly documents a cause for concern with respect to surface erosion and sediment transport to stream systems from management actions that disturb or expose soils. The East Fork of Cow Creek drainage naturally processes a high amount of background sediment and is roughly in balance for sediment transport and deposition from granite and schist bedrock (Forest Service, 1995a: 63). Given the historic processes that have increased surface erosion, transport, and delivery in the Upper Cow Creek watershed, and the fact that the project would further increase the level of surface disturbance aggressive erosion control, and streambank/streambed stabilization would be required to maintain the present sediment balance in the East Fork of Cow Creek. Additionally, there is a need to avoid mobilizing naturally occurring mercury that occurs within the watershed. Historically, water temperatures in Upper Cow Creek have been in the range of 55 to 60°F. There are five central concerns related to project effects and compliance with the ACS in this watershed.

1. Whether the clearing for the project would cause excessive erosion and sediment deposition and whether that sediment would aggregate downstream since there are several stream crossings in a short distance in the same stream system.

GeoEngineers completed a crossing risk analysis for turbidity, crossing construction impacts, and potential site response (see Section 1.3) (GeoEngineers 2013). Evaluations for stream channel crossings in the East Fork of Cow Creek are shown in table 2-27. BMPs that would be applied at each crossing, grouped by "blue," "yellow," and "green" turbidity and risk ratings, are shown in table 2-28[13].

- Crossings at MP 109.69 – HF-J (perennial) and 111.01 HF-N (perennial stream that is intermittent because of upstream diversion) were rated as Low Risk where standard stream crossing "Blue" BMPs would be applied.

[12] Earthflows are landslides that have plastic flow due to the cohesive nature of the soils and high soil moisture content.

[13] Note that during preconstruction surveys of crossings, any additional measures needed to accomplish objectives may be stipulated by agency representatives.

- Crossings at MP 109.17 – HF-C (perennial) and 109.33 – HF-F (intermittent) were rated as Moderate Risk for construction impacts and site response where "yellow" BMPs would be applied. The "yellow" BMP group includes additional measures for bank and stream bottom stabilization as needed including grading or terracing over steepened banks, use of geotextile fabrics and fiber rolls, rock and rip-rap placement, in-stream structures, stratified backfill, structural fill placement, and LWD, etc. (table 2-28).
- Crossings at MP 109.47 – HF-G and 109.78 – HF-K are classed as "green" crossings, which have a high risk for construction impacts to aquatic habitats. These crossings would add placement of rootwads and large wood as needed for stabilization of banks along with standard BMPs and those in the "yellow" group.

TABLE 2-28

Pacific Connector Proposed BMPS for Use at Waterbody Crossings

	Best Management Practices for Project Typical "Blue" Crossings and for All Other Crossings	**Best Management Practices for Moderate Risk "Yellow" Crossings**	**Best Management Practices for High Habitat Risk "Green" Crossings**
	Crossing MP **109.69 (HF-J), 111.01 (HF-N)**	**Crossing MP** **109.17 (HF-C), 109.33 (HF-F)**	**Crossing MP** **109.47 (HF-G), 109.78 (HF-K)**
Streambed	• Dry ditch crossings (5) • Backfill to match existing streambed gradation, composition as much as possible • Profile restored to existing profile and grade • Stratified backfill for fish-bearing streams	• Dry ditch crossings (5) • Backfill with native material (3, 4) • Backfill to match existing streambed gradation, composition as much as possible (4) • Profile restored to existing profile and grade (4) • Stratified backfill for fish-bearing streams (1) • Structural fill placement (2)	• Dry ditch crossings (5) • Backfill with native material (3, 4) • Backfill to match existing streambed gradation, composition as much as possible (4) • Profile restored to existing profile and grade (4) • Stratified backfill for fish-bearing streams (1)
Streambanks	• Revegetation with native plant materials (3, 4, 6) • Revegetation with native trees to within 15 feet of the pipeline parallel to the alignment • Widened riparian corridor (federal lands, willing landowners) (3, 6) • Use of fast growing native tree species to accelerate shading • Placement of large wood and boulders where appropriate • Maintenance of effective cover	• Typical erosion and sediment control BMPs including erosion control blankets, silt fence, etc. • Narrowed construction disturbance (75 feet) corridor where feasible (2, 3, 4) • Narrowed permanent management corridor (2, 3, 4) • Revegetation with native plant materials (3, 4, 6) • Bank graded/terraced to 3:1 (2, 3) • Geotextile reinforced slope (5) • Fiber rolls (3) • Stream barbs/flow deflectors (5) • Toe rock placement (3) • Riprap placement (3) • Biotechnical "vegetation" riprap (3) • Tree revetments (3)	• Typical erosion and sediment control BMPs including erosion control blankets, silt fence, etc. • Narrowed construction disturbance (75 feet) corridor where feasible (2, 3, 4) • Narrowed permanent management corridor (2, 3, 4) • Revegetation with native plant materials (3, 4, 6) **<u>Additional Measures</u>** • Rootwad enhancement of bank stabilization

TABLE 2-28 **Pacific Connector Proposed BMPS for Use at Waterbody Crossings**			
	Best Management Practices for Project Typical "Blue" Crossings and for All Other Crossings	**Best Management Practices for Moderate Risk "Yellow" Crossings**	**Best Management Practices for High Habitat Risk "Green" Crossings**
	Crossing MP 109.69 (HF-J), 111.01 (HF-N)	**Crossing MP 109.17 (HF-C), 109.33 (HF-F)**	**Crossing MP 109.47 (HF-G), 109.78 (HF-K)**
Riparian Vegetation	• Revegetation with native trees to within 15 feet of the pipeline parallel to the alignment (1, 3, 5, 6) • Revegetation with native woody riparian shrubs and trees (3) • Widened riparian corridor (federal lands (3, 6) • Use of fast growing native tree species to accelerate shading (3) • Entire Riparian Reserve between Hydrofeature J and K should be necked down to 75 feet wide (7) • Helicopter yarding to remove large trees to reduce soil mobilization (7) • LWD on exposed soils in Riparian Reserves to prevent overland flow (7) • Biosolids (treated sewage effluent) should be applied in concert with wood chips to accelerate soil rehabilitation and the development of effective ground cover vegetation (7)	• Revegetation with native trees to within 15 feet of the pipeline parallel to the alignment (1, 3, 5, 6) • Revegetation with native woody riparian shrubs and trees (3) • Widened riparian corridor (federal lands (3, 6) • Use of fast growing native tree species to accelerate shading (3) • Biosolids (treated sewage effluent) should be applied in concert with wood chips to accelerate soil rehabilitation and the development of effective ground cover vegetation (7)	• Revegetation with native trees to within 15 feet of the pipeline parallel to the alignment (1, 3, 5, 6) • Revegetation with native woody riparian shrubs and trees for willing landowners (3) • Widened riparian corridor (federal lands, willing landowners) (3, 6) • Use of fast growing native tree species to accelerate shading (3) • Biosolids (treated sewage effluent) should be applied in concert with wood chips to accelerate soil rehabilitation and the development of effective ground cover vegetation (7) • LWD within Riparian Reserve (360 feet each side of the channel) (7) • Decompact Riparian Reserve using hydraulic shovel with tines to ensure full infiltration of precipitation (7) • Entire Riparian Reserve between Hydrofeature J and K should be necked down to 75 feet wide (7) **Additional Measures** Emphasis on prevention and monitoring for invasive weeds and weed control during revegetation establishment.
Aquatic Habitat	• Stratified backfill for fish-bearing streams (1,2,4, 6) • Placement of large wood where appropriate (2, 4, 6)	• Stratified backfill for fish-bearing streams (1,2,4, 6) • Placement of large wood where appropriate (2, 4, 6)	• Stratified backfill for fish-bearing streams (1,2,4, 6) • Placement of large wood where appropriate (2, 4, 6) **Additional Measures** Rootwad enhancement of bank stabilization
BMP Source	1. FERC Guidelines 2. FEIS, JPA, Appendix C, Project Description 3. JPA Appendix 1B, ECRP 4. JPA Appendix F, Affected Waters, Section 2.1.8.3 5. JPA Appendices 2C, 2D 6. JPA Appendix H, Compensatory Mitigation Plan 7. Site Specific Crossing Prescriptions- Perennial Streams on NFS Lands (NSR, 2014) Representatives of the Forest Service may require additional measures necessary to meet agency standards under the terms of the Right-of-Way Grant.		

In all crossing groups:

- Sediment barriers, including silt fencing, would be installed and maintained until effective ground cover is reestablished. Silt fences have been shown to be up to 95% effective in trapping sediment in the short term (Robichaud et al. 2003).

- Effective ground cover would be in place prior to the onset of seasonal precipitation (table 1-15 in Chapter 1).
- Rapid reestablishment of vegetation would be emphasized.

Post-construction, the Forest Service, in consultation with ODEQ, developed the following additional recommendations in this immediate area:

(a) Within Riparian Reserves for all hydrologic features crossed by the pipeline between MPs 109 and 110, provide 100% ground cover on all disturbed areas. Wood fiber is the preferred material. In addition, construct effective water bars at 50-foot intervals. If necessary, biosolids would also be used in concert with wood chips to augment soil productivity to reestablish vegetation.

(b) At hydrologic features G, J, and K, ensure that all erosion control measures are in place before the onset of seasonal precipitation and monitor for rilling, gullying, and other forms of active erosion that may transport sediment into the aquatic environment. If rilling or gullying is occurring that may result in sediment transport into the aquatic environment, immediately take additional erosion control measures to preclude sediment transport.

(c) Until effective ground cover vegetation is established, inspect the construction corridor for sediment transport after each significant storm event (which would be more frequently than a bank-full event) or if there is a visual sediment plume downstream. If the sediment source is originating from the pipeline corridor, add whatever erosion control measures are necessary to preclude sediment transport. This would be done in consultation with the Forest Service. This may include additional silt fencing, aerial placement of ground cover and LWD, mulch, erosion control fabric or other measures as needed. An authorized agency representative would provide direction to Pacific Connector regarding these events if necessary.

(d) Based on field reviews by the Forest Service, GeoEngineers, and NSR, erosion control measures in the ECRP are expected to be successful. There is, however, potential for incremental and cumulative increases of minor amounts of sediment downstream since all of the crossings in the East Fork of Cow Creek occur in the same stream system and occur in close proximity to one another. In order to ensure that sediment during construction and post-construction does not aggregate downstream, the Forest Service would require monitoring of turbidity levels above the crossing at MP 109.78 (the farthest upstream crossing of the project) and at stream junctures downstream at the time of construction and during post-construction wet weather. If turbidity monitoring shows significant cumulative sediment, as defined by the Forest Service, from project crossings, Pacific Connector would need to take additional steps to reduce erosion from sediment sources. These would include adding appropriate methods noted above or specified by the Forest Service to further reduce the mobilization and transport of sediment.

2. Whether construction activity would intercept groundwater, causing "piping" or otherwise concentrating subsurface flows.

Complex subsurface routing of water is common within earthflow terrains. Stream temperatures in the East Fork of Cow Creek suggest ground water discharge to the streams. GeoEngineers also ranked the crossing at MP 109.47 as "High Sensitivity" for hyporheic flows, suggesting surface and ground water fluxes within the riparian zone (GeoEngineers 2013g). There is some possibility that during construction, the project may encounter shallow ground water. Because of the crossing proximity and the infiltration rates of the granitic and schistose soils, pumping water out of the crossing site may simply be moving it to the next crossing. If significant shallow ground water is intercepted, the Forest Service and Pacific Connector would agree on a site plan during construction to pump hyporheic flows from the channel to a stable location away from the channel. If post-construction review shows excessive piping (subsurface erosion creating macro-pores or soil pipes) as a result of pipeline construction that is causing resource damage as defined by the Forest Service, Pacific Connector would be required to take additional measures approved by the Forest Service to reduce piping and subsurface erosion. Additional trench blockers may also be necessary in the trench in this area to avoid channeling subsurface flows along the pipeline trench.

3. Whether the earthflow terrains between MP 109 and 111 would remain stable.

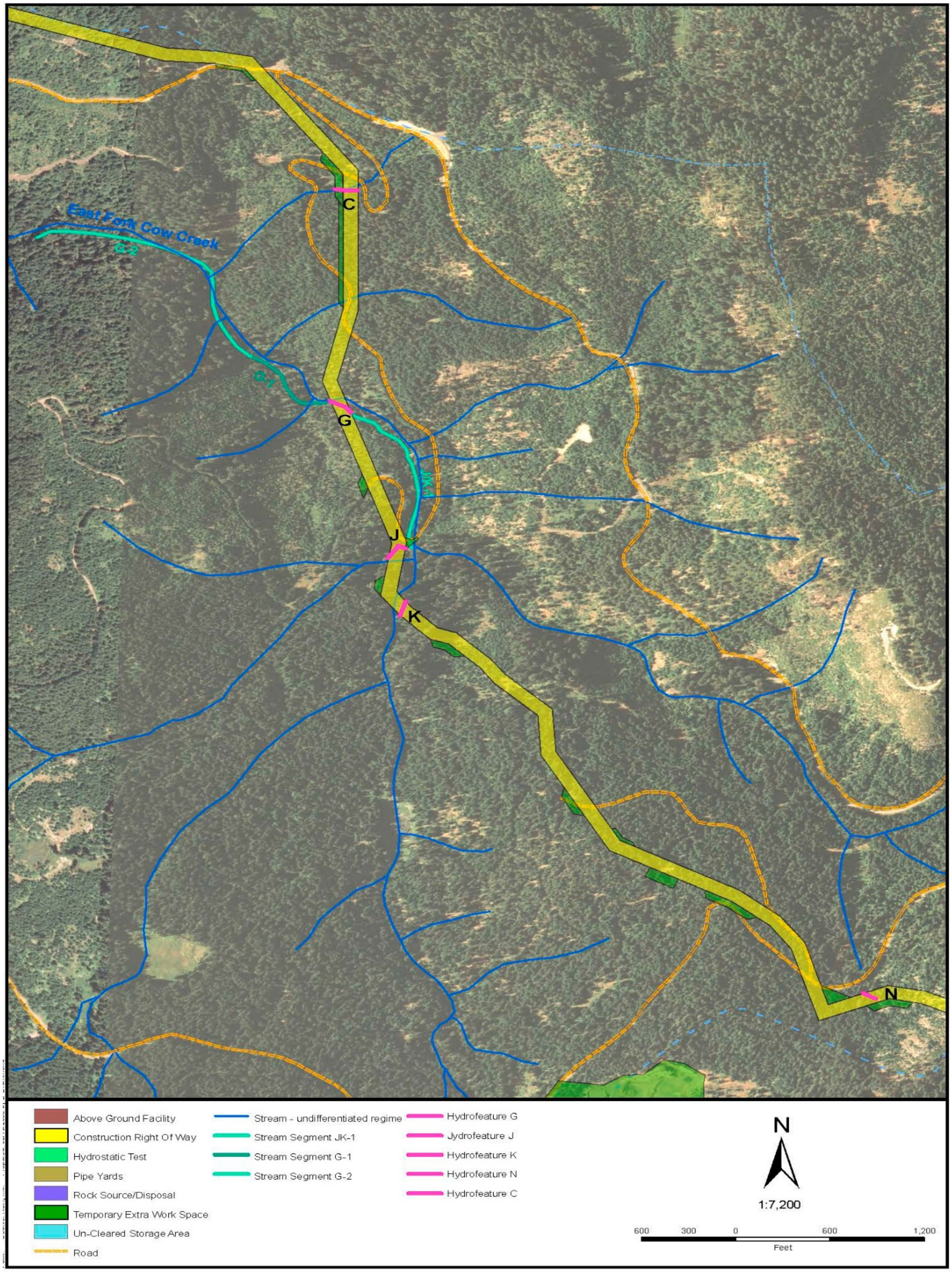
At the request of the Forest Service, both GeoEngineers and NSR have conducted additional field reviews in the East Fork of Cow Creek to ensure that the project routing would not destabilize earthflow terrains. An Oregon licensed civil engineer from the Forest Service (Hanek 2010), licensed geologists and geotechnical engineers from GeoEngineers (2013), and a licensed geologist from NSR (Koler 2012) have concluded that the earthflow terrains are stable due to their large size and position of the ground water units and that construction is not likely to destabilize them.

4. Whether the loss of effective shade at stream crossings would cause adverse and significant increases in stream temperature at the site of maximum impact or that accumulate downstream.

Stream temperatures are potentially affected by the removal of effective shade. Effects of shade removal depend on stream volume, aspect and stream orientation, and position in the watershed. Loss of effective shade on intermittent streams is not expected to impact water temperature during late summer months when stream temperatures are an issue. As illustrated on figure 2-7, with four perennial stream crossings of the East Fork of Cow Creek or its tributaries in less than a mile below MP 109.76, the possible cumulative impacts of increased stream temperatures are of concern.

Oregon state water quality standards (Oregon Administrative Rules [OAR] 340-041-0028) state that all nonpoint sources taken together at the point of maximum impact may not exceed 0.3°C (0.5°F). The Umpqua Basin TMDL (2006) is more restrictive and allocates the human use allowance to be a 0.1°C increase at the point of maximum impact (i.e., downstream of multiple tributaries impacted by pipeline construction). In addition, all of the stream crossings in the Upper Cow Creek watershed are designated as core cold water habitat (OAR 340-041 figure 320A). The OAR (340-041-0028) states that streams designated with a fish use of core cold water habitat may not exceed 16.0°C (60.8°F) as measured by the 7-day-average maximum stream temperature. (see www.oregon.gov/deq/Rulemaking%20Docs/figure320a.pdf).

Figure 2-7 Perennial Stream Channel Crossings in the East Fork Cow Creek Drainage



To address temperature issues, NSR (2009) conducted a water temperature assessment of the perennial waterbodies crossed within the East Fork Cow Creek drainage to assess the potential effects that the project would have on downstream temperatures. In 2013, NSR reevaluated hydrofeatures G, J, and K to reflect changes in the pipeline alignment. Hydrofeatures are geomorphic landforms that represent the geologically recent flood history within the basin. Data reported in tables and figures reflect the reevaluated results for these three hydrofeatures (NSR, "Water Temperature Impacts USFS," 2015). These crossings are shown in figures 2-6 and 2-7. This solar loading assessment used the valley, stream channel, and riparian zone characteristics of hydrofeatures; measured water temperature trends in East Fork Cow Creek; and used water temperature modeling results to predict the existing and future stream temperature regimes. The evaluation showed that *with on-site mitigation measures*, any temperature increases would be less than 0.2°C and limited to the point of maximum impact. No impacts were predicted at the stream network scale because of the small volume of affected streams, likely groundwater inputs, and the assimilative capacity of the stream network. The results of this evaluation are shown in table 2-29. An implementation and effectiveness monitoring plan is in place to ensure that these objectives are achieved. If temperatures do increase, Pacific Connector would be required to take additional measures such as planting additional trees or adding LWD to provide additional shade (GeoEngineers 2013f: 26 and EIS Section 4.3.1.5). On-the-ground conditions and water temperature model results suggest that it is unlikely that the stream temperature downstream of any of the perennial crossings would be increased above the ODEQ Core Cold-Water Habitat temperature criteria of 16°C (61°F) (NSR 2009:41-42, table 6.1.1; NSR, "Water Temperature Impacts USFS," 2015; see also table 2-29).

TABLE 2-29

SSTEMP Model Results for Perennial Stream Crossings in Upper Cow Creek by Hydro-Feature and Reach

Site Data a/	Hydro-K	Reach J-1	Hydro J	Reach JK-1	Hydro G	Reach G-1	Reach G-2
Base Flow Discharge (cfs)	0.02	0.18	0.04	0.26	0.115	0.50	0.55
Existing Temperature (Deg. C)	16.2	15.1	14.6	14.6	15.0	14.8	14.5
Existing Temperature (Deg. F)	61.2	59	58.3	58	59.0	59	58
Post-Project Temperature (Deg. C.)	19.1	15.6	16.1	14.9	15.6	15.0	14.6
Post-Project Temperature* (Deg. F)	66.3	60	60.9	59	60	59	58
Post-project temperature with Mitigation** (Deg. C)	16.5	15.2	14.9	14.7	15.0	14.8	14.5
Post-project temperature with Mitigation** (Deg. F)	61.7	59	58.8	59	59.0	59	59

a/ Hydrofeature N at MP 111.01 is a perennial stream that becomes intermittent in the summer because of an upstream diversion. It would be dry during summer months when water temperature is an issue and is not considered here because its current condition is an intermittent stream.
* Modeled result sare based on a 0% predicted shade retention (not including shade from topographic features).
** With mitigation was modeled based on 75% effective shade.

Stream temperatures at perennial crossings on NFS lands in the East Fork of Cow Creek were reanalyzed in 2013 to reflect minor changes in the pipeline alignment and to provide updated temperature and flow data (NSR 2015). The Stream Segment Temperature Model (SSTEMP; Bartholow 2002) model was selected for this analysis because it is the modeling tool most often used by the federal agencies and can provide outputs for single stream segments using available data. This is also the model used in the NSR 2009 analysis. Data recorders were placed at selected locations and 7-day average high temperatures were recorded for each crossing during the warmest part of the summer when lowest flows occurred. Flows in the 2013 data year were about 33% of those modeled in 2009 and bordered on intermittent at a perennial stream crossing at MP 109.69 (HF-J) in the East Fork of Cow Creek. These data provided a drought condition assessment of potential project impacts on perennial stream temperatures. To validate the model, existing conditions were input and predicted temperatures from the model were compared to measured temperatures. When compared to measured existing conditions, the SSTEMP model overstated actual stream temperature increases by as much as 2.0°F (table 2-29). If the SSTEMP model overstated the existing condition, then it would also be expected to overstate the post-construction impacts by comparable amounts. This overstatemeent highlights the inherent uncertainty and high variability in measuring stream temperatures in low-volume channels.

Modeling of stream temperatures *with 0% effective shade retention* in the East Fork of Cow Creek on the UNF using SSTEMP showed potential temperature increases *without on-site mitigation* of 1.0°F to 5.1°F.[14] Measured stream volumes ranged from 0.02 cfs to 0.115 cfs, which are very low flows and correlate with modeled temperature increases. As noted above, this is a drought condition assessment and may not be typical of most years or of post-construction shade levels. While there is a great deal of inherent variation in the stream conditions and a measure of uncertainty in the SSTEMP model results, results of the NSR 2014 analysis suggest that in a low-flow scenario without mitigation, there could be a potential for temperature increases above the TMDL thresholds (0.1°C or 0.18°F at the point of maximum impact) or ODEQ Core Cold-Water Habitat temperature criteria of 16°C (61°F) in small perennial channels in the East Fork of Cow Creek.

The 2014 analysis showed larger temperature impacts than those reported in NSR 2009. Model differences between the NSR 2009 and the NSR 2014 analyses are explained by the much lower flows measured in the 2013 water year and the sensitivity of the SSTEMP model to low flows.

Table 2-30 shows temperature impacts at Hdyrofeatures G (MP 109.47), J (MP 109.69) and K (MP 109.76). **These data are based on drought-condition flows and near total removal of shading vegetation and is subject to change based on model parameters**.

[14] These results have not been indexed or adjusted to reflect the measured overstatement of impacts by the SSTEMP model noted above. Actual temperature impacts are likely to be less.

TABLE 2-30 **Preliminary Assessment of Stream Temperature Impacts at Perennial Stream Crossings in the East Fork of Cow Creek**							
Hydrofeature	**Measured Flow (cfs)**	**Measured Existing Condition 7-Day Max. Temperature Below Crossing 2013 data (degrees F)**	**Modeled Predicted 7-Day Average Max. Temperature SSTEMP 2013 Data (degrees F)**	**Existing Condition Model Overestimate Compared to Actual Conditions (degrees F)**	**Modeled Post-Construction Average Max. Temperature (degrees F)**	**Modeled Post-Construction Max. Increase in Average Max. Temperature (degrees F)**	**Predicted Max 7-Day Average (Modeled Increase Added to Measured Existing Condition) (degrees F)**
HF-K MP 109.76	0.02	61.2°	61.2°	+0.0°	66.3°	+5.1°	66.3°
HF-J MP 109.69	0.04	58.3°	58.5°	+0.2°	60.9°	+2.6°	60.9°
HF-G MP 109.47	0.115	59.0°	59.2°	+0.2°	60.0°	+1.0°	60.0°
Data Source: NSR 2015. Table values reflect drought condition flows and 0% effective vegetation shading. Values were not adjusted for likely overstatement of impacts by SSTEMP model onsite mitigation measures to retain or replace existing shade.							

Crossing-Specific Preliminary Interpretation Based on NSR 2013 Data

Hydrofeature K at MP 109.76 is the uppermost perennial crossing in the East Fork Cow Creek system. This crossing is oriented north-south and is in a small clearing that receives several hours of sunlight each day. Figure 2-6 shows that in the existing condition, measured temperature increases by 4.8°F to 61.1°F between water temperature site (WTS) 11 and WTS 10 because of solar exposure, then immediately cools to 58.2°F at WTS 9 because of dense shade and possible hyporheic exchange with gravels in the stream bed. Post-construction reestablishment of effective shade at Hydrofeature K would likely prevent further temperature increases and may actually reduce temperatures since there is currently little shade at this crossing. Any temperature increase that may occur at this crossing is expected to follow the measured cooling trend between WTS 10 and WTS 9.

Hydrofeature J at MP 109.69 is the crossing with the lowest stream flow volume in the East Fork Cow Creek system at 0.04 cfs. This very small channel is oriented east-west and is shaded most of the day. In the existing condition, water temperatures actually decline by 2.6°F at this location between WTS 8 and WTS 7. Because of the very low stream volume, there is a potential temperature increase of approximately 2.6°F at this location if all of the shading vegetation is removed. This is a narrow channel that would be easily shaded by the placement of LWD and willow plantings. NSR 2009 also predicted temperature increases at this location and recommended planting larger conifers to provide shade. If preconstruction levels of shade are reestablished, the predicted temperature increases would likely not occur. Given the very small volume of the stream, the assimilative capacity of the large mainstem East Fork Cow Creek, and cold water inputs from adjacent tributaries, any temperature increase that does occur would likely be unmeasurable in the mainstem of the East Fork Cow Creek. Given the inputs of cold water from upstream tributaries and the temperature gradients in the East Fork Cow Creek, temperatures at WTS 3 are expected to remain at or near the existing condition.

Hydrofeature G at MP 109.47 is an east-west oriented crossing and is the lowest of the perennial crossings in the East Fork Cow Creek system. In the existing condition, water temperatures decrease from 58.7°F at WTS 2 to 58.1°F at WTS 1. This decrease is likely the result of ground water discharge from adjacent wetland complexes. Hydrofeature G is at the toe of an ancient but stable earthflow terrain. GeoEngineers identified this site as having possible hyporheic influence (GeoEngineers 2013g). This possibility is supported by the measured decrease in temperature at this location. This site is partially shaded by dense willows. A modeled temperature increase of 1.0°F is indicated at this site if all of the shading vegetation is removed. This site could easily be shaded by the placement of large wood and maintenance or replacement of the willows. If the existing shade condition is restored post-construction, no temperature increase would be expected. If shade is not restored and the modeled temperature increase of 1.0°F is realized, it would increase the 7-day average maximum temperature to 60.0°F. With this increase, water temperature would remain below the ODEQ Core Cold-Water Habitat temperature criteria of 16°C (61°F).

Discussion

Although exposure to solar radiation may cause temperature increases, temperatures downstream from limited stream-side forested clearings have often been found to cool rapidly once the stream re-enters forested regions (Zwienieck and Newton 1999). Other studies have noted downstream cooling below timber harvest areas as well, but the extent of this cooling is not entirely clear and varies by stream (Moore et al. 2005, Poole et al. 2001). Although there is some debate concerning the magnitude of cooling provided by riparian vegetation and the extent to which stream temperatures return to non-cleared temperature levels after exiting a cleared area, studies emphasize that riparian buffers assist in maintaining water temperatures (Correll 1997, Gomi et al. 2006). Generally, temperatures, especially in small streams, may recover quickly with cooler surrounding conditions downstream (e.g., streambed cooling, evaporation, hyporheic inflows, shade). This was validated by stream temperature data recorded on the UNF in 2013. Field measurements of existing conditions on the UNF showed decreasing stream temperatures of as much as -7.6°F/100 feet with an overall average over 2,040 feet of the East Fork Cow Creek of -0.1°F/100 feet (NSR 2014). The presence of number of small wetlands adjacent to the stream channel provide evidence of likely local ground water discharge as springs and seeps. Most of this 2,040-foot reach also has substantial shade. This suggests the retention of shading structures, or at least partial shade, may greatly reduce increases in stream temperature. This data also supports the NSR 2009 finding that potential temperature increases are partially offset by cooling from ground water interactions in the stream channel.

Observations as part of both NSR 2009 and NSR 2014 show that LWD and low-growing willows, huckleberries, and other brush species can provide effective shade for small, narrow channels. For example, Hydrofeature G at MP 109.47 has dense overhanging willows and other brush species that shade much of the channel. In many cases, low-growing brush outside of the immediate construction area for the crossing can be maintained, thus minimizing shade loss. In the mainstem of the East Fork Cow Creek, LWD provides significant shade and creates a complex channel structure with high retention of sand and gravel that helps maintain cooler water temperatures. As described in the ECRP and waterbody crossing requirements for the project, all LWD and boulders removed from the crossing area would be replaced during site restoration and low-growing brush will be retained where it is possible to do so. Many of the channels crossed by the PCGP are very small and could easily be shaded by the placement of LWD, larger logs, and willow plantings. Where site-specific modeling suggests temperature increases may be possible, a restoration plan to reestablish pre-crossing shade conditions using willows, logs, boulders, and LWD will be prepared for each of the perennial stream crossings on NFS lands. With the maintenance of existing shading brush on small channels, the placement of LWD, and the replanting of willows and other brush species, downstream temperatures are expected to be very close to the existing condition and to remain below ODEQ thresholds on the East Fork Cow Creek because these measures would provide immediate and effective shade. In small, first- and second-order streams, any temperature increase that does occur would likely be masked by the assimilative capacity of larger streams at the stream network scale (NSR 2009).

In all cases in South Fork Cow Creek, ground water discharge, downstream shade, and commingling with other tributaries is expected to limit any temperature increase to the site scale, with no accumulation of temperature increases downstream. However, since there are four perennial stream crossings in the same stream system in less than a mile and there is a TMDL threshold, it is appropriate to require project implementation and effectiveness monitoring. As a final measure to ensure that temperature standards are maintained, the Forest Service would require Pacific Connector to monitor temperatures above and below crossings of perennial streams during and post construction using Forest Service temperature protocols until effective shade is reestablished at perennial stream crossings or until it is evident that stream temperatures remain unaffected. If temperatures or temperature changes exceed thresholds established by ODEQ, Pacific Connector would be required to develop additional mitigations by agreement with the Forest Service to reduce project impacts on stream temperature. These measures may include placement of large logs so as to provide effective shade and reduce wetted stream width and limbs and small logs bridging the channel to provide effective shade or other methods as directed by the Forest Service.

Pacific Connector also assessed potential impacts to stream temperature. Pacific Connector used predictive modeling on a representative cross-section of crossings along the pipeline route, spanning the ecoregions, HUCs, width classes, and aspect classes from Coos Bay to Malin, Oregon, including stream crossings on NFS and BLM lands. Model results show a maximum predicted increase of 0.16°C over one 75-foot clearing. Thermal recovery analysis shows that temperatures return to ambient within a maximum distance of 25 feet downstream of the pipeline corridor, based on removal of existing riparian vegetation over a cleared right-of-way width of 75 feet. Given that mitigation for loss of effective shade would occur and that predictive modeling using SSTEMP shows that the local impacts are small in magnitude and spatially limited, the cumulative effects of the proposed project on the thermal regime in the Coos, Coquille, South Umpqua, Rogue, Klamath, and Lost River basins is expected to be extremely minor and well below detection in the field (GeoEngineers 2013f: 26).

5. Whether ground disturbance associated with PCGP construction could mobilize naturally occurring mercury found in the soils at or near crossings in the East Fork Cow Creek.

The Forest Service contracted with a consulting geologist to collect soil and stream sediment samples for analytical testing and reporting of mercury and other naturally occurring minerals along a 2,000-foot section of the proposed pipeline route between MP 109 and the East Fork Cow Creek (Broeker 2010b, GeoEngineers 2013e). Geochemical analysis of the soil and stream sediment samples have been analyzed, showing that the sediment has very low to nominal concentrations of naturally occurring mercury mineralization. The mercury level at one of the stream sediment sites was 0.29 part per million, which was above the Level II screening level value of 0.1 part per million for invertebrates (ODEQ 1998, cited in GeoEngineers 2013d). In order to prevent this naturally occurring mercury from mobilizing during and after construction, additional erosion control measures developed with ODEQ along with monitoring would be conducted at these sites. The proposed pipeline construction activities by Pacific Connector within the upper East Fork Cow Creek watershed are not anticipated to disturb and expose soils and bedrock strata that contain more than low amounts of natural occurring mercury mineralization and any sediment that is generated is not likely to reach the aquatic environment due to implementation of short-term and permanent mitigation measures outlined in Pacific Connector's ECRP (GeoEngineers 2013e). Pacific Connector would conduct periodic water quality monitoring during and post construction to ensure that mercury is not mobilized.

Table 2-31 compares the project effects to the historic range of variability for relevant ecological processes in the Upper Cow Creek watershed. These processes have been substantially altered by fire suppression, timber harvest, and road construction.

TABLE 2-31

Project Effects and Relevant Ecological Processes Described in the Upper Cow Creek Fifth-Field Watershed Analysis

Ecological Processes Relevant to the PCGP	Historic Range of Variability	Pacific Connector Effects
Erosional Processes	The Upper Cow Creek watershed has a high frequency of landslides in granitic and schistose soils. When high-intensity rainfall events or rain-on-snow events overlapped with areas burned in high-intensity fires, surface erosion and shallow mass wasting likely increased substantially, resulting in pulses of coarse sediments and LWD to stream channels. Ancient earthflow features (early to mid-Holocene) exist in the East Fork Cow Creek, but they are currently stable]	All but 1 mile of the 5.27 miles of thee PCGP corridor in Upper Cow Creek watershed is on a ridge top. The 1 mile stretch from MP 109 to 110 in the South Fork Cow Creek subwatershed crosses ancient but stable earthflow terrains. Application of measures described in the ECRP and BMPs including maintenance of effective ground cover in accordance with the UNF land management plan standards (table 1.3.1.2-1) during construction is expected to minimize the potential for sediment transport to streams. Dry dam-and-pump stream crossing methods described in Section 1.3.1 are expected to limit sediment during construction (see Section 1.3.1.2). Transport and deposition are currently roughly in balance in the East Fork Cow Creek (Forest Service 1995a: 49). Sediment produced by the PCPG is expected to be short-term during the period of construction and minor (see Section 1.3.1.2). The project is not expected to reactivate earthflow terrains or produce sediment amounts that would alter the current balance in the East Fork Cow Creek (Hanek 2011, Koler 2012, NSR 2014, . Project impacts are expected to remain within the range of natural variability for the Klamath Province and the erosionally active Upper Cow Creek watershed; however, a potential exists for aggradation of sediment from multiple stream crossings. Therefore, additional post-construction sediment monitoring that may require actions by Pacific Connector would be incorporated into the terms of the Right-of-Way Grant.

TABLE 2-31

Project Effects and Relevant Ecological Processes Described in the Upper Cow Creek Fifth-Field Watershed Analysis

Ecological Processes Relevant to the PCGP	Historic Range of Variability	Pacific Connector Effects
Ecological Succession/Vegetative Condition	Frequent, low-intensity fire with infrequent high-intensity, stand-replacing fires in dry years created a mosaic of open forest dominated by Douglas-fir and pines that ranged from 45% to 75% late successional forest (Forest Service 1995). Landslides associated with unstable granitic and schistose soils occasionally intersected stream channels creating openings in stream-side vegetation. Fire suppression and timber management have reduced and fragmented late-successional stands, reducing patch size, shifting species dominance to white fir, and increasing early and mid seral proportions of the drainage. LSOG acres in both upland and riparian areas are below historic averages. Vegetative condition throughout the Upper Cow Creek watershed has been significantly altered by timber management activities.	A total of 1.59 acres (0.02%) of Riparian Reserves would be cleared by the project in the Dismal Creek subwatershed. The project would affect 8.47 acres or 0.11% of Riparian Reserves in the South Fork Cow Creek subwatershed. Of the cleared Riparian Reserves in the watershed, approximately 4.46 acres are LSOG (table 2-25). Loss of LSOG vegetation in the corridor is a long-term impact, but minor in scale, and well within the historic range of vegetative change, given the fire and landslide history of the Upper Cow Creek watershed (see discussion of fire and landslides in watershed assessment). The federal lands on the Upper Cow Creek watershed are currently 36% LSOG and exceed the 15% LSOG threshold stipulated by the NWFP.
Peak Flow Processes	Most of the Upper Cow Creek watershed lies in the TSZ, where rain-on-snow events can increase the frequency and intensity of peak flows. Harvest units and roads have likely increased the frequency and intensity of peak flow events.	The Upper Cow Creek watershed analysis recommended site-specific evaluation of the potential for peak flows as a result of canopy removal. The PCGP would remove canopy on about 65 acres or about 0.3% of NFS lands in the watershed. Analysis by FERC showed that the project was highly unlikely to contribute to increases in peak flows because of the small proportion of the watershed affected by the project (see EIS Chapter 4.3, also FERC, 2009). Additionally, all but approximately 1 mile of the PCGP corridor lies on ridge top locations that have minimal interactions with Riparian Reserves. The portion of the project in the South Fork Cow Creek subwatershed that is not on ridge tops is unlikely to contribute to peak flows because hydrologic connectivity would be minimized by recontouring slopes, decompacting soils, maintaining effective ground cover, and other measures stipulated in the ECRP. Peak flows may increase in the TSZ where less than 75% of drainage is hydrologically recovered because of interactions of roads with stream crossings. Although the project area is in the TSZ, more than 85% of the NFS lands in the watershed are hydrologically recovered (Forest Service 1995a: 95, table 14) and the PCGP affects substantially less than 1% of the drainage. It is highly improbable that the PCGP could affect peak flows in the Upper Cow Creek watershed (see also EIS Section 4.3).
Stream Temperature	Maximum water temperature on the East Fork Cow Creek above the confluence with the South Fork Cow Creek was 55-60°F or below. The Umpqua Basin Watershed Council (2000) collected temperature data from 89 continuously sampling data loggers from sites throughout the Cow Creek watershed during summer 2000. Data from the East Fork mouth, downstream of the project crossing, indicated that the maximum temperature was 61.6°F. There were 74 days where the temperature exceeded 55°F, but there were no days where the temperature exceeded 64°F.	See table 2-29 and the previous discussion in this section. A site-specific evaluation of effects of the PCGP on stream temperature showed that with mitigations, stream temperatures at the site scale would be minor or not detectable, with no impact at the network scale, and would not exceed thresholds established by the State of Oregon in a TMDL for temperature in the Umpqua Basin (NSR 2009, NSR 2014). Temperatures are expected to remain within the range of natural variability, although there may be minor increases at the point of maximum impact (see also GeoEngineers 2013f: 26).

TABLE 2-31 **Project Effects and Relevant Ecological Processes Described in the Upper Cow Creek Fifth-Field Watershed Analysis**		
Ecological Processes Relevant to the PCGP	**Historic Range of Variability**	**Pacific Connector Effects**
Aquatic Habitat and Stream Channel Complexity	Stream channels had 40-60 pieces of LWD/mile with >30% pool habitat by area. Prior to human impact, beaver dams and high densities of LWD in log jams created complex channels and maintained pools in streams of the watershed. Water was stored in the channel and as ground water in the streambanks and floodplains. This water was slowly released during the summer, thereby sustaining flows. The combination of LWD and streambank vegetation was indicative of relatively stable streambanks and channels that were relatively resilient during floods. Past management practices have simplified channel conditions, removing LWD from channels and eliminated future sources of LWD.	During construction, the project would alter the bed and banks of stream channels and move LWD and boulders as necessary for construction. After construction, these sites would be restored to their preconstruction condition and stabilized as needed by placement of boulders, LWD, and erosion control structures as specified in the ECRP and Wetland and Waterbody Plan; therefore, no long-term effects to aquatic habitat and channel complexity are expected. Effects would be limited to the project scale and would be minor and short-term (typically 1 to 5 days per crossing).

Compliance with Land Management Plans

Project compliance with standards and guidelines contribute to compliance with the ACS. Where a project does not comply with a standard and guideline, the evaluation must show that non-compliance does not prevent attainment of the ACS. Table 2-32 provides NWFP Standards and Guidelines relevant to the ACS that are applicable to NFS lands in the Upper Cow Creek watershed.

TABLE 2-32 **Compliance with Standards and Guidelines**	
UNF/NWFP Standards and Guidelines	**PCGP Compliance**
LH-4: Issuing leases, permits, right-of-way and easements.	Terms and conditions to ensure compliance with ACS objectives have been incorporated into the POD prepared by the applicant in conjunction with the BLM, Forest Service, and ACOE and submitted as part of the Right-of-Way Grant application. The POD includes 28 exhibits, including the Wetland and Waterbody Crossing Plan, the Erosion Control and Revegetation Plan, the Hydrostatic Test Plan, the right-of-way Clearing Plan, and the Traffic Management Plan, etc. Specifically, in the South Fork Cow Creek subwatershed, Pacific Connector has agreed to maintain 100% effective ground cover to prevent surface erosion and minimize the risk of mobilizing naturally occurring mercury.
RA-4: Locating water withdrawal sites.	Pacific Connector has developed a Hydrostatic Test Plan that would minimize any potential short-term effects on stream flows from water discharge events from the project's hydrostatic testing operations. No potential hydrostatic test water sources occur within the Upper Cow Creek watershed; therefore, the biological, physical, and chemical integrity of these systems would remain unaffected by hydrostatic withdrawal activities.
RF-2: Road construction standards and guidelines.	The existing transportation system in the South Fork Cow Creek subwatershed would be adequate for construction of the project. No new temporary or permanent access roads are planned in the South Fork Cow Creek subwatershed.
RF-4: New culverts, bridges and other stream crossings.	No new road crossings of streams are proposed in the watershed. Crossings would be maintained to prevent diversions. Specific specifications in the TMP (see Section 2.2.3 and Exhibit F, Section F.9.e) require culvert and bridge replacements to meet agency standards and agency approval of plans.

TABLE 2-32

Compliance with Standards and Guidelines

UNF/NWFP Standards and Guidelines	PCGP Compliance
RF-5: Minimizing sediment delivery from roads.	Road maintenance specifications in the TMP require implementation of T-831, T-842, T-811, and T-834, which are maintenance specifications designed to minimize sediment delivery to aquatic habitats; these specifications would be implemented during project construction.
RF-6: Maintaining fish passage.	Fish passage would be maintained at all road crossings where project-related road repairs are implemented. Additionally, PCGP would install four "fish friendly" crossings that meet the current biological opinions of the USFWS and/or NMFS to replace culverts that currently block fish access and limit connectivity of aquatic habitats.
RF-7: Transportation Management Plan development.	The TMP submitted by the applicant and accepted by the Forest Service meets all the requirements of RF-7 in the Upper Cow Creek watershed.
WR-3: Proper use of planned mitigation and restoration.	Application of BMPs and aggressive erosion control measures, restricted construction windows, and numerous other impact minimization measures have been incorporated into several exhibits to the POD to prevent habitat degradation. These measures are not being used as a substitute for otherwise preventable habitat degradation or as surrogates for habitat protection.
Management direction for Survey and Manage Species in the NWFP ROD was replaced by the 2001 ROD and Standards and Guidelines for Amendments to the Survey and Manage, Protection Buffer, and other Mitigation Measures Standards and Guidelines as Modified by the 2011 Settlement Agreement in Conservation Northwest v. Sherman, Case No. 08-CV-1067-JCC (W.D. Wash.)	The project affects Survey and Manage species within the Upper Cow Creek watershed. Such effects would be inconsistent with management recommendations in the 2001 ROD to protect known sites of Survey and Manage species. However, the project does not threaten the persistence of any Survey and Manage species (see appendix J). Waiving application of Management Recommendations for Survey and Manage species in the watershed would not prevent attainment of any ACS objective.
Retain late-successional forest patches in landscape areas where little late-successional forest persists. This management action/direction will be applied in fifth-field watersheds (20 to 200 square miles) in which federal forest lands are currently comprised of 15% or less late-successional forest. (The assessment of 15% will include all federal land allocations in a watershed.) Within such an area, protect all remaining late-successional forest stands. Protection of these stands could be modified in the future when other portions of the watershed have recovered to the point where they could replace the ecological roles of these stands.	Federal lands in the Upper Cow Creek watershed are currently 36% LSOG and exceed this threshold.
New Developments in LSRs	Standards and Guidelines for New Developments in LSRs (NWFP C-17) require effects of developments be minimized and mitigated. Reallocation of Matrix lands to LSR (UNF-4) is a mitigation to partially meet this Standard and Guideline. See appendix K.
UNF Standards and Guidelines for Effective Ground Cover (Umpqua National Forest Forest Plan IV-67)	Standards and Guidelines for Effective Ground Cover (Umpqua National Forest Forest Plan IV-67) have been incorporated into the ECRP and are a requirement for the project (table 1-15 and ECRP table 10.15-1). The project would maintain 100% effective ground cover in affected Riparian Reserves in the South Fork Cow Creek subwatershed, which exceeds the requirements of this standard.
UNF Standards and Guidelines Forest Wide Fisheries #1 (LRMP IV-33)	Standards and Guidelines for maintenance of effective shade cannot be met. A Forest Plan amendment (UNF-1) is proposed to waive application of this standard and guideline.

TABLE 2-32 Compliance with Standards and Guidelines	
UNF/NWFP Standards and Guidelines	**PCGP Compliance**
UNF Prescriptions C2–II (LRMP IV–173) and C2–IV (LRMP IV–177)	Aquatic prescriptions prohibit utility corridors from running parallel to stream corridors. The PCGP runs parallel to the East Fork Cow Creek at MP 109.5 to 109.6. A Forest Plan Amendment (UNF-2) is proposed to waive application of this standard and guideline.
UNF Forest-Wide Soils Standard and Guideline #1 (LRMP IV-67)	The combined total amount of unacceptable soil condition (detrimental compaction, displacement, puddling, or severely burned) in an activity area (e.g., cutting unit, range allotment, site preparation area) should not exceed 20%. All roads and landings, unless rehabilitated to natural conditions, are considered to be in detrimental condition and are included as part of this 20%. Pacific Connector cannot meet this standard. A Forest Plan Amendment (UNF-3) is proposed to waive application of this standard.

Relationship of Proposed Forest Plan Amendments to the ACS

In the Upper Cow Creek watershed, four amendments to the Umpqua National Forest Forest Plan have a nexus with the ACS. The section addresses whether implementation of these Forest Plan amendments would prevent attainment of the ACS.

UNF-1. Amends standards and guidelines for fisheries and water quality to allow the removal of 3 acres of effective shading vegetation where perennial streams are crossed by the PCGP.

Forest-Wide Fisheries Standard and Guideline #1 (Umpqua National Forest Forest Plan IV-33) states:

> Maintain all effective shading vegetation on perennial streams. Utilize silvicultural practices to establish shade on perennial streams where currently lacking.

The purpose of this standard and guideline is to prevent stream temperature increases caused by the removal of effective shade. The Umpqua National Forest Forest Plan clearly allows utility corridors to cross riparian areas; however, the PCGP corridor cannot be constructed without removal of effective shade. Amendment Umpqua National Forest 1 allows the removal of effective shade where the PCGP corridor crosses perennial streams on the Umpqua National Forest.

See discussion of effects of shade removal related to stream temperature in Section 1.4.1.3 of this appendix.

Based on the limited impact on stream temperature, conditions created by this amendment are not likely to prevent attainment of ACS objectives in the Upper Cow Creek watershed.

UNF-2. Amends Prescriptions C2–II (LRMP IV–173) and C2–IV (LRMP IV–177) to allow the PCGP to run parallel to a Class II stream for approximately 0.1 mile (approximately 500 feet).

From approximately MP 109.47 to MP 109.69, the PCGP runs parallel to the East Fork Cow Creek. The Umpqua National Forest Forest Plan Management Prescriptions for riparian areas state:

> Utility/transportation corridors, roads or transmission lines may cross but must not parallel streams and lake shores in the riparian unit.

The purpose of this Standard and Guideline is to minimize the loss of riparian habitat from utility corridors. Removal of Riparian Reserves can damage aquatic habitats by removing coarse wood that may contribute to aquatic habitats in the future, cause increases in temperature by removing shade, and cause increases in sediment by exposing soil or removing filtering vegetation. To minimize the total number of stream crossings, use optimum crossing locations, and minimize overall disturbance, the PCGP route cannot avoid running parallel to the East Fork Cow Creek from MP 109.47 to 109.69. The project would clear approximately 3 acres of Riparian Reserve on the southwest side of the East Fork Cow Creek. In this circumstance, there is little likelihood stream temperatures or sediment deposition would occur or that this action would prevent attainment of ACS objectives because:

- Approximately 300 feet or 94% of the reach between MP 109.66 (Hydrofeature J) and 109.76 (Hydrofeature K) of effective shade remains on the southwest side of the East Fork Cow Creek so it is highly unlikely temperatures would increase from paralleling the stream.
- The ECRP requires that 100% effective ground cover be established and maintained. In addition, water bars would be installed as needed.

Based on this evaluation, it is unlikely that this amendment would prevent attainment of ACS objectives in the Upper Cow Creek watershed.

UNF-3. Allows the PCGP to exceed restrictions on detrimental soil conditions in the project corridor.

Forest-Wide Soils Standard and Guideline #1 (LRMP IV-67), states:

> The combined total amount of unacceptable soil condition (detrimental compaction, displacement, puddling or severely burned) in an activity area (e.g., cutting unit, range allotment, site preparation area) should not exceed 20%. All roads and landings, unless rehabilitated to natural conditions, are considered to be in detrimental condition and are included as part of this 20%.

Degraded soil conditions may occur in the cleared project areas. On NFS lands in the Upper Cow Creek watershed, approximately 100% (74 acres) of the project right-of-way would be cleared. Degraded soil conditions may result from displacement and compaction following completion of project construction and rehabilitation. Compaction can largely be addressed by subsoil ripping, but displacement would be unavoidable because of the nature of the project. Existing LRMP Standards and Guidelines allow up to 20% of the project right-of-way, or 15 acres, to result in a degraded soil condition on completion of a project. Thus, the proposed amendment allows an estimated additional 59 acres or 0.24% of NFS lands in the watershed to be in a degraded soil condition on completion of the project.

Severe disturbances such as soil mixing or displacement would reduce long-term site productivity by displacing the duff layer and soil surface (A horizon), thus reducing the soil's ability to capture and retain water and nutrients. As a result, sites with long-term detrimental soil conditions may have interrupted hydrologic function and poor site productivity. Compacted and/or displaced soils may increase runoff and sediment transport and have lower rates of vegetative recovery.

Environmental consequences associated with 59 acres of additional detrimental soil conditions over the corridor in the Upper Cow Creek watershed include:

- **A potential localized increase in sediment mobilization.** Pacific Connector selected the route to avoid areas with a high probability of geologic hazards. No unstable or potentially unstable terrain has been identified that poses a threat to the project (GeoEngineers 2009). The project does cross earthflow terrains in the East Fork Cow Creek, but routing avoided areas of instability on the affected earthflow terrains (Hanek 2011, NSR 2014). To ensure that the project does not initiate instability or mobilize sediment, a site-specific supplement to the ECRP has also been prepared for this area. Erosion control measures associated with this plan include:

  (1) Within Riparian Reserves for all hydrologic features crossed by the pipeline between MPs 109 and 110, provide 100% post-construction ground cover on all disturbed areas. Wood fiber is the preferred material. In addition, construct effective waterbars at 50-foot intervals. These measures have two purposes: (a) preventing soil erosion and (b) preventing the mobilization of naturally occurring mercury found in this watershed.

  (2) At hydrologic features G, J, and K, ensure that erosion control measures are in place before the fall rains and monitor for rilling, gullying, and other forms of active erosion that may transport sediment into and deposit it in the aquatic environment. If rilling or gullying is occurring that may result in sediment transport and deposition into the aquatic environment, improve erosion control measures to preclude sedimentation.

  (3) Inspect the construction right-of-way for sedimentation after each significant storm event (which would be more frequently than for a bank-full event) or whenever there is a visual sediment plume downstream. If the sediment source is originating from the project right-of-way, improve erosion control measures to preclude sedimentation. An authorized agency representative would provide information to Pacific Connector regarding these events.

- As noted in the Upper Cow Creek watershed analysis, the East Fork Cow Creek already has a high background sediment load. As a result of the dispersal of effects due to the linear nature of the project, maintenance of effective ground cover, the required application of BMPs, and implementation of site-specific erosion control methods, it is highly unlikely that amending the UNF Forest Plan to exceed the soil disturbance thresholds would result in the mobilization of sediment that would change the existing balance of sediment mobilization and transfer or would exceed the natural range of variability in this watershed (NSR 2014) (see Section 1.3.1.1 for a general discussion of erosion control measures).

- **A potential localized increase in peak flows**. The Upper Cow Creek watershed analysis recommended site-specific evaluation of the potential for peak flows as a result of canopy removal. The PCGP would remove canopy on about 65 acres, or about 0.3%, of NFS lands in the watershed. Analysis by FERC showed that the project was highly unlikely to contribute to increases in peak flows because of the small proportion of the watershed affected by the project (see EIS Section 4.4). Additionally, all but approximately 1 mile of the project right-of-way lies on ridge-top locations that have minimal interactions with Riparian Reserves. The portion of the project in the East Fork Cow Creek that is not on ridge tops is unlikely to contribute to peak flows because hydrologic connectivity is minimized by recontouring slopes, decompacting soils, establishing effective ground cover, and other measures in the ECRP. Peak flows may increase in the TSZ where less than 75% of drainage is hydrologically recovered because of interactions of roads with stream crossings. Although the project area is in the TSZ, more than 85% of the NFS lands in the watershed are hydrologically recovered (Forest Service 1995a: 94 table 14), and the project affects less than 1% of the drainage. As a result, it is highly improbable that the project would change flow regimes from current conditions or from those described in the Upper Cow Creek watershed analysis.

- **A potential loss of site productivity, which may slow vegetative recovery.** Granitic and serpentine soils such as those found in the Upper Cow Creek watershed are typically low in productivity. Earthflow terrains such as those found in the East Fork Cow Creek (Umpqua National Forest Soil Type 25) are widely variable, depending on parent materials, but tend to have higher clay content and are generally more productive than granite and schist soils. Mechanically decompacting the soil to a minimum depth of 20 inches and reestablishing soil organic matter would be a critical first step in rehabilitating the soil toward a more natural condition. Soil rehabilitation would also require recovery of the soil biology, which requires restoration of the soil organic matter and time. The project would decompact the corridor, fertilize disturbed areas, reestablish native vegetation (limiting the area directly over the pipe to grasses and shrubs), and scatter slash and large woody debris back across the site to provide for long-term nutrient cycling as required in the ECRP. Additionally, the Forest Service may require soil remediation with biosolids or other organic material to augment soil productivity.

Off-site mitigation measures contribute to further reducing these watershed effects. Road decommissioning is planned on 2.12 miles (approximately 15 acres) in the South Fork Cow Creek sixth-field watershed as part of the mitigation plan for the PCGP project. Decommissioning roads reduces sediment by reestablishing effective ground cover and increasing infiltration. It also contributes to reducing peak flow effects by reducing road-stream interactions, increasing infiltration, and reestablishing natural drainage. These effects reduce compaction and help offset the estimated 22 acres of project right-of-way in the Upper Cow Creek watershed that may be in a degraded soil condition on completion of the project.

Based on this evaluation, it is unlikely that this amendment would prevent attainment of ACS objectives in the Upper Cow Creek watershed.

UNF-4. Re-allocates approximately 585 acres from Matrix to LSR.

Amendment UNF-1 transfers approximately 585 acres of Matrix land in the South Fork Cow Creek to LSR. The purpose of this amendment is to offset effects of the PCGP on the LSR land allocation; this re-allocation also benefits aquatic ecosystems.

Under this amendment, the Matrix lands re-allocated to the LSR land allocation would be managed for late successional and old-growth stand characteristics. LSRs are also an important component of the ACS. The standards and guidelines under which LSRs are managed provide increased protection for all stream types. Because the area selected for re-allocation to LSR has late-successional characteristics, it may offer core areas of high-quality stream habitat that act as refugia and centers from which degraded areas can be recolonized as they recover. This amendment contributes to meeting multiple ACS objectives in the Upper Cow Creek watershed.

Off-Site Mitigation Measures

Offsite mitigation is intended to provide supplemental actions for projects that cannot be completely mitigated with on-site design features in order to ensure land management objectives are achieved. These projects also contribute to the "Maintain and Restore" objectives of the ACS. The Forest Service and PCGP have entered into an Agreement in Principle to accomplish off-site mitigation work in the Upper Cow Creek watershed, as shown in table 2-33. Mitigation measures were developed from the recommendations of watershed analyses and assessments, late successional reserve assessments, and the 2008 Northern Spotted Owl Recovery Plan. Mitigation measures in the Upper Cow Creek watershed are focused on integrated projects that are intended to:

- Restore natural erosional/depositional processes by reducing sediment contributions from roads and potential high-intensity fire.
- Restore historic stand and fuel-density levels to selected stands.
- Restore elements of aquatic and terrestrial habitats.
- Restore access to aquatic habitats that are currently blocked by culverts.

TABLE 2-33

Off-Site Mitigation Measures in the Upper Cow Creek Watershed

Project	Amount	Rationale
Fish Friendly Passage	6 sites	Poor culvert design, erosion at outlets, and lack of maintenance have resulted in several road-stream crossings that block access to upstream aquatic habitats. Culvert replacements with fish-friendly designs would benefit fish and other aquatic biota by reconnecting habitats and reducing sediment contributions from these locations. This is responsive to ACS objectives 1, 2, 3, and 5.
Road Closure Road Decommissioning	1.2 miles 1 mile	Road density and lack of road maintenance were identified as major sources of sediment in the Upper Cow Creek Watershed Analysis. Decommissioning and closing roads may reduce road-related sediment contributions. This is responsive to ACS objectives 4 and 5.
Fuels Reduction -Shaded Fuel Break	683 acres 378 acres	Forest stands in the Upper Cow Creek watershed are often overstocked with unnaturally high fuel loads that make them susceptible to high-intensity fire. Stand-density fuel-reduction projects were designed to reduce fuel loading and stand density in overstocked, fire-prone stands to historic ranges to reduce the risk of high-intensity, stand-replacing fire. Since these types of fires can be a major cause of surface erosion and mass wasting in granite and schist soils, these projects contribute to reestablishing a natural sediment regime over time by reducing the probability of a large, high-intensity fire in this area. This is responsive to ACS objectives 1, 2, and 5,
Stand Density Management Commercial Thinning Precommercial Thinning	 197 acres 116 acres	Commercial thinning and precommercial thinning are intended to enhance LSOG habitat by increasing the growth, health, and vigor of the trees remaining in the stands and restoring stand density, species diversity, and structural diversity to those considered characteristic under a natural disturbance regime. The project will result in additional fragmentation and preclude the recovery of fragmented habitat for those stands adjacent to the pipeline corridor. Maintenance of the pipeline corridor will provide a continued vector for predators, early seral species, and non-native species. Also, the project will result in a direct loss in biological services provided by mature forest characteristics for many decades past the life of this project. Both mature stands and developing stands will be removed during pipeline construction. Density management of forested stands will assist in the recovery of late seral habitat,reduce impacts from fragmentation, reduce in edge effects, and enhance the resilience of mature stands. Accelerating development of mature forest characteristics will shorten the impacts of those biological services lost due to pipeline construction. Thinning of young stands is a recognized treatment within LRSs if designed to accelerate development of late-successional habitat characteristics (NWFP ROD C-12; ROD Pages B-11, ACS Objectives , C-11 and C-17).
Terrestrial LWD LSR Snag Creation Matrix Snag Creation	65 acres 90 acres 11 acres	Logging, fire suppression, and fuels treatments have reduced the numbers of snags and pieces of LWD in the Upper Cow Creek watershed. Portions of snag creation and terrestrial LWD projects in Matrix and LSR would occur within Riparian Reserves. This would contribute to ACS objectives for restoring snag levels and down wood to historic ranges in treated areas and is responsive to ACS objectives 1 and 8.
Matrix to LSR Land Reallocation	585 acres	The project crosses LSR acres in the Upper Cow Creek watershed. Matrix to LSR reallocation provides aquatic protections by managing upland areas for LSOG conditions. This is responsive to all 9 ACS objectives.

Figure 2-8 East Fork Cow Creek Culvert. This culvert currently blocks migration of fish and other aquatic biota. It would be replaced by a "fish-friendly" design as part of the mitigation plan proposed by Pacific Connector.

Cumulative Effects

Activities on NFS Lands

The Forest Service manages about 51% of the Upper Cow Creek watershed. Projects on NFS lands that would contribute to cumulative effects along with the project are shown in table 2-34.

TABLE 2-34

Umpqua National Forest Projects That Contribute to Cumulative Effects along with the PCGP in the Elk Creek South Umpqua Watershed

Unit	Fifth-Field Watershed	Sixth-Field Watershed	Project Name	Project Description	Resource
UNF	Upper Cow Creek	South Fork Cow Creek	Proposed Tiller Aquatic Restoration Project. Published in program of work 2010. NEPA analysis on going. Implementation in 2013.	1 culvert replacement	Riparian vegetation, road network, fisheries/aquatic habitat, water quality
UNF	Upper Cow Creek	South Fork Cow Creek	Current grazing	7,757 ac. Cattle grazing	Upland and riparian vegetation, fisheries/aquatic habitat, water quality

These activities are expected to be consistent with the Standards and Guidelines and objectives of the Umpqua National Forest LRMP.

Activities on Private Lands

Private lands comprise about 28% of the Upper Cow Creek watershed. Private lands in the watershed are expected to be managed according to current land use patterns consistent with the Douglas County General Plan and existing federal and state statutes, including the Oregon Forest Practices Act and the Clean Water Act. Approximately 270 acres of clearcut timber harvest are currently anticipated in the Dismal Creek subwatershed of the Upper Cow Creek watershed. The Pacific Connector route is on a ridge top in the Dismal Creek subwatershed.

Cumulative Effects

The project comprises about 0.3% of NFS lands and 0.11% of private lands in the Upper Cow Creek watershed (table 2-23). The small proportion of the landscape affected by the project; ongoing land management on private lands; the regulatory framework between the BLM, ODWQ, and ACOE applicable to the project; and project location and routing make it highly unlikely that the portion of the project on federal lands, when considered with other past, present, and reasonably foreseeable future actions, would change watershed conditions in the Upper Cow Creek watershed in any significant, discernable, or measurable way. See also EIS Chapter 4.14.

Project Effects Compared by ACS Objectives

Table 2-35 evaluates project effects against each of the ACS objectives. NFS lands where the ACS applies comprise about 51% of the Upper Cow Creek watershed. Timber harvest and removal of LWD from creek channels have reduced the structural complexity of the aquatic habitat and its ability to retain sediments. Chronic, fine-grained sediment deposition, primarily related to roads, has negatively affected aquatic habitats. The presence of roads has segregated some stream reaches from upslope habitats that are needed for replenishment of LWD.

Through application of BMPs and the FERC Wetland and Waterbody Plan, sediment transport would be minimized, the physical integrity of riparian and instream areas would not be compromised, and instream flow regimes would be maintained. No riparian-related Survey and Manage species would be affected by project construction and operation.

TABLE 2-35

Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Upper Cow Creek Watershed

ACS Objective	Project Impacts
Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.	Riparian Reserves are watershed-scale features that would be affected by the project. There would be four perennial and two intermittent stream crossings in the South Fork Cow Creek subwatershed. [Note that Hydrofeature N at MP 111.01 is a perennial stream but, because of an upstream diversion, it is dry in the summer. It is counted here as an intermittent stream since that it is its current condition]. One small shrub-dominated wetland is also crossed. Riparian Reserves associated with1 perennial stream and 6 forested wetlands are clipped. The project right-of-way is located primarily in early or mid seral forests and largely on or near ridge tops to minimize impacts on aquatic habitats. The project right-of-way would affect 73.76 acres or about 0.31% of NFS lands in the Upper Cow Creek watershed and about 10.06 acres or 0.13% of the Riparian Reserves within the watershed. Impacts to aquatic systems are expected to be short-term and minor and limited to the project scale because of application of BMPs and erosion control measures. LWD cleared in construction of the corridor would be used to stabilize and restore stream crossings. Off-site mitigation measures including road decommissioning and installation of fish-friendly culverts are expected to improve watershed conditions in the Upper Cow Creek watershed (p. 2-89-90; table 2-33). While there are long-term changes in vegetation in Riparian Reserves from construction clearing of the corridor, these would be minor in scale and well within the range of natural variation given the disturbance history of the Upper Cow Creek watershed (p. 2-70-83).
Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life-history requirements of aquatic and riparian-dependent species.	The project is not expected to affect spatial or temporal connectivity in the Upper Cow Creek watershed except during the construction period because the pipeline would be buried in all aquatic habitats crossed, consistent with the requirements of the Wetland and Waterbody Crossing Plan. In the short-term, connectivity would be disrupted during construction. At each crossing, the corridor would be narrowed down to 75 feet wide. Bed and bank disturbances associated with equipment and trenching are small (<15 feet wide). After construction, all disturbed areas would be returned to their approximate original contours to restore preconstruction contours and drainage patterns. The temporary construction right-of-way would be restored and revegetated with native grasses, forbs, conifers, and shrubs, as outlined in the ECRP. After construction, key habitat components such as LWD and boulders would be restored onsite and the bed and banks would be returned to preconstruction conditions. By implementing these measures, lateral and longitudinal connectivity at the site scale would be maintained, although in the short-term during construction, connectivity may be disrupted. With the exception of a few days during the construction of the crossing, access to areas necessary for life-histories of aquatic- and riparian-dependent species would not be obstructed. By restricting stream crossing operations to the ODFW in-stream work window, possible impacts to sensitive life stages of aquatic biota would be minimized. Connectivity would be improved by installation of fish-friendly culverts at six sites that currently preclude passage of aquatic organisms (see table 1-14, p. 2-89-91). The residual levels of disturbance are anticipated to be well within the range of natural variability in the Klamath–Siskiyou Province.
Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.	Impacts to the beds and banks of aquatic features would be minor and limited to the site of construction because the pipeline would be buried, and the actual area of bank and stream bottom disturbance associated with equipment crossing and trenching is small at each crossing (<15 feet wide). After construction, key habitat components such as LWD and boulders would be restored onsite and the beds and banks would be returned to preconstruction conditions, consistent with the POD requirements. By implementing these measures, the physical integrity of the aquatic system at the site scale would be maintained, although in the short-term (during construction), elements of the aquatic system could be disturbed. This level of disturbance is well within the range of natural variability for the watersheds of the Klamath-Siskiyou Province.

TABLE 2-35

Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Upper Cow Creek Watershed

ACS Objective	Project Impacts
Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.	Mercury from abandoned mercury mines in the South Fork Cow Creek subwatershed is a known issue. Broeker (2010b) and GeoEngineers (2013) assessed the potential risk of release of mercury from disturbance of affected sediments. Mercury concentration of 0.29 parts per million (ppm)), which is in exceedance of the ODEQ threshold of 0.1 ppm, was detected in soil and stream sediment samples at one site. Special measures including maintenance of 100% effective ground cover have been adopted as recommended by ODEQ. As a result, the presence of inorganic mercury is not anticipated to cause any health risk. Minor amounts of sediment would be mobilized during construction, particularly during the dry open-cut and dam and pump crossing of the East Fork Cow Creek and its perennial tributaries (GeoEngineers 2013). Water quality impacts from sediment are expected to be short-term and limited to the general area of construction (section 1.4.1.2). No long-term impacts on water quality are expected because of application of the ECRP, including maintenance of effective ground cover (Section 1.4.1 and previous discussion) and BMPs during construction. Approximately 3.1 total acres of effective shading vegetation would be removed at four perennial stream crossings. A site-specific shade analysis conducted by Pacific Connector (NSR 2009, NSR 2014) showed minor temperature increases were possible at the project scale but no impacts would occur beyond the immediate area of construction; there were no temperature impacts at the stream-network scale. Water quality is expected to remain within the range that supports aquatic biota.
Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.	The Upper Cow Creek watershed sediment regime was historically characterized by pulse-type disturbances (Forest Service 1995, Everest and Reeves 2007). The East Fork Cow Creek, a drainage in the South Fork Cow Creek subwatershed, is characterized in the Cow Creek watershed analysis as being "in balance" for sediment transport and deposition. The project is not likely to alter these conditions. Eighty percent (3.73 of 5.27 miles) of the project in the Upper Cow Creek watershed is on ridge tops with little or no aquatic connectivity. Site-specific field reviews by geologists show the project is unlikely to cause landslides or activate currently stable earth-flow terrains because unstable areas have been avoided (GeoEngineers 2009, Hanek 2011, Stantec 2013). Surface erosion and sediment transport to streams would be minimized because the project would maintain 100% effective ground cover, effective sediment barriers, and other erosion control measures as needed (see the sediment discussion at the beginning of this section). Sediment generated during construction is expected to be minor and to be limited to the general area of construction by the use of dry dam-and-pump measures that isolate the crossing from flowing water during construction (section 1.3.1). The project is not expected to alter the balance of sediment transport and storage in the East Fork Cow Creek. The project is not expected to alter either the pulse-type disturbance or surface erosion sediment regimes of the Upper Cow Creek watershed (Section 1.4.1.2). A pulse of sediment could be observed following the first seasonal rain, but this is likely to dissipate within a few hundred feet and would be indistinguishable from background levels.
Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.	Instream flows would be interrupted for a short time during installation of dams during dam and pump crossings. The area of construction that is between upstream and downstream dams would be dewatered during the actual crossing construction. During construction, water would be pumped around the construction site to maintain downstream flows. It is possible that there would be local increases in runoff from canopy removal but, at the watershed scale, flow regimes would not be altered by the project because of the small scale of the project relative to the watershed, the relatively high proportion (85%) of the watershed that is hydrologically recovered, and the lack of connectivity of most of the route to any stream network. See the discussion of peak flow processes on p. 2-70-83 for additional information.

TABLE 2-35 **Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Upper Cow Creek Watershed**	
ACS Objective	**Project Impacts**
Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.	The project right-of-way clips the Riparian Reserve of six forested wetlands and crosses one delineated wetland. Trench plugs would be installed on each side of these wetlands as needed to block subsurface flows and maintain water table elevations, as required by FERC's Wetland and Waterbody Construction and Mitigation Procedures. Regardless, project construction may have short-term impacts on water tables in these isolated forest wetlands. These site-specific impacts would be minor (i.e., limited to the general area of construction) and are not connected to larger wetland areas; they may also be regulated under Section 404 of the Clean Water Act. By restricting crossings to the dry season (July 1 to Sept. 15), possible impacts on water tables of these wetland areas are expected to be minor and short-term.
Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation; nutrient filtering; and appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse, woody debris sufficient to sustain physical complexity and stability.	Project impacts on riparian vegetation in the Upper Cow Creek watershed would be minor. In the short term, all vegetation would be removed from the project right-of-way. About 4.45 acres of the Riparian Reserves to be cleared in the project right-of-way are LSOG (table 2-25). Existing herbaceous and brush cover would be maintained in Riparian Reserves to the extent practicable. Overall, project construction would affect ~0.13% of the Riparian Reserves in the watershed (table 2-25). Following construction, replanting with native species would facilitate reestablishment of vegetation communities. LWD and boulders from the corridor would be returned to disturbed riparian areas. These restoration efforts, along with the limited impacts to which they are directed, would maintain and restore biological and physical functions of the Riparian Reserves in the watershed.
Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.	Project impacts on riparian vegetation in the Upper Cow Creek watershed would be minor (10.06 acres, or 0.13%, of the Riparian Reserves in the watershed) (table 2-25). Existing herbaceous and brush cover within the project clearing limits would be maintained to the extent practicable. Consistent with the requirements of the POD, LWD and boulders removed from the corridor during construction would be replaced to restore and stabilize channel crossings. Revegetation would be accomplished using native riparian species. The persistence of riparian-dependent Survey and Manage species would not be threatened by project construction and operation in the watershed. See Appendix F5.

Summary

The South Fork Cow Creek subwatershed has four perennial stream crossings within 1 mile. This is the highest number of perennial stream crossings in one subwatershed on NFS lands. Construction of the project in the Upper Cow Creek watershed has a high potential for impacts that could prevent attainment of ACS objectives, particularly as related to sediment, water temperature, and mobilization of naturally occurring mercury (see p. 2-70-84. The project has addressed these issues as follows:

- **Project Routing—**Approximately 80% of the route in the Upper Cow Creek watershed is on a ridge top with little or no connectivity to aquatic habitats or Riparian Reserves. Between MPs 109 and 110 in the South Fork Cow Creek subwatershed, the route has been selected and modified to avoid potentially unstable areas. The Forest Service has participated extensively in routing of the project and concurs that the location is unlikely to trigger mass wasting or excessive surface erosion.

- **Implementation of Water Quality Best Management Practices—**A site-specific BMP implementation plan based on construction impact and site-response risk has been prepared that is expected to maintain water quality (GeoEngineers 2013c). Within Riparian Reserves for all hydrologic features crossed by the pipeline between MPs 109 and 110, the project would provide 100% post-construction ground cover on all disturbed areas. Wood fiber is the preferred material, supplemented as needed by biosolids. In addition, the project would construct water bars at 50-foot intervals. Other erosion control measures would be used as needed to prevent surface erosion associated with stream crossings or to prevent sediment transport and deposition that may affect riparian systems.

- **Mitigation of Potential Impacts on Stream Temperature**—A temperature analysis on perennial stream crossings showed the project may have minor temperature impacts (~0.1°C) at the project scale (NSR 2009, NSR 2014). Although the analysis showed there would be no impact at the next downstream reach below the crossings because of ground water discharge, flow volumes, and existing shade, the project would transplant larger conifers to riparian areas and use logs and slash to provide shade at perennial crossings in the East Fork Cow Creek to mitigate for temperature impacts at the project scale. Temperatures are expected to remain below those specified by the State of Oregon for streams in the Umpqua Basin.

- **Mercury--** The Forest Service contracted with a geologist consultant to collect soil and stream sediment samples for analytical testing and reporting of mercury and other naturally occurring minerals along a 2,000-foot section of the proposed pipeline route between MP 109 and the East Fork Cow Creek (Broeker 2010b, GeoEngineers 2013e). Geochemical analysis of the soil and stream sediment samples showed very low to nominal concentrations of naturally occurring mercury mineralization. The mercury level at one of the stream sediment sites was 0.29 ppm, which was above the Level II screening level value of 0.1 ppm for invertebrates (ODEQ 1998, cited in GeoEngineers 2013d). In order to prevent this naturally occurring mercury from mobilizing during and after construction, additional erosion control measures and monitoring would be conducted at these sites. The proposed pipeline construction activities by Pacific Connector within the East Fork Cow Creek subwatershed are not anticipated to disturb or expose soils and bedrock strata that contains more than low amounts of natural occurring mercury mineralization, and any sediment that is generated is not likely to reach the aquatic environment due to implementation of short-term and permanent mitigation measures outlined in Pacific Connector's ECRP and as listed in GeoEngineers 2013e.

There are approximately 7,849.12 acres of Riparian Reserves (NFS lands only) in the Upper Cow Creek watershed, of which approximately 3,313.66 acres are LSOG. Approximately 10.06 acres of Riparian Reserves, or 0.13% of the Riparian Reserves on NFS lands in the watershed, would be cleared (table 2-24). Of this amount, approximately 4 acres are LSOG (table 2-25), which is about 0.13% of the LSOG in Riparian Reserves on NFS lands in the Upper Cow Creek watershed. Early and mid seral forest vegetation constitutes the remaining 10.79 acres of the affected Riparian Reserve vegetation. LSOG and mid seral vegetation (approximately 14.2 acres) cleared in the corridor would be a long-term, but minor in scale, change in vegetation that is within the range of natural variability for the Upper Cow Creek watershed considering its history of disturbance from stand-replacing fire and subsequent landslides (see p 2-70-83.). Federal lands are currently 35.20% LSOG and exceed minimum watershed thresholds for LSOG forest after consideration of PCGP impacts (see p. 2-56).

Several site-specific proposed amendments to the Umpqua National Forest LRMP are required to make provision for the Pacific Connector project. These proposed amendments are not expected to prevent attainment of the ACS in the Upper Cow Creek watershed (see p. 2-83; Table 2-32). These proposed amendments are as follows:

- Proposed amendment UNF-1 would allow removal of effective shade on perennial streams. This amendment would not prevent attainment of the ACS objectives because a site-specific temperature assessment (NSR 2009, NSR 2014) showed that any temperature increase resulting from removal of effective shade would be minor and would be limited to the point of maximum impact at the site of construction.

- Proposed amendment UNF-2 would allow the Pacific Connector corridor to run parallel to an existing stream within the riparian zone. The amendment would not prevent attainment of ACS objectives because an uncut buffer 30 to 60 feet wide remains between the corridor and the East Fork Cow Creek. An estimated 94% of the effective shade is maintained adjacent to the East Fork Cow Creek, erosion control measures specified in the ECRP are expected to be effective at controlling surface erosion, and LWD would not be removed from the stream. Sources of LWD would remain on both sides of the channel.

- Proposed amendment UNF-3 would allow the project to exceed limits on detrimental soil conditions within the construction corridor. This would not prevent attainment of ACS objectives because soil decompaction and remediation required in Riparian Reserves are expected to effectively moderate detrimental soil conditions. Implementation of measures in the ECRP is expected to effectively control surface erosion and restore native vegetation. (see DEIS section 4.3.4).

- Proposed amendment UNF-4 would reallocate approximately 588 acres from the Matrix land allocation to the LSR allocation. This would benefit aquatic habitats because this area would be managed for late-successional stand conditions that provide additional aquatic protections.

- Proposed amendment of the Umpqua National Forest LRMP to waive protection measures for Survey and Manage species would not prevent attainment of ACS objectives because the project does not threaten the persistence of any riparian-dependent species (see Appendix F5).

The routing of the project through NFS lands, coupled with the relatively small area of NFS land affected by project construction (73.76 acres, or 0.31%, of the NFS lands in the fifth-field watershed – table 2-23), makes it highly improbable that project impacts could affect watershed conditions. Although there are project-level impacts (e.g., short-term sediment and a long-term change in vegetative condition at stream crossings), these would be minor in scale and largely limited to the boundaries of the project area (see Section 1.4.1.2).

No project-related impacts that would prevent attainment of ACS objectives have been identified (see Section 2.4.6.8). All relevant project impacts are within the range of natural variability for watersheds in the Oregon Cascade Mountains and Klamath Mountains, although some of these processes have been altered from their natural condition (see p 2-70-84).

2.2.2 Rogue River Basin

2.2.2.1 Geographic Setting

The Rogue River Basin encompasses parts of four provinces: the High Cascades (14%), Western Cascades (16%), Klamath-Siskiyou (56%), and Coast Range (1%). The Rogue River's largest tributaries, the Applegate and Illinois Rivers, are predominantly within the Klamath-Siskiyou Province[15]. The four provinces reflect unique ecosystem and geologic conditions. Basin biota are tied to the geology which influences the province ecosystem. Geologic histories and conditions result in distinct ecosystem characteristics such as basin relief, drainage density, erosion processes, and soil/rock permeability. These are collectively also relevant to sediment yield and transport.

The headwaters of the Rogue River Basin (including most of the basin east of the confluences of the South Fork, Middle Fork, and mainstem Rogue River) are within the High Cascades Province. The High Cascades Province is underlain by highly permeable Pliocene and Quaternary lava flows that have low rates of surface water runoff and sediment transport. The parts of the Rogue River Basin within this province include the western slopes of Crater Lake, which is the remnant of a large Quaternary-age stratovolcano that erupted cataclysmically about 7,700 years ago and blanketed parts of the Rogue River's headwaters with thick tephra and pyroclastic flow deposits (USGS 2012). The Dead Indian Plateau in the eastern portion of the Little Butte Creek fifth-field watershed is typical of this landscape. In the central to eastern part of this province are the High Cascades, which are younger volcanic composite (stratovolcano) volcanoes and associated cinder cones overlying the older Western Cascades, which are exposed in the western part of the province. The older, more heavily eroded Western Cascades are now thought to be part of a mountain range with the southern portion being the Sierra Nevada. Under this hypothesis, the cessation of volcanism in the Western Cascades and Sierra Nevada occurred with the initiation of the San Andreas Fault, the creation of the Mendocino Triple Junction point, and the consumption of the Farrallon Oceanic Plate. Volcanism in the modern High Cascades is from the subduction of the Pacific Oceanic Plate.

In the western part of the Rogue River watershed is a 20-kilometer- (12.5-mile-) wide band running north-south between the upstream confluence of the mainstem and the South Fork Rogue River and the downstream confluence of the mainstem and Trail Creek. This part of the province is underlain by Tertiary volcanic and volcanoclastic rocks that are typically weathered and highly dissected and, thus, are susceptible to high rates of runoff and mass wasting processes. The remainders of the Trail Creek and the western portion of Little Butte Creek fifth-field watersheds lie within the Klamath-Siskiyou Province.

2.2.2.2 Climate and Hydrology

Within the Rogue River Basin, only the Upper Rogue River Subbasin is crossed by the project. Streamflow in the Upper Rogue River Subbasin is driven by seasonal precipitation that typically falls in winter as snow in the upper basin near Crater Lake and as rainfall and occasional snow

[15] Provinces discussed in this document are based on both ecological and geological conditions and therefore do not match those recognized by the Oregon Department of Geology and Mineral Industries and the Oregon State Board of Professional Geologists and Geophysicists. The Klamath-Siskiyou Province is known by professional geologists as the Klamath Mountains Province and the Western Cascades and the High Cascades are two mountain ranges within the Cascades Mountains Province. See https://www.oregongeology.org/learnmore/geologicsightseeing.htm

below 4,000 feet. Peak flows on the mainstem Rogue River typically derive from winter frontal systems, with the largest flows resulting from regional rain-on-snow events. From July to October, base flows are sustained by groundwater contributions from the Upper Rogue River Subbasin and occasional precipitation events. Pumice soils from the composite volcanoes and especially the cinder cones of the High Cascades Province tend to have high infiltration rates and are easily eroded when saturated. Low-gradient pumice plateaus tend to have a large storage capacity. Older, more-developed soils in the Cascades Province have lower infiltration rates but tend to be thin, with little water-holding capacity. This is also true with soils where the basin is in the Klamath-Siskiyou Province. As a result, streams tend to be "flashy" and respond rapidly to storm events.

TMDL thresholds and a Water Quality Restoration Plan (WQRP) were established for temperature and other pollutants for the Rogue River Basin in 2008 (https://www.oregon.gov/deq/FilterDocs/rogueChapter1andExecutiveSummary.pdf).

2.2.2.3 Trail Creek Fifth-Field Watershed HUC 1710030706

Overview

The Trail Creek fifth-field watershed is located in southwestern Oregon between Medford and Crater Lake National Park. It is one of eight fifth-field watersheds in the 2,618-square-mile Upper Rogue River Subbasin. The watershed lies north and west of the Rogue River and extends upslope to the divide with the South Umpqua River Basin to the north. Below the confluence of Trail Creek with the Rogue River (at the town of Trail), the Rogue River turns south and traverses the Shady Cove–Rogue River fifth-field watershed. Upon leaving the Shady Cove–Rogue River watershed, the Rogue River turns westward and flows through the Rogue River–Siskiyou National Forest (RRNF) and the Klamath Mountains to the Pacific Ocean at Gold Beach, Oregon, about 32 miles from the border with California. The entire Rogue River drainage basin is about 132 miles wide (east to west). See figure 1-1 for the regional setting of this watershed and its relationship to the other fifth-field watersheds traversed by the project right-of-way.

Most of the watershed lies in Jackson County, although the northernmost portion lies in Douglas County. The towns of Trail and Shady Cove (population approximately 3,276 [U.S. Census Bureau 2016]) are within or adjacent to the watershed. Oregon State Highway 227 passes through the center of the Trail Creek Basin. Approximately 12.3% of the land in the watershed is in the Umpqua National Forest, and 41.6% is managed by the BLM Medford District. The rest (46.1%) is in non-federal ownership. Logging and agriculture dominate human land use in the watershed.

The Trail Creek watershed lies predominantly within the Western Cascades Province, although some lands in the southern portion of the watershed are more representative of the Klamath-Siskiyou Province. The entire Trail Creek watershed is formed from Tertiary Period (1.6 to 66 million years before present) volcanoclastic rocks deposited as lahars (volcanic mudflows) and pyroclastic rocks (supraheated ash flows) on a nearly flat to gently sloping landscape. Weathering processes in the northern part of the watershed and higher elevations have resulted in rugged topography, with irregular ridges and deep narrow valleys. Gentle to moderate slopes predominate in the southern and lower elevations of the watershed, with slope steepness generally increasing with increasing elevation to the north.

Elevations on the Trail Creek watershed range from a low of 1,436 feet at the town of Trail, where Trail Creek empties into the Rogue River, to 4,698 feet at Threehorn Mountain, located on the northern margin of the watershed along the divide that separates the Rogue and Umpqua river basins. Much of the northern divide and adjoining western and eastern margins of the watershed exceed 4,000 feet in elevation.

The 55.2-square-mile (35,338-acre) Trail Creek watershed includes three subwatersheds (figure 2-9, table 2-36). The West Fork and Upper Trail Creek subwatersheds occupy most of the watershed, while the Lower Trail Creek subwatershed occupies the southernmost portion of the watershed. The watershed is bounded on the north by the Elk Creek–South Umpqua River and Upper Cow Creek fifth-field watersheds of the South Umpqua Subbasin, by the Elk Creek–Rogue River fifth-field watershed on the east, the Shady Cove–Rogue River fifth-field watershed on the southeast and south, and the Evans Creek fifth-field watershed of the Middle Rogue River Subbasin to the west. Headwater areas are dominated by dendritic drainage patterns with first- and second-order streams comprising the majority of the stream miles.

The watershed experiences a Mediterranean-type climate characterized by wet, mild winters, hot, dry summers and a long frost-free period. Mean annual precipitation is about 40 inches and is lowest near the confluence of Trail Creek and the Rogue River and generally increases to the north and with increasing elevation. Approximately 70% of the annual precipitation in the watershed falls in the five months of November through March. Lightning storms are common and contribute to extreme fire dangers.

Streamflow patterns reflect the distribution of precipitation, with lows in the summer and high flows beginning in late fall and peaking in winter. Most of the watershed is in the TSZ, where total to partial snow melt during warm mid-winter rain-on-snow events are associated with nearly all major peak flows.

Figure 2-9 shows the contiguous nature of NFS lands (found largely in the northwest corner of the watershed) and the allocation status of these lands. NFS lands are found only in the Upper Trail Creek and West Fork Trail Creek subwatersheds, where they are similarly represented (2,225 acres and 2,127 acres, respectively). Together, they constitute 12.3% of the land in the watershed. Approximately 46.1% of the land in the watershed is privately owned (table 2-36).

Location and Routing

At MP 111.10, the project right-of-way crosses over the divide separating the Umpqua River drainage from the Rogue River drainage and moves into the Trail Creek fifth-field watershed (figure 2-9). Once in the Trail Creek watershed, the corridor runs in a south-southeast direction along the ridge tops that form the divide between the West Fork Trail Creek and Upper Trail Creek subwatersheds. Along this segment, the corridor runs alternately on both sides of the divide. At MP 118.36, the corridor leaves the subwatershed divide and runs south across the southeast corner of the West Fork Trail Creek subwatershed, over the divide separating the West Fork Trail Creek and Lower Trail Creek subwatersheds, and across the Lower Trail Creek subwatershed (mainly on private land). The corridor exits the Trail Creek watershed at MP 121.77, passing into the Shady Cove–Rogue River fifth-field watershed to the south.

Within the Trail Creek watershed, the project traverses a total of 10.68 miles, with 2.39 miles in the Lower Trail Creek subwatershed, 4.67 miles in Upper Trail Creek subwatershed, and 3.62 miles in West Fork Trail Creek subwatershed. On NFS lands, the project right-of-way travels 2.09 miles, which includes 1.41 miles in Upper Trail Creek subwatershed and 0.68 mile in West Fork Trail Creek subwatershed (table 2-37). Most of the traversed land is in the TSZ, where land clearing may contribute to elevated peak flow conditions during warm rain-on-snow events.

The project is in the Umpqua National Forest from MP 111.10, where it enters the watershed, to MP 113.2. This segment of the project lies on a ridge top between the West Fork of Trail Creek and the Upper Trail Creek subwatersheds. The project right-of-way (cleared and modified project areas) on the Umpqua National Forest occupies approximately 50.27 acres, of which approximately 20.48 acres are in the Upper Trail Creek subwatershed and 29.79 acres are in the West Fork Trail Creek subwatershed (table 2-37). From MP 113.2 to 121.77, the project crosses interspersed private lands forming a checkerboard with and BLM lands. There are no designated LSRS[16] on NFS lands in the Trail Creek watershed. Approximately 415.86 acres of unmapped LSRs are associated with KOACs[17]; however, none of the LSRs are affected by the project.

Project effects in the Trail Creek watershed on all ownerships total 220.90 acres (table 2-37). These affected acreages include 50.27 acres of NFS land (41.28 acres cleared and 8.99 acres modified and constituting 1.15% of the NFS lands in the watershed). All NFS lands within the project corridor are in the Matrix[18] or Riparian Reserve land allocation (table 2-38). There are several stream crossings on BLM or private lands but no streams or waterbodies are crossed on NFS lands. Approximately 50.27 acres of Matrix land would be affected in the Trail Creek watershed, including 41.28 acres cleared and 8.99 acres modified. No Riparian Reserves are affected within the Trail Creek watershed.

[16] Late Successional Reserves (LSR) values only apply to NFS lands.
[17] Known Owl Activity Centers (KOACs) only apply to NFS lands.
[18] Matrix is a NFS land allocation

Figure 2-9 PCGP Routing and Subwatershed Boundaries, Trail Creek Fifth-Field Watershed

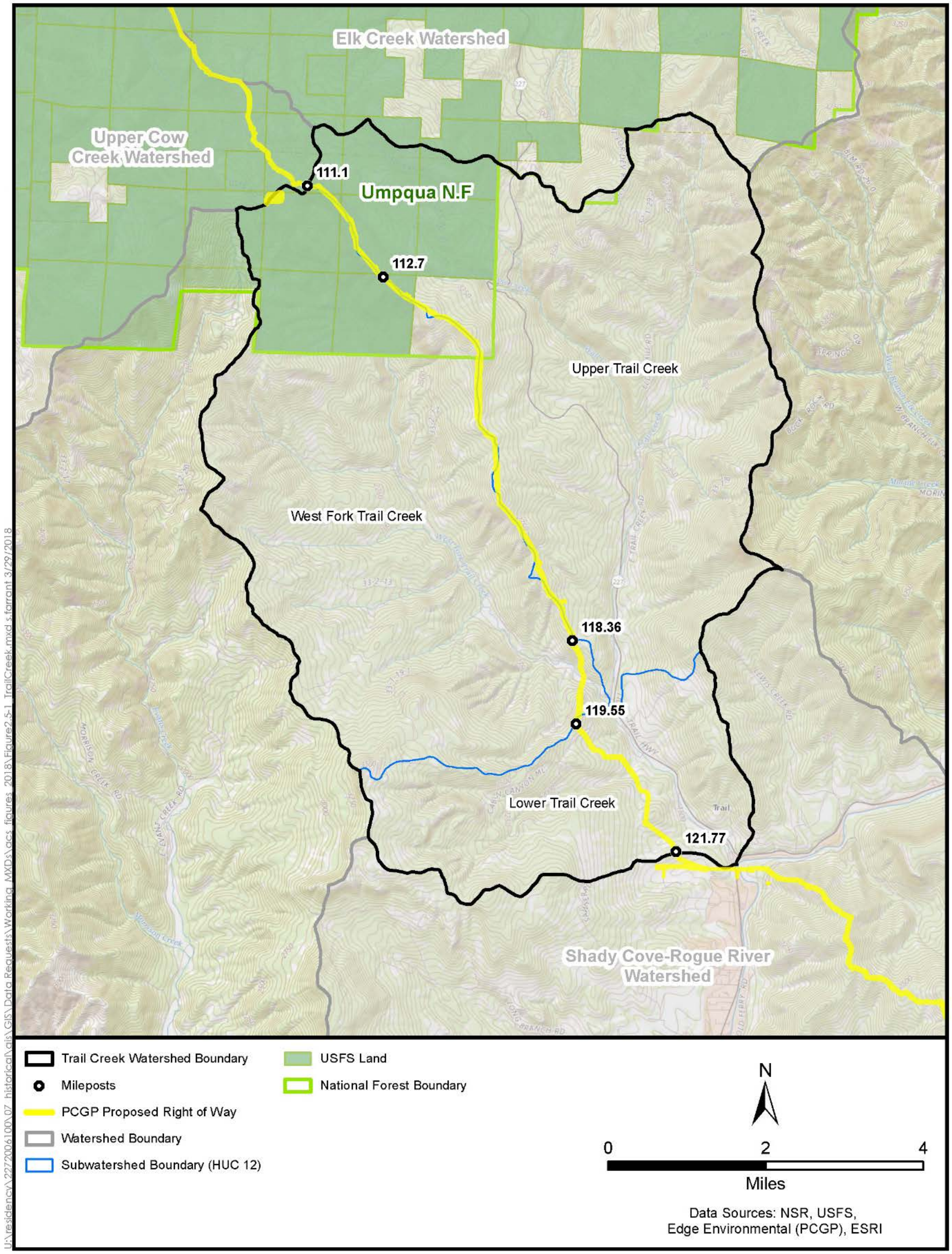


TABLE 2-36

Land Ownership and Forest Service Land Allocations (acres) in Trail Creek Fifth-Field Watershed (HUC 1710030706)

	Land Ownership (acres)					Forest Service Land Allocation (acres)		
Sixth-Field Watershed	**Sixth-Field Watershed (acres) a/**	**NFS Land**	**BLM**	**Total NFS and BLM**	**Other**	**LSR**	**Riparian Reserves b/**	**Matrix**
Lower Trail Creek	5,534.07	0.00	2,374.75	2,374.75	3,159.32	0.00	0.00	0.00
Upper Trail Creek	15,493.67	2,225.61	7,551.61	9,777.22	5,716.45	0.00	633.83	2,120.14
West Fork Trail Creek	14,309.95	2,127.64	4,774.99	6,902.63	7,407.32	0.00	733.19	1,807.01
Watershed Total	**35,337.69**	**4,353.25**	**14,701.35**	**19,054.60**	**16,283.09**	**0.00**	**1,367.02**	**3,927.15**

a/ All data derived from Stantec-based GIS layers.
b/ May occur within other NFS land allocations.

TABLE 2-37

Project Corridor (miles) and Project Area (acres) in Trail Fifth-Field Watershed (HUC 1710030706) by Land Ownership

	Land Ownership							
	NFS Lands				Entire Sixth Field Watershed			
		Project Area (acres)				Project Area (ares) b/		
Sixth-Field Watershed a/	**Corridor Length (miles)**	**Cleared**	**Modified**	**% of NFS Land Impacted**	**Corridor Length (miles)**	**Cleared**	**Modified**	**% of Sixth-Field Watershed Impacted**
Lower Trail Creek	0.00	0.00	0.00	0.00	2.39	31.24	6.91	0.11
Upper Trail Creek	1.41	16.87	3.61	0.47	4.67	58.49	21.22	0.23
West Fork Trail Creek	0.68	24.41	5.38	0.68	3.62	74.65	28.39	0.29
Watershed Total	**2.09**	**41.28**	**8.99**	**1.15**	**10.68**	**164.38**	**56.52**	**0.63**

a/ All data derived from Stantec-based GIS layers
b/ Includes NFS, BLM, and other ownerships

TABLE 2-38

Project Area (acres) on NFS Lands in the Trail Creek Fifth-Field Watershed (HUC 1710030706) by Land Allocation

	Designated LSR b/				Matrix				Riparian Reserves b/			
	Project Area (acres)		% of Total LSR on NFS Land		Project Area (acres)		% of Total Matrix on NFS Land		Project Area (acres)		% of Total Riparian Reserves on NFS lands c/	
Sixth-Field Watershed a/	**Cleared**	**Modified**	**Cleared**	**Modified**	**Cleared**	**Modified**	**Cleared**	**Modified**	**Cleared**	**Modified**	**Cleared**	**Modified**
Lower Trail Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upper Trail Creek	0.00	0.00	0.00	0.00	16.87	3.61	0.80	0.17	0.00	0.00	0.00	0.00
West Fork Trail Creek	0.00	0.00	0.00	0.00	24.41	5.38	1.35	0.30	0.00	0.00	0.00	0.00
Watershed Total	0.00	0.00	0.00	0.00	**41.28**	**8.99**	**1.05**	**0.23**	**0.00**	**0.00**	**0.00**	**0.00**

a/ All data derived from Stantec-based GIS layers.
b/ Includes mapped and unmapped LSR on NFS lands.
c/ Riparian Reserve acres overlap with LSR and Matrix land allocations.

Existing Conditions

Original Watershed Assessment Findings

The BLM completed the watershed assessment for the Trail Creek watershed in 1999 (BLM 1999b). Past activities on NFS lands are listed in table 2.39. Watershed conditions are as follows:

- Road density in the watershed (all ownerships) is about 3.4 miles of road per square mile. Road density for NFS lands only is not specified.
- Soils in the Trail Creek watershed are subject to erosion where exposed and compacted or puddled with associated destruction of internal macro-porosity, leading to surface runoff. Delivery of sediment to streams is a concern, particularly on steep slopes. Due to their high clay content, road surfaces have poor bearing strength when wet, and unsurfaced roads are subject to rutting, concentration of surface flows, and delivery of sediment to streams. Debris flows and debris torrents, however, were not observed on aerial photos dating from 1966, suggesting that Trail Creek and its tributaries are not as susceptible to this type of disturbance as other channels in the Cascades.
- Deep-seated landslides and earthflows are common in the Trail Creek watershed. Earthflows have plastic silt and clay soils formed from volcanic parent materials that underlie the entire watershed. Deep-seated landslide movements are associated with climatic shifts and fluvial undercutting of the landslide toes. Prior to European settlement, these deep-seated landslides usually moved during wet periods of the Holocene and Anthropocene Epochs and remained stable during drier periods.
- A defining characteristic of the Trail Creek watershed is that response reaches contain very little wood and coarse sediment, which are critical for formation of quality fisheries rearing and spawning habitat.
- All subwatersheds in the Trail Creek watershed, as well as the watershed as a whole, have predicted increases in peak flows of less than 10% for both the average and unusual storm simulations. Therefore, all subwatersheds have been assigned a low sensitivity to peak flow increases.
- Roads are the single greatest source of management-related delivered sediment in the watershed.

TABLE 2-39

Past Activities on NFS Lands in Trail Creek Watershed since Publication of the Trail Creek Watershed Assessment, June 1999

Name	Activity Type	Dates	Total Acres/Miles	Location
Cattle Grazing	Cattle grazing	1999–2012	4,230 ac	Upper and West Fk. Trail (6th)
Reforestation	Tree planting	1998–2000	54 ac	Upper and West Fk. Trail (6th)
Road Maintenance	Brushing, grading, resurfacing	2010–2012	3 mi	Upper and West Fk. Trail (6th)

Current Watershed Conditions

Overall watershed conditions remain similar to those described in the watershed assessment. Watershed conditions have improved somewhat on NFS lands since the watershed assessment was written. Collectively, watershed restoration efforts have improved watershed condition in the subwatersheds and stream reaches where projects occurred; however, ongoing timber management, grazing, and development continue to affect watershed conditions on private lands, which, in turn, affect overall watershed conditions. Small-scale disturbances have had local effects. No large-scale disturbance events have occurred that would affect overall watershed conditions on NFS lands. Forest Service Watershed Condition Class rating for the Trail Creek watershed was “functioning at risk,” with “at risk” scores for fire, roads, and water quality (Attachments: Section 3.3.1). Northwest Forest Plan aquatic monitoring showed a slightly declining trend in overall watershed condition in the Upper Trail Creek subwatershed, with negative trends for vegetation. The West Fork and Lower Trail Creek subwatersheds showed slightly improving watershed conditions and positive trends in vegetation (Attachments: Section 3.3.2).

Natural Disturbance Processes

Surface erosion of well-forested areas rarely occurred in the watershed, with the possible exception of erosion that occurred immediately following severe wildfire. Thin and stony soils, which are often sparsely vegetated with hardwoods and grasses, may also have been subject to surface erosion. However, most natural erosion within the watershed likely occurred as mass wasting, soil creep, and related streambank and channel erosion, most of which is likely to have occurred during major flood events. Channel-scouring debris flows and debris torrents (i.e., saturated debris flows) have occurred in steep first-, second-, and some third-order channels, depositing coarse sediment and LWD into transport/response transitional areas. However, no debris torrent tracks were observed to have occurred in the Trail Creek watershed in the photo record made available for the watershed assessment (1966, 1969, 1975, 1985, and 1996). This suggests that debris torrent events may not have been as frequent as is common for steeper and more failure-prone areas of the Cascades Range, Coast Range, and Klamath Mountains (BLM 1999: 3-10).

Project Effects and Range of Natural Variability

Watershed assessment/analysis is the assessment and documentation of the historic range of variability and provides recommendations for management activities that contribute to restoring watershed health and achieving the objectives of the ACS (table 2-40). The Trail Creek watershed assessment described reference and current conditions and general ecological trends, but it did not establish metrics that reflect the natural variability at the watershed scale. Management recommendations to improve watershed health were provided that are responsive to the conditions and trends in the watershed. Those that are pertinent to the project from the Trail Creek watershed assessment are summarized below. The congruence of the project with each recommendation is noted.

TABLE 2-40 **Project Effects and Relevant Ecological Processes Described in the Trail Creek Fifth-Field Watershed Assessment**		
Ecological Processes Relevant to the Project	**Historic Range of Variability**	**Pacific Connector Effects**
Erosional Processes	Mass wasting was generally associated with major storms and floods. Channel-scouring debris flows and debris torrents undoubtedly occurred in steep first-, second-, and some third-order channels, depositing coarse sediment and LWD into transport/response transitional areas. However, no debris torrents were observed to have occurred in the Trail Creek watershed in the photo record made available for this analysis (from 1966, 1969, 1975, 1985, and 1996). This suggests that debris torrents may never have been as frequent as is common for steeper and more landslide failure-prone areas of the Cascades Range, Coast Range, and Klamath Mountains. Prior to disturbance of soils by road construction, logging, and forest conversion to non-forest land uses, the rate of surface erosion of well-vegetated areas was low in the watershed, with the exception of erosion that occurred immediately following severe wildfire or other forms of vegetation mortality. Thin and stony soils, which are often sparsely vegetated with hardwoods and grasses, have been subject to surface erosion over geologically recent time. Most natural erosional processes within the watershed are mass wasting, soil creep, and related streambank and channel erosion, most of which is likely to have occurred during major flood events.	Pacific Connector has been routed to avoid unstable or potentially unstable areas. There are approximately 2.09 miles of corridor on NFS lands within the watershed. Nearly the entire length of the project in the Trail Creek watershed is on ridge tops with no hydrologic connection. There are no river or stream crossings on NFS lands in the watershed. No Riparian Reserves would be affected in the Trail Creek watershed.
Ecological Succession/Vegetative Condition	Fire was the major disturbance factor affecting vegetation patterns in the watershed. Wildfires in the mixed evergreen forests of southern Oregon and northern California occurred at frequencies of 5 to 25 years. Naturally occurring fires were ignited primarily by lightning sources, which can strike more or less randomly, regardless of elevation. Hot, dry climatic conditions are common in the region, further increasing the chances of ignition and spread. During pre-settlement, Native Americans also used fire on a much more frequent basis to maintain grasslands and oak woodlands in the major river valleys. These fires were generally of relatively low to moderate intensity and limited extent, burning in mosaic patterns. Because of this fire cycle, fuel loads were maintained at relatively low levels. Understory and ground fuels were typically consumed, reducing the probability of crown fires. Because of these frequent, minor reductions in fuel profiles, the potential for large-scale catastrophic events was greatly reduced. Overall, this process maintained a more or less stable ecosystem dominated by fire-tolerant species such as Douglas-fir, ponderosa pine, and Oregon white oak. Fire suppression and timber management have reduced and fragmented late successional stands, reducing patch size, shifting species dominance to white fir, and increasing early and mid seral proportions of the drainage. Late-successional or old-growth acres in both upland and riparian areas are below historic averages. Vegetative condition throughout the Upper Cow Creek watershed has been significantly altered by timber management activities.	No Riparian Reserves would be affected by the project. Approximately 1,968 acres of NFS lands in the watershed are characterized as LSOG, and approximately 15 acres of these LSOG acres would be cleared by the project. Loss of LSOG vegetation in the project right-of-way is a long-term impact, but it is minor in scale and well within the historic range of vegetative disturbance in the Trail Creek watershed. Standards and Guidelines for the NWFP (C-44) require retention of all LSOG where less than 15% of federal lands in a watershed are in LSOG condition. Federal lands in the Trail Creek watershed are currently 28% LSOG, exceeding this threshold.

TABLE 2-40

Project Effects and Relevant Ecological Processes Described in the Trail Creek Fifth-Field Watershed Assessment

Ecological Processes Relevant to the Project	Historic Range of Variability	Pacific Connector Effects
Flow Regime processes	Most of the watershed is subject to periodic snowfall and subsequent total to partial snow melt during warm mid-winter rain-on-snow events, which are associated with nearly all major peak flows. The reference condition for this watershed is fully forested, interrupted by widespread severe wildfire at intervals of several decades to centuries. Wildfires may have caused partial water repellency of soils (hydrophobicity) in severely burned areas in the watershed That may causeelevated peak flows for one to five years following fire.	In the complete project right-of-way, the greatest disturbance within the TSZ on a percentage basis would occur within the Trail Creek watershed. The project would disturb a total of 127.64 acres within the TSZ in this 28,867-acre watershed, which represents 0.44% of the total watershed area (GeoEngineers 2012, Resource Report 2, p 46). Whether this increase in peak flows depends on watershed conditions. The Trail Creek watershed assessment determined that all subwatersheds in the Trail Creek watershed, as well as the watershed as a whole, have predicted increases in peak flows of less than 10% for both the average and unusual storm simulations. Therefore, all subwatersheds have been assigned a low sensitivity to peak flow increases. The watershed assessment indicates that current rain-on-snow flood magnitudes are not substantially different than the reference condition (BLM 1999b: 4-8). Given the small surface area affected by the corridor, it is highly unlikely that the project would increase peak flows in the watershed (See also EIS Chapter 4.3).
Stream Temperature	There are no reports or data that define the reference condition for streams within the Trail Creek watershed (BLM 1999, p. 3-31). The watershed assessment indicates that summer maximum water temperatures naturally exceed the Oregon 64ºF standard in many streams. Furthermore, the regression model predicts that the 64ºF standard cannot be achieved at elevations below 2,000 feet even with 100% shade, a level of shading that is seldom, if ever, achievable at the lower elevations in the Trail Creek watershed. Conversely, the model indicates that the 64°F standard is likely to be met at elevations above 3,400 feet, regardless of stream shade levels. In the Trail Creek watershed, all fish-bearing streams lie below 3,400 feet, and most are below 2,600 feet (BLM 1999, p. 3-64). Notwithstanding the ability of the watershed to reach desired conditions, it is likely that timber harvest and road construction have reduced shade in the upper portions of the watershed. The seven-day maximum temperature (ºF) exceeded the Oregon standard of 64ºF at five monitoring stations located within the Trail Creek watershed. Seven-day maximum daily temperatures near the mouth of the West Fork and Trail Creek reach 80.3 and 83.5ºF, respectively.	The project does not cross any perennial streams on NFS lands in the Trail Creek watershed; therefore, it is unlikely that stream temperatures would be impacted by the project on lands where the ACS applies.
Aquatic Habitat and Stream Channel Complexity	There are no reports or data that define the reference condition for streams within the Trail Creek watershed. Conditions representative of western Oregon Cascades streams are presumed to have existed in the Trail Creek watershed. Many streams within forested west coast watersheds had a higher density of LWD than is found under current conditions (BLM, 1999, 3-31). Typically, these stream channels had 40–60 pieces of LWD/mile with >30% pool habitat by area. Prior to human impact, beaver dams and high densities of LWD in log jams created complex	No wetlands or streams are affected on NFS lands in the Trail Creek watershed. Ttherefore, no long-term effects to aquatic habitat are expected.

TABLE 2-40 **Project Effects and Relevant Ecological Processes Described in the Trail Creek Fifth-Field Watershed Assessment**		
Ecological Processes Relevant to the Project	**Historic Range of Variability**	**Pacific Connector Effects**
	channels and maintained pools in streams of the watershed. Water was stored in the channel and as shallow perched aquifers or shallow unconfined ground water aquifers in the streambanks and floodplains. This water was slowly released during the summer, thereby sustaining flows. The combination of LWD and streambank vegetation was indicative of relatively stable streambanks and channels that were relatively resilient during floods. Well-developed mid-channel and channel-margin gravel bars may have been common. The large mainstem channels of Trail Creek (Lower Trail, East Fork, and West Fork) appear to have been scoured by large flood events, such as occurred in 1964, and gravel and cobble substrate are uncommon. Streambanks are typically stable along Trail Creek and the lower reaches of the main tributaries due to the dominance of rock or well-vegetated streambanks (BLM 1999: 3-33).	

Recommendation—Vegetation. Decrease ladder fuels in forest stands by cutting dense patches of suppressed tree regeneration and shrub species.

Recommendation—Hydrologic Change. Fire-hazard reduction should directly reduce risk to areas with high percentages of drainage area in the rain-on-snow zone (elevation 3,600 to 4,800 feet). These are areas where hydrologic change is most responsive to changes in canopy cover that would result from catastrophic wildfire.

- **Project:** The applicant-filed mitigation plan includes 175 acres of shaded fuel breaks on NFS lands in the Trail Creek watershed that are responsive to these recommendations.

Recommendation—Vegetation. Consider the use of sterile and/or competitive grasses on disturbed sites to prevent encroachment of noxious weeds. Use of native grass seeds should also be considered in instances where noxious weeds have not yet become established. Active and non-active roads should be considered in this recommendation, as should early seral-stage vegetation conditions, which are both extensive in the watershed. Prevention activities should be applied in all activities , including minimization of ground disturbance, where possible; use of native, non-invasive, or non-persistent species in reclamation; and equipment decontamination. This recommendation should be implemented through standard operating procedures.

Consider aggressive post-harvest prescriptions to control noxious weed infestation of harvested lands and adjoining lands and roads. Any of the prescriptions outlined above would be considered under such a strategy.

- **Project:** The ECRP exhibit to the POD, which was filed as part of FERC application, is consistent with these recommendations.

<u>*Recommendation—Hydrologic Processes.*</u> If future management alternatives or projects are extensive and therefore have a potential for increasing peak flows above acceptable limits, consider additional analysis consistent with the procedures used in this watershed assessment to define acceptable subwatershed canopy removal and stand treatment limits.

- **Project:** FERC conducted a site-specific evaluation of peak flow potential in Trail Creek watershed. FERC's evaluation concluded that, although increased snow accumulation may occur (which can lead to peak flow increases in rain-on-snow events), the probability of any measurable increase in peak flows is unlikely because of the relatively small areas affected in any single watershed and the design measures incorporated by Pacific Connector to minimize effects on forest hydrology. These findings are consistent with the Trail Creek watershed assessment conclusions that amount, timing, and delivery of water, sediment, and wood from the forested parts of this watershed are not changed appreciably from the reference conditions. Changes in sensitivity to peak flow increases would remain inconsequential unless large areas of forest are harvested or burned in the near future. Results of simulation of watershed conditions during mid-winter rain-on-snow runoff events presented in the Trail Creek watershed assessment suggest that the magnitude of current rain-on-snow flood events are not substantially different from the reference condition.

<u>*Recommendation—Hydrologic Processes.*</u> Allow for 100-year runoff events, including associated bed-load scouring and depositing, when installing new stream crossing structures and for existing stream crossing structures that pose substantial risk to Riparian Reserves.

<u>*Recommendation—Erosional Processes.*</u> Maintain and enhance the sediment erosion, transportion, and deposition under which the aquatic ecosystem evolved and improve, maintain, or restore federal road systems with an emphasis on adequate drainage and surfacing. Reconstruct, stabilize, reroute, close, obliterate, or decommission roads and landings that pose substantial risk to Riparian Reserves.

<u>*Recommendation—Erosional Processes.*</u> Reconstruct, stabilize, reroute, close, obliterate, or decommission roads and landings that pose substantial risk to Riparian Reserves.

Project: Roads used by the project for access and construction would be maintained or improved as needed to minimize erosion. In addition, the applicant-filed mitigation plan provides for storm-proofing 2.2 miles and decommissioning 0.3 mile of roads in the Trail Creek watershed on NFS lands. Table 2-39 compares the historic range of variability and the project effects for selected ecological processes relevant to the project.

Compliance with Land Management Plans

Table 2-41 provides Umpqua National Forest/NWFP Standards and Guidelines relevant to the ACS and project compliance with this management direction on NFS land in the Trail Creek watershed.

TABLE 2-41

Consistency of the Project in Trail Creek Watershed with Umpqua National Forest ACS-Related Management Direction

Umpqua National Forest/NWFP Standard and Guideline	Project Compliance
LH-4: Issuing leases, permits, right-of-way and easements.	Terms and conditions to ensure compliance with ACS objectives have been incorporated into the POD prepared by the applicant in conjunction with the BLM, Forest Service, and Reclamation and submitted as part of the Right-of-Way Grant application. The POD includes 28 exhibits, including the Wetland and Waterbody Crossing Plan, the Erosion Control and Revegetation Plan, the Hydrostatic Test Plan, the right-of-way Clearing Plan, and the Traffic Management Plan, etc.
RA-4: Locating water withdrawal sites.	Pacific Connector has developed a Hydrostatic Test Plan (see the POD) that would minimize any potential short-term effects on stream flows from water discharge events from the project's hydrostatic testing operations. No potential hydrostatic test water sources occur within the Trail Creek watershed; therefore, the biological, physical, and chemical integrity of these systems would remain unaffected from hydrostatic withdrawal activities.
RF-2: Road Construction Standards and Guidelines.	The existing transportation system in the Trail Creek watershed would be adequate for construction of the project. No new temporary or permanent access roads are planned in the Trail Creek watershed.
RF-4: New culverts, bridges and other stream crossings.	No new road crossings of streams are proposed in the Trail Creek watershed. Crossings would be maintained to prevent diversions. Specific specifications in the TMP (see Section 2.2.3 and Exhibit F, Section F.9.e) require culvert and bridge replacements to meet agency standards and agency approval of plans.
RF-5: Minimizing sediment delivery from roads.	Road maintenance specifications in the TMP require implementation of T-831, T-842, T-811, and T-834, which are maintenance specifications designed to minimize sediment delivery to aquatic habitats; these specifications would be implemented during project construction. Several road improvement projects and road decommissionings are proposed in the Trail Creek watershed. These are expected to reduce sediment delivery from roads, in some places significantly.
RF-6: Maintaining fish passage.	Fish passage would be maintained at all road crossings where project-related road repairs are implemented.
RF-7: Transportation Management Plan development.	The TMP submitted by the applicant and accepted by the Forest Service meets all of the requirements of RF-7 in the Trail Creek watershed.
WR-3: Proper use of planned mitigation and restoration.	Application of BMPs and aggressive erosion control measures, restricted construction windows, and numerous other impact minimization measures have been incorporated into several exhibits to the POD to prevent habitat degradation. These measures are not being used as a substitute for otherwise preventable habitat degradation or as surrogates for habitat protection.
Umpqua National Forest Forest-Wide Soils Standard and Guideline #1 (LRMP IV-67)	The combined total amount of unacceptable soil condition (detrimental compaction, displacement, puddling, or severely burned) in an activity area (e.g., cutting unit, range allotment, site preparation area) should not exceed 20%. All roads and landings, unless rehabilitated to natural conditions, are considered to be in detrimental condition and are included as part of this 20%. Pacific Connector cannot meet this standard. A Forest Plan Amendment (UNF-3) is proposed to waive application of this standard.
Management direction for Survey and Manage Species in the NWFP ROD was replaced by the 2001 ROD and Standards and Guidelines for Amendments to the Survey and Manage, Protection Buffer, and other Mitigation Measures Standards and Guidelines as Modified by the 2011 Settlement Agreement in Conservation Northwest v. Sherman, Case No. 08-CV-1067-JCC (W.D. Wash.)	The project affects Survey and Manage species within the Trail Creek watershed. This is not consistent with Management Recommendations in the 2001 Survey and Manage ROD; however, the project does not threaten the persistence of any Survey and Manage species (see appendix J). Waiving application of Management Recommendations for Survey and Manage species in the watershed would not prevent attainment of any ACS objective.

TABLE 2-41

Consistency of the Project in Trail Creek Watershed with Umpqua National Forest ACS-Related Management Direction

Umpqua National Forest/NWFP Standard and Guideline	Project Compliance
Retain late-successional forest patches in landscape areas where little late-successional forest persists. This management action/direction will be applied in fifth-field watersheds (20 to 200 square miles) in which federal forest lands are currently comprised of 15% or less late-successional forest. (The assessment of 15% will include all federal land allocations in a watershed.) Within such an area, protect all remaining late-successional forest stands. Protection of these stands could be modified in the future, when other portions of the watershed have recovered to the point where they could replace the ecological roles of these stands.	Federal lands in the Trail Creek watershed are currently 28% LSOG and exceed the 15% threshold.

Relationship of Proposed Forest Plan Amendments to the ACS

UNF-3. Allows the project to exceed restrictions on detrimental soil conditions in the project right-of-way.

Approximately 41.28 acres of the Umpqua National Forest would be cleared by the project in the Trail Creek watershed (table 2-37). The only Forest Plan amendment with an ACS nexus in this watershed is UNF-3, which allows the project to exceed restrictions on detrimental soil conditions resulting from displacement and compaction in the project right-of-way.

Umpqua National Forest LRMP IV-67-1, Forest-Wide Soils Standard and Guideline, states:

> The combined total amount of unacceptable soil condition (detrimental compaction, displacement, puddling or severely burned) in an activity area (e g., cutting unit, range allotment, site preparation area) should not exceed 20%. All roads and landings, unless rehabilitated to natural conditions, are considered to be in detrimental condition and are included as part of this 20%.

Degraded soil conditions may occur in cleared project areas. On NFS lands in the Trail Creek watershed, approximately 82% (41 acres) of the project right-of-way would be cleared. Degraded soil conditions may result from displacement and compaction following completion of project construction and rehabilitation. Compaction can largely be addressed by subsoil ripping, but displacement would be unavoidable because of the nature of the project. Existing LRMP Standards and Guidelines allow up to 20% of the project right-of-way, or 10 acres, to result in a degraded soil condition upon completion of a project. Thus, the proposed amendment allows an estimated additional 31 acres or 0.71% of the NFS lands in the Trail Creek watershed to be in a degraded soil condition on completion of the project.

Severe disturbances such as soil mixing or displacement would reduce long-term site productivity by displacing the duff layer and soil surface (A horizon), thus reducing the soil's ability to capture and retain water and nutrients. As a result, sites with long-term detrimental soil conditions would have interrupted hydrologic function and poor site productivity. Compacted and/or displaced soils may increase runoff and sediment transport and have lower rates of vegetative recovery. Sites with long-term detrimental soil conditions would have interrupted hydrologic function and poor site productivity. Without mitigation, bare soil surfaces in granitic or serpentine soils can persist more than 50 years following a severe disturbance.

Environmental consequences associated with 31 acres of additional detrimental soil conditions within the project right-of-way within the Trail Creek watershed include:

- **A potential localized increase in sediment mobilization**. The project right-of-way was located to avoid areas with high likelihood of geologic hazards. No landslides have been identified that pose a threat to the project. The project right-of-way does not cross earthflow terrains in the Trail Creek watershed. Effective erosion control measures and BMPs are required, as shown in the ECRP (see Section 2.1.2 for a general discussion of erosion control measures). Additionally, the project would comply with LRMP Standards and Guidelines for maintenance of effective ground cover. As a result of the dispersal of effects by the linear nature of the project, maintenance of effective ground cover, the required application of BMPs, ridge top location, lack of stream crossings and Riparian Reserves impacts, and implementation of the ECRP, it is highly unlikely that amending the LRMP to exceed the soil disturbance thresholds by 31 acres would result in the mobilization of sediment that would change the existing equilibrium or would exceed the natural range of variability in this watershed described in the Trail Creek watershed assessment.

- **A potential localized increase in peak flows**. The project would remove canopy on about 43 acres or about 1.0% of NFS lands in the Trail Creek watershed. FERC noted that this watershed was the most impacted of all of the fifth-field watersheds crossed by the project with respect to canopy removal as a proportion of watershed size. The Trail Creek watershed assessment determined that all subwatersheds in the Trail Creek watershed had low sensitivity to peak flow increases because of the small proportion of the watershed that is in a hydrologically immature condition and the small area that is potentially affected by rain-on-snow events. Analysis by FERC showed that the project was highly unlikely to contribute to increases in peak flows because of the small area affected by the project as a proportion of the watershed. Additionally, the entire project right-of-way within the watershed lies on ridge top locations that have minimal interactions with aquatic systems. The Trail Creek watershed assessment concluded that:

    - *Amount, timing, and delivery of water, sediment, and wood from the forested parts of this watershed are not changed appreciably from the reference conditions due to forest harvest effects on peak flows. Effects would remain inconsequential unless large areas of forest are harvested or burned in the near future.*

  Because the project right-of-way does not intersect any streams on NFS lands in the Trail Creek watershed, there is no direct routing of water to stream channels. Given the ridge top location, lack of stream intersections and impacts to Riparian Reserves, low watershed sensitivity to peak flows, and application of BMPs in construction and rehabilitation of the corridor, it is highly improbable that the amendment of LRMPs to exceed soil compaction limitations in the project right-of-way would change flow regimes from current conditions or from those described in the Trail Creek watershed assessment.

- **A potential loss of site productivity, which may slow vegetative recovery**. Volcanoclastic soils such as those found in the Trail Creek watershed may be low in productivity. Mechanically decompacting the soil to a minimum depth of 20 inches and reestablishing soil organic matter would be a critical first step in rehabilitating the soil toward a more natural condition. Soil rehabilitation would also require recovery of the soil biology, which requires restoration of the soil organic matter and time. Pacific Connector would decompact the corridor, fertilize disturbed areas, reestablish native vegetation (limiting the area directly over the pipe to grasses and shrubs), and scatter slash and large woody debris back across the site to provide for long-term nutrient cycling as required in the ECRP. The Forest Service may also require soil remediation with biosolids or other organic material to augment soil productivity.

Off-site mitigation measures contribute to further reducing these watershed effects. Approximately 0.3 mile of existing roads would be decommissioned; storm proofing is planned on 2.2 miles in the Trail Creek watershed as part of the mitigation plan for the project on NFS lands. Decommissioning roads reduces sediment by allowing reestablishment of effective ground cover and reducing soil compaction, thus increasing infiltration. Decommissioning roads contributes to reducing peak flow effects by reducing road-stream interactions, increasing infiltration, and reestablishing natural drainage.

Based on this evaluation, it is unlikely that this amendment would prevent attainment of ACS objectives in the Trail Creek watershed.

Off-Site Mitigation Measures

Offsite mitigation is intended to provide supplemental actions for projects that cannot be completely mitigated with on-site design features in order to ensure land management objectives are achieved. These mitigation measures also contribute to the "Maintain and Restore" objectives of the ACS. The NFS and Pacific Connector have entered into Agreements in Principle to accomplish off-site mitigation work in the Trail Creek watershed, as shown in table 2-42. Mitigation measures were developed from the recommendations in watershed assessments, LSR assessments, and the 2011 Northern Spotted Owl Recovery Plan. Mitigation measures in the Trail Creek watershed are focused on integrated projects that are intended to:

- Restore natural sediment regimes by reducing sediment contributions from roads and potential high-intensity fire.
- Restore historic stand- and fuel-density levels to selected stands.
- Restore elements of aquatic and terrestrial habitat.

TABLE 2-42

Offsite Mitigations on NFS and BLM Lands in the Trail Creek Watershed

Agency	Project Type	Mitigation Group	Project Name	Project Rationale
Forest Service	Fuel Reduction	Stand Density Fuel Break	Trail Cr LSR Road Shaded Fuel Break (175 Acres)	High-intensity fire has been identified as the single factor most impacting late successional and old-growth forest habitats on federal lands in the area of the NWFP. Construction of the pipeline and

TABLE 2-42

Offsite Mitigations on NFS and BLM Lands in the Trail Creek Watershed

Agency	Project Type	Mitigation Group	Project Name	Project Rationale
	Fuel Reduction	Stand-Density Fuel Break	Trail Cr. Matrix Integrated Fuels Reduction (500 Acres)	associated activities remove both mature and developing stands and will increase fire suppression complexity. Existing forest roads can provide a fuel break. Fuels reduction along each side of existing roads would increase the effectiveness of the roads as a fuel break. Road shaded fuel breaks will lower the risk of loss of developing and existing mature stands and other valuable habitats to high-intensity fire.
Forest Service	Precommercial Thinning	Stand-Density Managamant	Trail Cr. LSR PCT Enhancement (112 Acres)	PCGP will cause direct impacts to existing interior, and developing interior habitat. The project will result in additional fragmentation and preclude the recovery of fragmented habitat for those stands adjacent to the pipeline corridor. Maintenance of the pipeline corridor will provide a continued vector for predators, early seral species, and non-native species. Also the project will result in a direct loss in biological services provided by mature forest characteristics for many decades past the life of this project. Both mature stands and developing stands will be removed during pipeline construction. Density management of forested stands will assist in the recovery of late-seral habitat, reduce impacts from fragmentation, reduction in edge effects, and enhance resilience of mature stands. Accelerating development of mature forest characteristics will shorten the impacts of the loss of biological services due to pipeline construction. Thinning of young stands is a recognized treatment within LRSs if designed to accelerate development of late-successional habitat characteristics (NWFP ROD C-12). ROD Pages B-11 ACS Objectives , C-11 and C-17.
Forest Service	Road Decommissioning	Road Sediment Reduction	Upper Trail Creek Road Decommissioning (0.3 Miles)	Sediment has been identified by the Upper Rogue Watershed Council as a limiting factor for aquatic habitat in Trail Creek. Road decommissioning reduces habitat fragmentation, reduces road-related sediment, and improves hydrologic connectivity and by reducing road density.
Forest Service	Road storm-proofing	Road Sediment Reduction	Trail Creek Road Stormproofing (2.2 Miles)	Sediment has been identified by the Upper Rogue Watershed Council as a limiting factor for aquatic habitat in Trail Creek. Stormproofing improvement of existing roads restores hydrologic connectivity and reduces sediment by managing drainage and restoring surfacing where needed.
				Sediment has been identified by the Upper Rogue Watershed Council as a limiting factor for aquatic habitat in Trail Creek. Road improvement efforts (resurfacing) help restore hydrologic and reduce road-related sediment that could be delivered to stream channels.

TABLE 2-42 **Offsite Mitigations on NFS and BLM Lands in the Trail Creek Watershed**				
Agency	**Project Type**	**Mitigation Group**	**Project Name**	**Project Rationale**
Forest Service	Snag Creation in Matrix Lands	Upland Terrestrial	Snag Creation (109 Acres)	The project would remove current and future sources of snags, which provide a key wildlife habitat element. Snag creation replaces the existing and potential snags lost in the corridor. Lack of large wood and recruitment of LWD into streams is a consistent factor limiting aquatic habitat quality in all watersheds crossed by the Pacific Connector pipeline. Implementation of the project would result in the removal of large woody debris from the Riparian Reserves associated with intermittent and perennial streams. The removal of vegetation within and adjacent to the channel would preclude future recruitment of large woody debris into the channel and associated Riparian Reserves. Placing large woody debris at key locations within the channel and associated Riparian Reserves would offset both the short-term and long-term effects from loss of LWD recruitment to Riparian Reserves and associated aquatic and riparian habitat and contribute to the accomplishment of ACS objectives.

Cumulative Effects

Activities on NFS Lands

The Forest Service manages about 12% of the Trail Creek watershed; projects on NFS lands that would contribute to cumulative effects with the project are shown in table 2-43.

TABLE 2-43 **Current and Reasonably Foreseeable Future Actions on BLM and NFS Lands in the Trail Creek Watershed**					
Unit	**Fifth-Field Watershed**	**Sixth-Field Watershed**	**Project Name**	**Project Description**	**Resource**
UNF	Trail Creek	West Fork Trail Creek	Current Grazing	2,133 ac. cattle grazing	Upland and riparian vegetation, fisheries/aquatic habitat, water quality
UNF	Trail Creek	Upper Trail Creek	Current Grazing	2,270 ac. cattle grazing	Upland and riparian vegetation, fisheries/aquatic habitat, water quality
MD_BLM	Trail Creek	West Fork Trail Creek	Proposed Trail Creek Forest Management. Published in 2012 *Medford Messenger*. NEPA analysis ongoing. Implementation in 2015.	336 acres restoration thinning, 13 acres riparian thinning, 414 acres of hazardous fuels treatment, 263 acres precommercial thinning, 8 pump chances restored, block 4 roads, replace 1 culvert, decommission 0.48 mile of road, stream restoration on 0.45 mile	Owls, NRF habitat, CHU, WUI, fish, upland and riparian vegetation, road sedimentation, road density, water quality, sensitive soils

TABLE 2-43

Current and Reasonably Foreseeable Future Actions on BLM and NFS Lands in the Trail Creek Watershed

Unit	Fifth-Field Watershed	Sixth-Field Watershed	Project Name	Project Description	Resource
MD_BLM	Trail Creek	Upper Trail Creekin	Proposed Trail Creek Forest Management. Published in 2012 *Medford Messenger*. NEPA analysis ongoing. Implementation in2015.	714 acres restoration thinning, 75 acres riparian thinning, 1,075 acres hazardous fuels treatment, 282 acres meadow restoration, 50 acres small-diameter thinning, 6 pump chances restored, 259 acres roadside firewood cutting, 0.78 mile of temporary roads	Owls, NRF habitat, CHU, WUI, fish, upland and riparian vegetation, road sedimentation, road density, water quality, sensitive soils
MD_BLM	Trail Creek	Lower Trail Creek	Proposed Trail Creek Forest Management. Published in 2012 *Medford Messenger*. NEPA analysis ongoing. Implementation in 2015.	20 acres restoration thinning, 1,044 acres hazardous fuels treatment, and 2 pump chances restored	Owls, NRF habitat, CHU, WUI, fish, upland and riparian vegetation, road sedimentation, road density, water quality, sensitive soils

These activities are expected to be consistent with the Standards and Guidelines and objectives of the Umpqua National Forest land management plan. Restoration thinning and hazardous fuels reductions are expected to contribute to improvements in watershed conditions by reducing stand density and reducing the probability of stand-replacing fire. Road improvements and decommissioning are expected to reduce road-related sediment transport to aquatic systems.

Activities on BLM and Private Lands

The BLM accounts for about 42% and private lands comprise about 46% of the Trail Creek watershed. Projects that might contribute to cumulative effects within the project right-of-way are shown in in table 2-43. Private lands in the watershed are expected to be managed according to current land use patterns consistent with the Douglas County General Plan and existing federal and state statutes, including the Oregon Forest Practices Act and the Clean Water Act. Most of the private lands in the watershed are small ranches where the dominant use of the land is grazing.

Cumulative Effects

The Pacific Connector corridor comprises about 1.42% of the NFS lands, 0.53% of BLM lands, and 0.57% of private lands in the Trail Creek watershed (table 2-37). The small proportion of the landscape affected by the project, ongoing land management on private lands, the regulatory framework between the BLM, ODEQ, and ACOE applicable to the project, and project location and routing make it highly unlikely that the portion of the Pacific Connector project on federal lands, when considered with other past, present, and reasonably foreseeable future actions would change watershed conditions in the Trail Creek watershed in any significant, discernible, or measureable way. See also Chapter 4.14, Cumulative Effects.

Project Effects Compared by ACS Objective

Table 2-44 compares the project impacts to the objectives of the ACS for the Trail Creek watershed. NFS lands where the ACS applies comprise about 12% of the Trail Creek watershed (table 2-37). Watershed conditions and recommendations are found in the Trail Creek watershed assessment (BLM 1999b) and described in detail in appendix J. In the Trail Creek watershed, timber harvest and removal of LWD from creek channels has reduced the structural complexity of the aquatic habitat and its ability to retain sediments. Chronic, fine-grained sediment, most recently related to roads and timber harvest, has negatively affected aquatic habitats by adding large volumes of sediment above the geomorphic background rate during recent geologic time (i.e., Holocene and Anthropocene Epochs, 10000 BCE to 1800 ACE). The presence of roads has segregated some stream reaches from upslope habitats that are needed for replenishment of LWD. The project would not affect any Riparian Reserves in the watershed (table 2-40).

TABLE 2-44

Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Trail Creek Watershed

ACS Objective	Project Impacts
Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.	Riparian Reserves are watershed landscape-scale features that would be affected by the project. No Riparian Reserves are affected in the Trail Creek watershed (table 2-41). On NFS lands subject to the ACS, the project right-of-way is located primarily in early or mid seral forests (table 2-41). There are no river or stream crossings on NFS lands, and the project right-of-way is located largely on or near ridge tops to minimize impacts on aquatic habitats. No wetlands or streams are crossed or clipped in the watershed. Use of native vegetation and the anticipated rapid revegetation of disturbed areas would likely further reduce project impacts. Off-site mitigation measures including road stormproofing and decommissioning are expected to improve watershed conditions in the Trail Creek watershed (see p.2-113-115).
Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life-history requirements of aquatic and riparian-dependent species.	The project is not expected to affect spatial or temporal connectivity in the Trail Creek watershed because no wetlands or waterbodies are crossed. No rivers or streams would be crossed on NFS lands.
Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.	No stream channels are crossed on NFS lands where the ACS applies so the physical integrity of banks and stream bottoms would not be affected.
Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.	No wetlands or streams are crossed on NFS lands in the Trail Creek watershed. No long-term impacts on water quality are expected because of application of the ECRP, including maintenance of effective ground cover and BMPs during construction (see Section 1.4.1 and previous discussion).
Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.	The Trail Creek watershed was historically characterized by pulse-type depositions of coarser sediments from landslides and surface erosion following major disturbances such as fires and high-intensity winter storms (BLM 1999b, Everest and Reeves 2007). Chronic erosion and deposition of fine sediments, primarily from roads and to a lesser degree from land use, have replaced these pulse-type disturbances in the watershed. Project construction and operation are not likely to alter sediment erosion and deposition in the watershed nor are they likely to exacerbate these conditions. Proposed mitigation projects would contribute to a reduction of adverse sediment scouring and depositing and restoration of aquatic functions (see p. 2-113-115).

TABLE 2-44 **Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Trail Creek Watershed**	
ACS Objective	**Project Impacts**
Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.	The project is not likely to affect peak flows in the Trail Creek watershed because of its predominately ridge top location, the relatively small area of the watershed affected (less than 1%), the absence of stream crossings, and the relative lack of connectivity to aquatic systems. The Trail Creek watershed assessment noted that increases in peak flows are a low risk in all of the subwatersheds and in the watershed as a whole.
Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.	The project would not cross any meadows or wetlands in the Trail Creek watershed on NFS lands, so there would be no impact from the project on water tables or seasonal inundation of these areas
Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation; nutrient filtering; and appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse, woody debris sufficient to sustain physical complexity and stability.	The project would not affect Riparian Reserves in the Trail Creek watershed (table 2-39). Following construction, replanting with native species would facilitate reestablishment of vegetation communities.
Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.	The project would not affect any Riparian Reserves in the Trail Creek watershed (table 2-39). Consistent with the requirements of the POD, LWD and boulders removed from the corridor during construction would be replaced to restore and stabilize channel crossings. Revegetation would be accomplished using native riparian species. The project would waive application of Management Recommendations for Survey and Manage species in the watershed but would not threaten the persistence of riparian-dependent Survey and Manage species or prevent attainment of the ACS objectives (see appendix F5).

Summary

Given the ridge top location of the pipeline corridor on NFS lands, the lack of intersections with waterbodies, and the lack of impacts to Riparian Reserves, it is highly unlikely that project construction and operation would prevent attainment of ACS objectives on NFS land in the Trail Creek watershed.

The high clay content soils in the watershed (BLM 1999:1-4) presents a potential issue with respect to possible compaction and sediment that could be mobilized by overland flow. Subsoil ripping (including the use of hydraulic excavators) is a proven method to reduce soil compaction. Measures in the ECRP, including soil remediation with biosolids or other organic materials, rapid revegetation, and maintenance of effective ground cover, are likely to control surface erosion. The Forest Service may require additional erosion control measures if needed.

Off-site mitigation measures identified by the Forest Service would supplement onsite minimization, mitigation, and restoration actions. These proposed offsite mitigation measures are responsive to recommendations in the Trail Creek watershed assessment and would contribute to improving terrestrial and aquatic conditions within the watershed (see p. 2-113-115).

A site-specific amendment of the Umpqua National Forest LRMP to waive the limitation on detrimental soil compaction is proposed to provide for the project. This proposed amendment is minor in scope and is not expected to prevent attainment of ACS objectives because of implementation of the ECRP and the fact that there are no stream intersections on NFS lands in the Trail Creek watershed. The proposed amendment of the Umpqua National Forest LRMP to waive protection measures for Survey and Manage species would not prevent attainment of ACS objectives (see Appendix F5).

The relatively small area of NFS land affected by project construction (50.27 acres, or 1.15% of NFS lands) makes it highly improbable that project impacts could affect watershed conditions beyond the site scale. Although there are project-level impacts such as short-term surface erosion, these would be minor and limited to the boundaries of the project area (see Section 1.4.1).

No project-related impacts that would retard or prevent attainment of ACS objectives have been identified (see table 2-44). Impacts, as they relate to relevant ecological processes, are within the range of natural variability for watersheds in the Western Cascades, High Cascades, and Klamath-Siskiyou Provinces, although some of these processes have been altered from their natural condition (see p. 2-105-109, table 2-40).

2.2.2.4 Little Butte Creek Fifth-Field Watershed, HUC 1710030708

Overview

The Little Butte Creek fifth-field watershed (figure 2-10) is located in the southern Cascades Mountain Range in southwestern Oregon about 10 miles southeast of Medford. The Little Butte Creek watershed is a Tier 1 Key Watershed above the confluence of the North and South Forks of Little Butte Creek. It is one of eight fifth-field watersheds in the 2,618-square-mile Upper Rogue River subbasin. The Upper Rogue River subbasin is one of five subbasins within the Rogue River Basin. The entire Rogue River drainage basin is about 132 miles wide (east to west). See figure 1-1 for the regional setting of this watershed and its relationship to the other fifth-field watersheds traversed by the project right-of-way.

The watershed lies south of the Rogue River, with Little Butte Creek draining in a northwest direction. Major tributaries include Antelope Creek and the North and South Forks of Little Butte Creek. The North Fork begins at Fish Lake (northeast corner of the watershed), while the South Fork begins near the eastern boundary in the Fourmile Creek watershed. The North Fork headwaters are considerably lower in elevation than those of the South Fork. The two forks meet to form the main stem of Little Butte Creek near Lake Creek (elevation of 1,647 feet amsl). Little Butte Creek then continues in a northwest direction for 17 miles through the communities of Eagle Point and White City before emptying into the Rogue River about 3 miles west of Eagle Point at the junction of the Little Butte Creek and Shady Cove–Rogue River fifth-field watersheds. The Rogue River then turns westward and flows through the Rogue River–Siskiyou National Forest and the Klamath Mountains, discharging to the Pacific Ocean at Gold Beach, Oregon, about 32 miles north of the California border.

The Little Butte Creek watershed lies mainly in Jackson County (354 square miles), but the eastern extremity is in Klamath County (19 square miles). Elevations range from 1,204 feet amsl at the confluence of Little Butte Creek and the Rogue River to 9,495 feet amsl at the top of Mount

McLaughlin on the northeastern divide with the Big Butte Creek fifth-field watershed. Average land elevation over the entire watershed is 3,496 feet. About 31% of the watershed is in the TSZ, where warm rain-on-snow events contribute to peak flow events.

The City of Eagle Point is the only municipality within the watershed boundary, but unincorporated White City borders along the same lower reach and the unincorporated settlements of Waynsboro and Lake Creek are also found along the valley portions of the watershed. The eastern portion of the city of Medford approaches the western edge of the watershed. In this vicinity, the Interstate 5 corridor lies about 5 miles from the watershed. State Highway 140, which connects Medford and Klamath Falls, is a major transportation corridor through the watershed. Other major roads include State Highway 62, Highway 722 (Dead Indian Memorial Highway), County Road 1000, and South Fork Little Butte Creek, Lake Creek, and Antelope Creek roads.

Farming (especially orchards), forestry, and cattle grazing dominate human land use in the watershed. The BLM manages 28 grazing allotments and the Forest Service manages an additional four grazing allotments in the watershed. Water withdrawals from Little Butte Creek associated with agricultural and domestic uses constitute a major concern for aquatic water and habitat quality.

Much of the terrain in the Little Butte Creek watershed is transitional between the Klamath-Siskiyou Province and the High Cascades Province. The western and central portions where most federal land is BLM-administered are generally in the Klamath-Siskiyou Province. The eastern, higher elevation portion where most NFS land occursis generally in the High Cascades Province. [19]

Soft volcanic materials dominate the geology of the Cascades Range portion of the watershed. Lava flows of basaltic-andesite, basalt, and andesite are the dominant flow rock types from composite and shield volcanic eruptive vents. These lavas are interlayered with softer pyroclastic flows of andesitic tuff, basaltic breccia, ash flow tuff, dacite tuff, and andesitic breccia. These pyroclastic materials often interfinger with the lavas, making the area subject to landsliding during rain-on-snow or intense storm events. The pyroclastics have a higher porosity than the lava flows, and, hence, landslides initiate from these units as ground water levels increase after rainfall. As a result of landslides and surface erosion processes, the landscape is deeply dissected, with a well-developed dendritic drainage pattern. The clay content of the soils is high (particularly in the subsoil), resulting in low infiltration rates.

In the eastern portion of the watershed and a small part of the central portion along the north-central watershed divide with the Big Butte Creek watershed, High Cascades volcanic deposits prevail. These deposits consist of much younger and harder lava flows that have developed from large composite and shield volcanos. Volcanism from these local vents produced the more prominent peaks that form the High Cascades including Brown Mountain and Mount McLoughlin, which appear in sharp contrast to the Western Cascades topography, which are the older rock formations and complexes. Rock types include basaltic-andesite, andesite, and basalt lavas. Most

[19] Provinces discussed in this document are based on both ecological and geological conditions and therefore do not match those recognized by the Oregon Department of Geology and Mineral Industries and the Oregon State Board of Professional Geologists and Geophysicists. The Klamath-Siskiyou Province is known by professional geologists as the Klamath Mountains Province and the Western Cascades and the High Cascades are two mountain ranges within the Cascades Mountains Province. See https://www.oregongeology.org/learnmore/geologicsightseeing.htm

of these lava flows were from the north and east, overlapping the eastern margin of the Western Cascades. As a result, a high plateau developed above the older topography. Since the geological substrate is less erodible and more stable than in the Western Cascades, the landscape is much less dissected. Soils are generally shallower and less weathered and have high infiltration rates.

Most of the large alluvial stream terraces, located above the floodplains in the western third of the watershed, developed during the formation of the High Cascades. These terraces consist of unconsolidated deposits of gravel, cobbles, and boulders intermixed and interlayered with clay, silt, and sand. The alluvium and valley bottom are much wider in the western part of the watershed. Large portions of the western and central portions of the watershed are moderately stable to unstable soils due to steep slopes, moderate precipitation rates, and the natural weakness of many of the volcanic soil/rock types of the Western Cascades.

The 373.0-square-mile (238,879-acre) Little Butte Creek watershed includes 12 subwatersheds, nine of which (moving from northwest to southeast, Lick Creek, Salt Creek, Lake Creek, Lower North Fork Little Butte Creek, Lower South Fork Little Butte Creek, Upper North Fork Little Butte Creek, Upper South Fork Little Butte Creek, Middle South Fork Little Butte Creek, and Beaver Dam Creek) are crossed by the project right-of-way (figure 2-10 and table 2-45). The watershed is bounded on the northwest to the northeast by the Shady Cove–Rogue River and Big Butte Creek watersheds, on the east by the Fourmile Creek fifth-field watershed, on the south by several fifth-field watersheds of the Upper Klamath fifth-field watershed, and on the west by the Rogue River–Gold Hill and Bear Creek subwatersheds of the Middle Rogue River subbasin.

The region experiences a Mediterranean-type climate, with mild, wet winters and hot, dry summers. The general area has the highest summer temperatures and lowest annual precipitation in western Oregon. Summer weather is dominated by the Pacific high-pressure system. Annual precipitation ranges from 22 inches at the lower elevations to 66 inches in the upper reaches of the watershed. July through October is the driest period, while December through April is the wettest. Winter precipitation at elevations above 5,000 feet amsl typically occurs as snow, with spring melting and runoff occurring from April through June. Rainfall predominates below 3,500 feet amsl. Between the two (i.e., in the TSZ) is a mix of rain and snow in winter. Locally intense thunderstorm precipitation events may occur during summer months.

The Little Butte Creek watershed contains approximately 784 miles of streams, based on BLM and Forest Service GIS layers. This includes about 167 miles of fish-bearing (and perennial) streams, 69.9 miles of perennial nonfish-bearing streams, and 547.4 miles of intermittent streams (BLM and Forest Service, 1997: 36). The watershed also contains 1,383.0 acres of palustrine wetlands and 393.0 acres of lacustrine wetlands. Headwater areas are dominated by dendritic drainage patterns with first- and second-order streams comprising 80% of the stream miles. Sediment, loss of LWD, and large wood recruitment along streams from logging activity have negatively impacted many of the streams in the watershed.

Streamflow patterns reflect the distribution of precipitation. The range of elevations across the watershed results in a variety of runoff events, including rain, rain-on-snow, and snowmelt. Partial to total snow melt typically occurs in the TSZ during warm mid-winter rain-on-snow events, and is associated with nearly all major peak flows. Thirty-four percent of the surface runoff from the watershed is collected from rain, 31% from rain-on-snow events, and 35% from snowmelt.

Agricultural production (farms, orchards, and cattle grazing) requires annual withdrawal of many thousands of acre feet of water from Little Butte Creek for irrigation. The Medford Water Commission services customers throughout the Rogue Valley with water from Little Butte Creek from about April to September. An extensive canal system facilitates these withdrawals. The resulting low flows in summer are accompanied by elevated temperatures, hearty bacterial growth, and other water quality problems.

The vegetation in the watershed is very diverse. Approximately 65% of the total area, mainly in the higher elevations, consists of temperate coniferous forest. Low elevations are characterized by dry pine/oak woodland savannahs (chaparral). Virtual elimination of fire due to fire suppression efforts has resulted in high stocking levels, which in turn have caused poor tree growth and the success of many non-preferable species. Grass/oak savannahs have become choked with brush and open ponderosa pine stands have developed dense understories of Douglas-fir and white fir. Fire suppression has also resulted in accumulation of dead fuels. Under drought conditions, these fuel loads may cause large, high-intensity fires.

Figure 2-10 shows the more contiguous NFS lands in the eastern uplands and the checkerboard pattern of BLM lands in the western and central portions of the watershed. Approximately 25.1% of the land in the watershed is within the RRNF. Substantial acreages of NFS lands are found in only the four easternmost subwatersheds (i.e., Upper North Fork, Upper South Fork, Middle South Fork, and Beaver Dam Creek subwatersheds). Approximately 22.9% of the land in the watershed is managed by the BLM Medford District, and 52.0% of the land is privately owned.

Matrix[20] lands account for about 5.40% of the NFS land in the watershed, and LSRs account for 88%. Riparian Reserves, which occur in both the Matrix and LSR land allocations, account for an estimated 8,096.50 acres, or 13.52%, of the NFS lands in the Little Butte Creek watershed (table 2-45). There is an additional 0.02 acre of unmapped LSR associated with KOACs [21] on NFS lands in the watershed.

Location and Routing

The project enters the Little Butte Creek fifth-field watershed from the Big Butte Creek fifth-field watershed at MP 135.04 (figure 2-10). As it traverses the Lick Creek, the Salt Creek and the northern portion of the Lake Creek subwatersheds, the project right-of-way runs cross country. After entering the Lower North Fork subwatershed, the project right-of-way runs along subwatershed divides most of the rest of the way through the watershed. A major exception is in the northeast corner of the Middle South Fork and western half of the Upper South Fork subwatersheds (figure 2-10). The project right-of-way exits the watershed at MP 168.00, moving into the Spencer Creek fifth-field watershed of the Upper Klamath Basin.

In all, the project right-of-way travels through 32.93 miles of the Little Butte Creek watershed. On NFS lands, the project right-of-way traverses approximately 13.75 miles in the six easternmost subwatersheds crossed by the project. Corridor lengths in the subwatersheds that cross NFS land range from 0.05 mile to 5.55 miles.

[20] Matrix is an NFS land allocation.
[21] Known Owl Activity Centers (KOAC) are relevant only on NFS lands.

A total of 607.48 acres of land would be affected by the project right-of-way in the Little Butte Creek watershed, of which 510.67 acres would be cleared and 96.81 acres would be modified. On NFS lands, there would be 207.17 acres cleared and 69.51 acres modified, which constitute 46% of the total affected acres (table 2-46). The largest NFS effects occur in the five eastern subwatersheds and constitute 0.49% of the NFS land.

No Matrix lands are affected by the project in the Little Butte Creek watershed. The project right-of-way affects 274.13 acres of LSR, which accounts for 0.46% of the NFS lands in the watershed. Approximately 10.22 acres of Riparian Reserves on NFS lands would be affected by the project right-of-way, which accounts for roughly 0.02% of the NFS lands in the watershed.

One perennial stream (South Fork of Little Butte Creek, MP 162.45) and one intermittent stream would be crossed on NFS lands in the Little Butte Creek watershed (table 2-48). Riparian Reserves on one intermittent Forest Service stream would be clipped by the project right-of-way, but the associated waterbody would not be crossed. In total, 7.66 acres of Riparian Reserves would be cleared and 2.56 acres would be modified (table 2-47), which constitutes 0.13% of the Riparian Reserves in the watershed (table 2-47). Approximately 3.70 acres of LSOG in Riparian Reserves would be cleared in the project right-of-way (table 2-48). Table 2-49 delineates the stream crossing turbidity and risk rating by the green, blue, and yellow rating categories.

Figure 2-10 PCGP Routing and Subwatershed Boundaries, Little Butte Creek Watershed

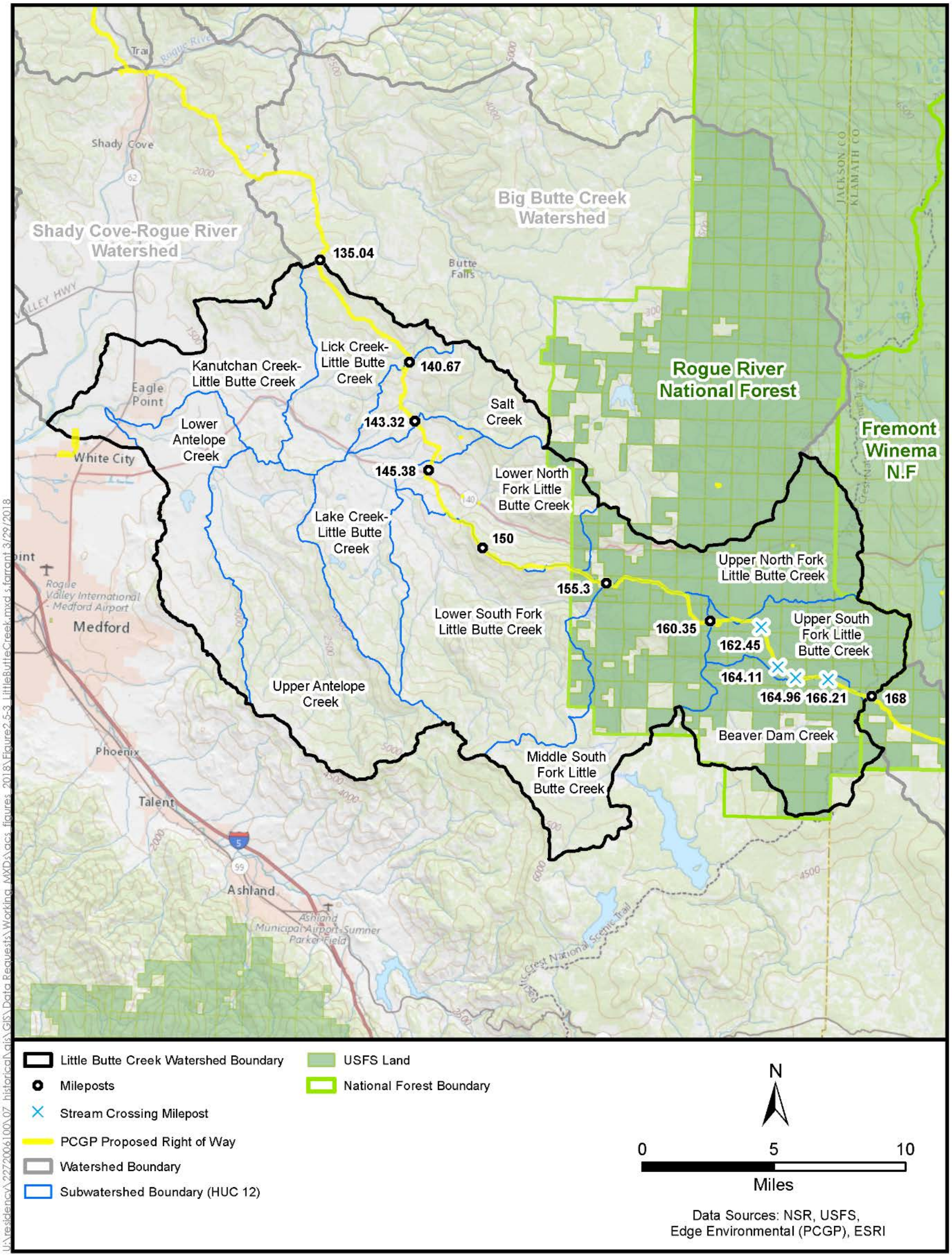


TABLE 2-45

Land Ownership and Forest Service Land Allocations (acres) in Little Butte Creek Fifth-Field Watershed (HUC 1710030708)

	Land Ownership (acres)					Forest Service Land Allocation (acres)		
Sixth-Field Watershed	**Sixth-Field Watershed (acres) a/**	**NFS Land**	**BLM**	**Total NFS and BLM**	**Other**	**LSR**	**Riparian Reserves b/**	**Matrix**
Beaver Dam Creek	17,862.75	12,989.80	599.03	13,588.83	4,273.92	12,512.25	2,855.48	435.26
Kanutchan Creek-	21,959.17	0.00	3,732.43	3,732.43	18,226.74	0.00	0.00	0.00
Lake Creek	16,974.66	0.00	4,023.36	4,023.36	12,951.30	0.00	0.00	0.00
Lick Creek	14,838.25	0.00	5,619.05	5,619.05	9,219.20	0.00	0.00	0.00
Lower Antelope Creek	16,096.61	0.00	294.91	294.91	15,801.70	0.00	0.00	0.00
Lower North Fork Little Butte Creek	15,714.05	1,344.23	5,948.61	7,292.84	8,421.21	320.10	152.25	1,014.48
Lower South Fork Little Butte Creek	33,078.77	1,572.84	14,950.78	16,523.62	16,555.15	1,557.48	161.46	0.00
Middle South Fork Little Butte Creek	26,193.88	12,427.33	5,495.86	17,923.19	8,270.69	12,315.57	1,726.75	0.00
Salt Creek	11,029.22	0.47	4,698.08	4,698.55	6,330.67	0.00	0.00	0.43
Upper Antelope Creek	32,108.75	0.00	9,480.66	9,480.66	22,628.09	0.00	0.00	0.00
Upper North Fork Little Butte Creek	20,358.40	18,901.65	0.00	18,901.65	1,456.75	13,447.78	1,623.64	1,777.87
Upper South Fork Little Butte Creek	12,664.06	12,664.06	0.00	12,664.06	0.00	12,659.47	1,576.92	3.63
Watershed Total	**238,878.57**	**59,900.38**	**54,842.77**	**114,743.15**	**124,135.42**	**52,812.65**	**8,096.50**	**3,231.67**

a/ All data derived from Stantec-based GIS layers.
b/ May occur within other NFS land allocations.

TABLE 2-46

Project Corridor (miles) and Project Area (acres) in Little Butte Creek Fifth-Field Watershed (HUC 1710030708) by Land Ownership

	Land Ownership							
	NFS Lands Only				Entire Sixth Field Watershed, All Owneships			
		Project Area (acres)				Project Area (ares) b/		
Sixth-Field Watershed a/	**Corridor Length (miles)**	**Cleared**	**Modified**	**% of NFS Land Impacted**	**Corridor Length (miles)**	**Cleared**	**Modified**	**% of Sixth-Field Watershed Impacted**
Beaver Dam Creek	1.68	21.26	10.63	0.25	1.68	21.26	10.63	0.18
Kanutchan Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lake Creek	0.00	0.00	0.00	0.00	2.09	31.31	0.45	0.19
Lick Creek	0.00	0.00	0.00	0.00	5.63	82.24	14.39	0.65
Lower Antelope Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lower North Fork Little Butte Creek	0.05	0.89	0.72	0.12	5.70	82.01	8.21	0.57
Lower South Fork Little Butte Creek	1.0	12.71	4.94	1.12	3.84	72.91	7.93	0.24
Middle South Fork Little Butte Creek	3.59	51.98	21.13	0.59	3.59	53.96	21.13	0.29
Salt Creek	0.00	0.00	0.00	0.00	2.66	42.76	1.50	0.40
Upper Antelope Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upper North Fork Little Butte Creek	1.88	25.57	7.83	0.18	2.19	29.46	8.31	0.19
Upper South Fork Little Butte Creek	5.55	94.76	24.26	0.94	5.55	94.76	24.26	0.94
Watershed Total	**13.75**	**207.17**	**69.51**	**0.46**	**32.93**	**510.67**	**96.81**	**0.25**

a/ All data derived from Stantec-based GIS layers
b/ Includes NFS, BLM, and other ownerships

TABLE 2-47

Project Area (acres) on NFS Lands in the Little Butte Creek Fifth-Field Watershed (HUC 1710030708) by Land Allocation

Sixth-Field Watershed a/	Designated LSR b/				Matrix				Riparian Reserves b/			
	Project Area (acres)		% of Total LSR on NFS Land		Project Area (acres)		% of Total Matrix on NFS Land		Project Area (acres)		% of Total Riparian Reserves on NFS lands c/	
	Cleared	Modified	Cleared	Modified	Cleared	Modified	Cleared	Modified	Cleared	Modified	Cleared	Modified
Beaver Dam Creek	21.26	10.63	0.17	0.09	0.00	0.00	0.00	0.00	0.90	0.58	0.03	0.02
Kanutchan Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lake Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lick Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lower Antelope Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lower North Fork Little Butte Creek	0.89	0.72	0.28	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lower South Fork Little Butte Creek	12.94	4.96	0.83	0.32	0.00	0.00	0.00	0.00	0.31	0.14	0.19	0.09
Middle South Fork Little Butte Creek	51.88	21.13	0.42	0.17	0.00	0.00	0.00	0.00	0.88	0.31	0.05	0.02
Salt Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upper Antelope Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upper North Fork Little Butte Creek	23.76	7.83	0.17	0.06	0.00	0.00	0.00	0.00	0.83	0.00	0.05	0.00
Upper South Fork Little Butte Creek	94.76	24.26	0.75	0.19	0.00	0.00	0.00	0.00	4.75	1.53	0.30	0.10
Watershed Total	**204.60**	**69.53**	**0.39**	**0.13**	**0.00**	**0.00**	**0.00**	**0.00**	**7.66**	**2.56**	**0.09**	**0.03**

a/ All data derived from Stantec-based GIS layers.
b/ Includes mapped and unmapped LSR on NFS lands.
c/ Riparian Reserve acres overlap with LSR and Matrix land allocations.

TABLE 2-48

Riparian Reserve Effects in the Little Butte Creek Watershed HUC 1710030708

Jurisdiction	**MP**	**Waterbody**	**Description**	**Waterbody Type**	**Crossed a/**	**Width of Crossing (feet)**	**Wetland Acres Crossed**	**Clipped b/**	**Riparian Reserve Vegetation Cleared in Construction Corridor and TEWAs by Age Class (Acres)** RR_Conifer_LSOG	**RR_Hardwood_LSOG**	**RR_Mixed_Conifer_Hardwood_LSOG**	**Total_LSOG (80+)**	**RR_Conifer_MS**	**RR_Hardwood_MS**	**RR_Mixed Conifer Hardwood MS**	**Total Mid-Seral (40-80)**	**RR_Conifer_ES**	**RR_Shrub_ES**	**RR_Grasslands**	**Total Early Seral (0-40)**	**Stream Channel or Wetland Area**	**Net Riparian Reserve Cleared**	**Uncleared Storage Area in RR**	**Total Direct Impact in RR (Cleared plus UCSA)**	**Roads and Other Altered Habitats c/**	**Gross Riparian Reserves**	**Fish Bearing**	**Anadromy d/**
Upper South Fork of Little Butte Creek HUC 171003070803 (Tier One Key Watershed)																												
RRNF	162.45	ASP165 South Fork Little Butte Creek	2-30' wide, U-shaped,1% gradient, braided channels	P	Yes	19.62		No	1.38			**1.38**				**0.00**	1.16			**1.16**	0.04	**2.58**	0.08	**2.66**		**2.66**	Yes	No
RRNF	164.11	EW075	RR of adjacent emergent wetland in forest clearing.	W	No	0.00	0.00	Yes	0.13			**0.13**				**0.00**	0.39			**0.39**		**0.52**	0.26	**0.78**		**0.78**	No	No
RRNF	164.96	ASI164	RR of lateral stream clipped	I	No	0.00		Yes				**0.00**	0.28			**0.28**				**0.00**		**0.28**	0.12	**0.40**		**0.40**	No	No
Subtotal Upper South Fork Little Butte Creek		**Crossed:** **1 Per. Channel**	**Clipped:** **1 wetland RR** **1 Int. Stream RR**		**1**			**2**	**1.51**	**0.00**	**0.00**	**1.51**	**0.28**	**0.00**	**0.00**	**0.28**	**1.55**	**0.00**	**0.00**	**1.55**	**0.04**	**3.38**	**0.46**	**3.84**	**0.00**	**3.84**	**1**	**0**
Beaver Dam Creek HUC 171003070804 (Tier One Key Watershed)																												
RRNF	166.21	ESI076 (ESI084) Daley Creek	30-40' wide braided channel, coble/gravel substrate, trib. to Daley Creek	I	Yes	26.51		No				**0.00**				**0.00**		0.73	0.20	**0.93**	0.10	**1.03**	0.63	**1.66**		**1.66**	No	No
Total, Key Watershed Portion of Little Butte Creek (North and South Forks above Pipeline MP 145.38)																												
Total Key Watershed		Crossed: 3 Int. Channels 1 Per. Channel 1 Wetland	Clipped: 1 Int. Stream RR 1 Wetland RR		5		0.01	2	1.51	0.00	0.00	1.51	0.84	0.00	0.00	0.84	4.81	0.73	0.20	5.74	0.14	8.23	1.09	9.32	0.35	9.67		
Totals, Little Butte Creek Watershed																												

TABLE 2-48

Riparian Reserve Effects in the Little Butte Creek Watershed HUC 1710030708

Jurisdiction	MP	Waterbody	Description	Waterbody Type	Crossed a/	Width of Crossing (feet)	Wetland Acres Crossed	Clipped b/	Riparian Reserve Vegetation Cleared in Construction Corridor and TEWAs by Age Class (Acres)														Uncleared Storage Area in RR	Total Direct Impact in RR (Cleared plus UCSA)	Roads and Other Altered Habitats c/	Gross Riparian Reserves	Fish Bearing	Anadromy d/
									RR_Conifer_LSOG	RR_Hardwood_LSOG	RR_Mixed_Conifer_Hardwood_LSOG	Total_LSOG (80+)	RR_Conifer_MS	RR_Hardwood_MS	RR_Mixed Conifer Hardwood MS	Total Mid-Seral (40-80)	RR_Conifer_ES	RR_Shrub_ES	RR_Grasslands	Total Early Seral (0-40)	Stream Channel or Wetland Area	Net Riparian Reserve Cleared						
Total Forest Service		Crossed: 1 Int. Channel 1 Per. Channel	Clipped: 1 Int. Channel RR 1 Wetland RR		2			2	1.51	0.00	0.00	1.51	0.28	0.00	0.00	0.28	1.55	0.73	0.20	2.48	0.14	4.41	1.09	5.50	0.00	5.50	1	
Total		Crossed: 1 Int. Channels 1 Per. Channel	Clipped: 1 Int. Channel RR 1 Wetland RR		1		0.01	2	2.15	1.79	1.66	5.60	0.84	0.00	0.00	0.84	4.81	3.52	0.20	8.53	0.23	15.20	1.90	17.10	0.60	17.70		

RR = Riparian Reserve

a/ "Crossed" indicates that the pipeline trench crosses the waterbody or wetland.

b/ "Clipped" indicates that the pipeline corridor or TEWA clearing crosses a portion of the Riparian Reserve, but the pipeline trench does not cross the associated waterbody.

c/ Roads and other altered habitats such as rock pits sometimes occur within Riparian Reserves. These features do not have riparian features, and are not considered as part of the Riparian Reserve vegetated area.

d/ "Anadromy" means that a stream contains anadromous fish, or that it is a tributary directly influences an anadromous stream.

TABLE 2-49

Stream Crossing Turbidity and Risk Assessment

Fifth-Field Watershed	Sixth-Field Subwatershed	MP	Type a/	Description a/	Bankfull Width (ft) b/	Width of Crossing (ft) a/	Channel Gradient (%) b/	Channel Incision (ft) b/	Bank Character b/	Streambed Material b/	Turbidity Rating c/	Site Response Rating d/	Construction Impact Rating d/	Overall Rating e/
Little Butte Creek	Upper SF Little Butte Cr.	162.45	P	U-shaped,1% gradient,	22	19.62	0.87		Erosion resistant	Gravel/ cobble	M	M	M	YELLOW
Little Butte Creek	Beaver Dam Cr.	166.21	I	30-40’ wide braided channel, cobble/gravel substrate, Daley Creek.		26.51				Cobble gravel	L	L	L	BLUE

Sources:
a/ Table 2A-3a, Resource Report 2, Water Use and Quality,PCGP 2013
b/ Table A-2, Stream Crossing Risk Analysis, GeoEngineers 2011
c/ Table B-1, Turbidity, Nutrients and Water Quality Analysis, GeoEngineers 2011
d/ Table A-1, Stream Crossing Risk Analysis, GeoEngineers 2011
e/ Figure 4, Stream Crossing Risk Analysis, GeoEngineers 2011

Existing Conditions Little Butte Creek Watershed, HUC 1710030708

In 1997, the Forest Service and BLM prepared an interagency watershed assessment for federal lands in the Little Butte Creek watershed (BLM and Forest Service 1997). The Little Butte Creek Watershed Council completed an assessment that addressed issues throughout all ownerships in the watershed in 2003.

Original Watershed Analysis Findings

- Soils on the young volcanic landforms associated with the High Cascades Province (i.e., plateaus, valley floors, and stream channels) where the project is routed have higher infiltration rates than the older landforms of the Western Cascades Province in the Little Butte Creek watershed. Erosion potential is characterized as slight to moderate on these plateaus and valley floors and moderate to high in the associated stream channels.

- The key aquatic issue in the watershed is water quality. High-priority issues that affect water quality and limit factors for long-term sustainability of native fish and other aquatic species in this watershed are temperature, habitat modification, and sedimentation.

- Water withdrawals and transbasin diversions have had the greatest impact on summer stream flows in the Little Butte Creek watershed. Except for the smallest tributaries, all of the streams in the Little Butte Creek watershed have been over allocated for water rights during the summer season. This means that there are more legal rights to water than there is water in the system (Little Butte Creek Watershed Council 2003). The majority of water diverted from streams in the watershed is used for irrigation. Transbasin diversions out of the Little Butte Creek watershed dramatically decrease stream flows in the diverted tributaries and downstream reaches during the irrigation and reservoir storage seasons.

- The South Fork of Little Butte Creek is CWA section 303(d) listed for flow modification, habitat modification, sediment, and temperature from the mouth to the confluence of Beaver Creek. The project right-of-way crosses the South Fork of Little Butte Creek, a perennial stream, and Daley Creek, an intermittent stream, several miles above the confluence of Beaver Creek. The reach of the South Fork of Little Butte Creek and Daley Creek crossed by the project is not 303(d) listed.

- Removal of CWD in past fuel treatments has affected site productivity. Maintaining the maximum levels of CWD consistent with reasonable fuel loadings appears to have considerable potential for enhancing site quality. Mid-seral stands with no CWD may have yields 12% lower than stands with sufficient CWD (BLM and Forest Service 1997: 75).

- The Little Butte Creek watershed assessment suggests that roads contribute the greatest amount of sediment to streams in the watershed. Roads located in unstable areas and adjacent to streams, as well as those with inadequate drainage control and maintenance and no surfacing, are most likely to cause sedimentation of stream habitats. Stream-adjacent roads confine the channel and restrict the natural tendency of streams to move laterally. Roads crossing through riparian areas have fragmented riparian habitat connectivity. Some culverts impede or prevent fish passage. Road density (all ownerships) described in the watershed assessment is 3.3 miles per square mile. Two sections (T37, R3E, Section 12; T37 S, R4E, Section 14) have road densities of 4.4 miles per square mile and 6.0 miles per square mile, respectively.

- Peak flows associated with past rain-on-snow events have altered the South Fork of Little Butte Creek by eroding streambanks, scouring channels, and removing CWD. Peak flow effects on the primary channels within the subwatershed are not expected to change noticeably in the future. Peak flows in the headwater streams are expected to decrease slightly as the areas recover hydrologically. Reduced harvest and restoration efforts under the existing land allocations within the LRMP would accelerate the recovery process. Roads would continue to affect peak flows. At the time it was prepared, the Little Butte Creek watershed assessment estimated conservatively that vegetation in the South Fork of Little Butte Creek subwatershed was 72% hydrologically recovered. This is at or above the UNF Forest Plan threshold of 70% for increasing peak flows by removing vegetation in the timber types on the Dead Indian Plateau.

- High stream temperatures (approximately >70°F) are lethal to fish and limit summer rearing habitat in Little Butte Creek watershed. Summer stream temperatures vary throughout the watershed, with cooler temperatures generally found in most headwater streams. Elevated summer water temperatures are a limiting factor in Little Butte, North Fork Little Butte (below the National Forest boundary), South Fork Little Butte (below Beaver Dam Creek), and Antelope, Conde, and Dead Indian creeks.

- Stream temperatures for the mainstems of Little Butte, North Fork Little Butte, and South Fork Little Butte creeks tend to show a correlation with elevation: cooler stream temperatures are found in the stream reaches at higher elevations. Federal lands (located at higher elevations) account for 75 to 85% of the viable salmonid production during summer months. Stream temperatures on the lower reaches of these streams are warm to near-lethal (physiologically stressful) or lethal for salmonids and other native fishes (sculpins, suckers, lamprey, etc.) during summer months due to habitat alteration. Warm stream temperatures limit fish production (growth) and occupation of habitat.

Changes in Watershed Condition

The following projects or natural disturbance events have occurred on NFS lands since the watershed assessment was written in 1997 (table 2-50).

TABLE 2-50

Changes in Watershed Condition Since Publication of the Little Butte Creek Watershed Assessment

Subwatershed	Fires or Other Terrestrial Disturbance Events	Flood or Channel Forming Events	Recommended Watershed Assessment Restoration Projects Completed
Kanutchan Creek-Little Butte Creek	Major blowdown, 83 ac., 2008		Decommissioned 2.2 miles of road. Rehabbed approximately 3 acres of meadows damaged by off highway vehicles (OHVs).
Lick Creek	Major blowdown, 886 ac., 2008; Doubleday Fire, 316 ac., 2008		Decommissioned 1.3 miles of road. Replaced 2 undersized culverts on Lick Creek with one properly sized bottomless structure for fish passage. Rehabbed approximately 7.3 acres of meadow damaged by OHVs.
Salt Creek	2008 blowdown event		Decommissioned/closed 2.8 miles of road.

TABLE 2-50 **Changes in Watershed Condition Since Publication of the Little Butte Creek Watershed Assessment**			
Subwatershed	**Fires or Other Terrestrial Disturbance Events**	**Flood or Channel Forming Events**	**Recommended Watershed Assessment Restoration Projects Completed**
Lower South Fork Little Butte Creek	2002 Lost Lake Fire, 230 acres; 2008 blowdown event	1997: Flood event in 5+ steep headwater tributaries; blew out lots of large wood, scoured riparian areas, sluiced out several miles of channels, deposited uprooted trees and tons of sediment on flat benches, road crossings, etc., changed channels, wiped out bridges and culverts, extensive erosion of roads 2005 and 2011: floods/debris torrents	• 2 large wood projects (Soda and Lost Creek) • 4 road obliteration projects - 1.5 miles; • riparian planting
Lower North Fork Little Butte Creek	2005 Wasson Canyon Fire, 1507 acres, some salvage; 2008 blowdown event		Decommissioned/closed 2.8 miles of road.
Middle South Fork Little Butte Creek	2011 Little Butte Fire, 276 acres; 2008 blowdown event		
Upper North Fork Little Butte Creek	2005 Jack Springs Fire, 7 acres; 2008 blowdown event		
Upper South Fork Little Butte Creek	2008 blowdown event		
Beaver Dam Creek	2008 blowdown event		

Current Watershed Conditions

Although watershed restoration projects have improved local and subwatershed conditions where the projects have been completed, the issues described in the watershed assessment remain at the watershed scale. Large amounts of water are diverted from Little Butte Creek for irrigation and and other water supply needs. Canal systems deliver the water to nearby Howard Prairie Lake and the Klamath River watershed, Agate Lake, and the Rogue Valley. Rural development has exacerbated sediment and water quality issues.

Despite being moderately polluted, Little Butte Creek is one of the best salmon-producing tributaries of the Rogue River. Coho and Chinook salmon migrate upstream each year; however, several dams hinder their progress. A fish ladder was built in 2005 to help fish swim past a dam constructed at Eagle Point in the 1880s. The fish ladder was destroyed by flooding just three months after construction but was rebuilt in 2008. Restoration of a 1.3-mile (2.1-km) artificially straightened section of the creek in the Denman Wildlife Area was completed in 2011. The most severe barriers to anadromous fish passage are located on private lands, either on the mainstem of Little Butte Creek or South Fork Little Butte Creek. Steelhead and coho are the species most impacted by the barriers that have been surveyed so far (table 2-51). Summer steelhead are particularly impacted as they have the most extensive distribution in the Little Butte Creek watershed. Coho are affected only by those barriers lower in the tributaries (LBWC 2003). South Fork Little Butte Creek is one of the primary rearing areas and contains one of the largest populations of rearing coho salmon in the upper Rogue River Basin. Resident fish include cutthroat, rainbow, and brook trout.

TABLE 2-51

Anadromous Fish Distribution in Little Butte Creek Subwatersheds Crossed by the Project (miles)

	Little Butte Cr.	South Fork Little Butte Cr.	North Fork Little Butte Cr.	Antelope Cr.	Lake Cr.	Lick Cr.	Dead Indian Cr.	Soda Cr.	Total
Fall Chinook	17								
Spring Chinook	17	1							18
Coho	17	16.4	7.5	6.3	2.5	2.25	0.5	0.25	52.7
Winter Steelhead	17	16.4	10						43.4
Summer Steelhead	17	16.4	10	13	3.1	3	0.9	2.6	66

Source: Little Butte Creek watershed assessment, Little Butte Creek Watershed Council, 2003, p. 67

NWFP aquatic and riparian monitoring data is shown in table 2-52. Only the Lower North Fork and Lick Creek subwatersheds showed declining trends; both were caused by declining trends in vegetation (see Attachments: Section 3.3.2 of this appendix).

TABLE 2-52

NWFP Aquatic and Riparian Monitoring Trends, Subwatersheds in Little Butte Creek

Subwatershed a/	Watershed Condition 1994	Watershed Condition 2009	Watershed Condition Trend b/
Upper North Fork Little Butte Creek	0.0870	0.1400	0.0530
Lower North Fork Little Butte Creek	-0.3360	-0.3460	-0.0100
Upper South Fork Little Butte Creek	0.1000	0.2310	0.1310
Beaver Dam Creek	0.0690	0.0970	0.0280
South Fork Little Butte Creek/Dead India	-0.0480	-0.0130	0.0350
Lower South Fork Little Butte Creek	-0.3410	-0.3320	0.0090
Salt Creek/Long Branch	-0.4980	-0.4810	0.0170
Little Butte/Lick	0.0130	-0.0080	-0.0210

a/ Data Source: Northwest Forest Plan AREMP monitoring program. See Attachments: Section 3.3.2 of this appendix.
b/ Positive numbers indicate improving watershed conditions. Negative numbers indicate declining conditions.

Natural Disturbance Processes

Disturbance processes for the Little Butte Creek watershed are consistent with those described for the Klamath-Siskiyou Province on the west half of the watershed (generally BLM lands), and the High Cascades on the east half of the watershed (generally NFS lands). Fires were (and are) the dominant disturbing force on the landscape (table 2-50). Fire effects were highly variable because of the diversity of the landscape.

Currently much of the lower elevation areas have dense shrubs, hardwoods and conifer forests due to decades of fire exclusion. Previously open grass/oak/pine savannas or Douglas-fir and other conifers historically dominated this landscape. Before effective fire suppression, fires burned with lower intensity and were widespread.

Moderate severity regimes dominated transition zones between lower valleys and the cool, moist uplands of the Dead Indian Plateau. Fires were more infrequent (25 to 100 years) and burned with varying degrees of intensity. High-intensity, stand-replacing fires occasionally occurred in this zone. A complicated mosaic of vegetation was the overall effect of fire on the landscape.

The high-severity regime found at upper elevations is characterized by moist and cool conditions, resulting in infrequent fires. Fires within these areas are due to unusual conditions such as drought or low precipitation periods associated with high winds, and fires historically resulted in stand replacement. Fire return intervals for the Mixed Conifer and drier portions of the White Fir zone areas of the Dead Indian Plateau range from 8 to 125 years with an average of about 35 years. Fire ignitions that occurred did not spread to the same degree as ignitions with similar vegetation on steep slopes because of the gentle slopes of the plateau (BLM and Forest Service: 34).

Fire return intervals within the Shasta Fir and Mountain Hemlock vegetation zones in the High Cascades are much longer than within similar zones in the Klamath Mountain Range (Atzet et al. 1982, cited in BLM and Forest Service 1997). Fire return intervals of 100 to 300 years were not uncommon because of the higher precipitation amounts in the Cascades Range as compared with the extreme eastern Siskiyou Mountains of the Klamath-Siskiyou Province. In the lava fields, fires historically occurred from lightning resulting in burned islands of trees. The Brown Mountain area has exposed lava fields with little or no ground fuels. Field observations in the lava fields have shown that many of the large Douglas-fir and ponderosa pine have old fire scars.

There is often substantial erosion within two years after a high-intensity fire consumes duff layers and a significant rainfall event occurs (Robichaud et al, 2000). Soils are protected from further rainfall impact when duff layers are not removed, or where vegetative cover or litterfall is reestablished within a year after a disturbance., There can be a significant amount of surface erosion and mass wasting on exposed soils when intense rainstorm events occur shortly after fire disturbance. Topsoil loss has probably been reduced over the past 70 years since fire suppression has resulted in fewer natural fires exposing soils. However, this situation increases the risk that a hot-burning wildfire would occur and may cause increased soil erosion and landslide events. Large lightningcaused wildfires periodically swept across the Little Butte Creek watershed, mainly in the lava plateau and canyon sideslopes during the late nineteenth and early twentieth centuries. The middle elevations of the watershed contain the highest fire occurrence and intensity in the watershed and are considered to be high risk wildfire areas. The canyon sideslope landscape is located in unstable and highly erodible terrain of South Fork and Dead Indian canyons (BLM and Forest Service 1997).

Thick snow packs in the TSZ that are rapidly melted by warm rain storms are the primary natural event that affects water quality and fisheries. Several earthflows and debris flows reactivated mainly in the canyon sideslopes landform during the 1955, 1964, 1974, and 1997 rain-on-snow events. Several new landslides also occurred in the steep canyon sideslopes terrain. These storms, especially the 1964 and 1997 events, caused both natural and management related slides to transport sediment to nearby streams (BLM and Forest Service 1997: 58). Where rain-on-snow events occur within a few years after a high-intensity fire, there can be a synergistic effect from the lack of vegetation on the forest floor, increased snowpack in the opening created by the fire, lack of interception from the canopy and rapid melting of snowpack. When this overlap of disturbance events occurs significant mass-movement and erosion activity may occur.

Project Effects and Natural Range of Variability

The Little Butte Creek watershed is an active landscape with respect to erosional processes. Conditions in the Little Butte Creek watershed are highly variable and have been substantially altered by past management practices such as timber harvest and fire exclusion, private land development and irrigation withdrawals. The Little Butte Creek watershed assessment described current and reference conditions for aquatic processes and functions and discussed ecological trends but it did not establish metrics that reflect the natural variability at the watershed scale.

There are two central concerns in the Little Butte Creek watershed based on the Little Butte Creek watershed assessment:

1: Whether the clearing for the project would cause excessive erosion and sediment deposition that would adversely impact any of the affected streams. Sediment levels throughout the Little Butte Creek system are limiting and excess or chronic sediment deposition to streams is a significant cause for concern.

GeoEngineers completed a stream crossing turbidity, construction risk, and site response analysis (see Section 1.3). Evaluations for stream channel crossings in the Little Butte Creek watershed are summarized in table 2-49. Best Management Practices that would be applied at each crossing, grouped by "blue" (low risk) and "yellow" (moderate risk) turbidity and risk ratings are shown in table 2-53.

- The crossing at MP 166.21 (Daley Creek) is an intermittent stream with a "Low" crossing risk. Best Management Practices from the "blue" category in table 2-53 would be applied at this crossing.
- The crossing at MP 162.45 (Upper South Fork Little Butte Creek subwatershed) was rated as Moderate Risk for construction impacts and/site response where "yellow" BMPs would be applied. The "yellow" BMP group includes additional measures for bank and stream bottom stabilization as needed including grading or terracing over steepened banks, use of geotextile fabrics, fiber rolls, rock and rip-rap placement, in-stream structures, stratified backfill, structural fill placement and LWD placement (table 2-53).

In all crossing groups,

- Silt fencing would be installed and maintained until effective ground cover is reestablished.
- Effective ground cover would be in place prior to the onset of seasonal precipitation (table 2-14).
- Rapid reestablishment of vegetation would be emphasized.

These are all proven and effective erosion control and water quality BMPs andbased on site-specific evaluations and field reviews (GeoEngineers, 2011; Koler 2013), these are expected to be effective. If these BMPs are applied, sediment impacts are expected to be minor, short term and consistent with the evaluation in Section 1.3.1. Long-term adverse consequences on water quality from soil erosion are not expected to occur due to the establishment of effective ground cover, revegetation of disturbed areas, installation of waterbars to disperse water, regrading over-steepened slopes, and the relative lack of corridor intersects with aquatic systems.

2: Whether removal of effective shade may increase water temperatures in streams.

Restoring stream crossings reconnects aquatic habitats by allowing the passage of aquatic biota and restoring riparian vegetation. Over time, these actions reduce sediment and restore shade. Restoration of these crossings includes riparian planting as a mitigation which will help offset the impact of shade removal at pipeline R/W crossings.

There are two stream crossings on NFS lands in the Little Butte Creek watershed where Riparian Reserve vegetation would be cleared. One crossing is an intermittent channel and one crossing is on a perennial stream. In addition, two Riparian Reserves are clipped, one with an associated intermittent channel and one with a wetland. The intermittent stream crossing is not expected to affect water temperatures because it would likely be dry or become discontinuous by the time that warmer water temperatures become an issue in late summer. A site-specific temperature evaluation of the perennial crossing at the South Fork of Little Butte Creek at MP 162.45 showed no change in water temperature (NSR, 2009; see Section 1.3.1.3).

Pacific Connector used predictive modeling on a representative cross-section of crossings along the Pacific Connector route, spanning the ecoregions, HUCs, width classes, and aspect classes present from Coos Bay to Malin, Oregon, including stream crossings on NFS lands. Model results show a maximum predicted increase of 0.16°C over one 75-foot clearing. Thermal recovery analysis shows that temperatures return to ambient within a maximum distance of 25-feet downstream of the project right-of-way, based on removal of existing riparian vegetation over a cleared right-of-way width of 75-feet. These findings are consistent with NSR 2009. Pacific Connector also assessed the cumulative impact of right-of-way clearing on stream temperatures. The cumulative effects of the proposed project on the thermal regime in the Coos, Coquille, South Umpqua, Rogue, Klamath, and Lost River basins is expected to be exceptionally minor and well below detection in the field given that mitigatiom for effective shade loss would occur, and that predictive modeling within SSTEMP shows local impacts are small in magnitude and spatially limited (GeoEngineers 2013f: 26). No discernable effect on stream temperatures would be expected based on these evaluations.

TABLE 2-53

Pacific Connector Proposed BMPs for Use at Waterbody Crossings

	Best Management Practices for Project Typical "Blue" Crossings and for all other crossings.	**Best Management Practices for Moderate Risk "Yellow" Crossings**	**Best Management Practices for High Habitat Risk "Green" Crossings**
Crossing MP	**166.21**	**162.48**	None
Streambed	• Dry ditch crossings (5) • Backfill to match existing streambed gradation, composition as much as possible • Profile restored to existing profile and grade • Stratified backfill for fish-bearing streams	• Dry ditch crossings (5) • Backfill with native material (3,4) • Backfill to match existing streambed gradation, composition as much as possible (4) • Profile restored to existing profile and grade (4) • Stratified backfill for fish-bearing streams (1) • Structural fill placement (2)	• Dry ditch crossings (5) • Backfill with native material (3,4) • Backfill to match existing streambed gradation, composition as much as possible (4) • Profile restored to existing profile and grade (4) • Stratified backfill for fish-bearing streams (1)

TABLE 2-53

Pacific Connector Proposed BMPs for Use at Waterbody Crossings

	Best Management Practices for Project Typical "Blue" Crossings and for all other crossings.	**Best Management Practices for Moderate Risk "Yellow" Crossings**	**Best Management Practices for High Habitat Risk "Green" Crossings**
Streambanks	• Revegetation with native plant materials (3, 4,6) • Revegetation with native trees to within 15 feet of the pipeline parallel to the alignment • Widened riparian corridor (federal lands, willing landowners) (3, 6) • Use of fast growing native tree species to accelerate shading) • Placement of large wood and boulders where appropriate • Maintenance of effective cover	• Typical erosion and sediment control BMPs including erosion control blankets, silt fence, etc. • Narrowed construction disturbance (75 feet) corridor where feasible (2,3,4) Narrowed permanent management corridor (2,3,4) • Revegetation with native plant materials (3, 4,6) • Bank graded/terraced to 3:1 (2,3) • Geotextile reinforced slope (5) • Fiber rolls (3) • Stream barbs/flow deflectors (5) • Toe rock placement (3) • Riprap placement (3) • Biotechnical "vegetation" riprap (3) • Tree revetments (3) • Anchor banks with LWD and boulders (7)	• Typical erosion and sediment control BMPs including erosion control blankets, silt fence, etc. • Narrowed construction disturbance (75 feet) corridor where feasible (2,3,4) Narrowed permanent management corridor (2,3,4) • Revegetation with native plant materials (3, 4,6) **Additional Measures** • Rootwad enhancement of bank stabilization
Riparian Vegetation	• Revegetation with native trees to within 15 feet of the pipeline parallel to the alignment (1, 3, 5, 6) • Revegetation with native woody riparian shrubs and trees (3) • Widened riparian corridor (federal lands (3, 6) • Use of fast growing native tree species to accelerate shading (3)	• Revegetation with native trees to within 15 feet of the pipeline parallel to the alignment (1, 3, 5, 6) • Revegetation with native woody riparian shrubs and trees (3) • Widened riparian corridor (federal lands (3, 6) • Use of fast growing native tree species to accelerate shading (3)	• Revegetation with native trees to within 15 feet of the pipeline parallel to the alignment (1, 3, 5, 6) • Revegetation with native woody riparian shrubs and trees for willing landowners (3) Widened riparian corridor (federal lands, willing landowners) (3, 6) • Use of fast growing native tree species to accelerate shading (3) **Additional Measures** • Emphasis on prevention and monitoring for invasive weeds and weed control during revegetation establishment.
Aquatic Habitat	• Stratified backfill for fish-bearing streams (1,2,4, 6) • Placement of large wood where appropriate (2, 4, 6)	• Stratified backfill for fish-bearing streams (1,2,4, 6) • Placement of large wood where appropriate (2, 4, 6)	• Stratified backfill for fish-bearing streams (1,2,4, 6) • Placement of large wood where appropriate (2, 4, 6) **Additional Measures** • Rootwad enhancement of bank stabilization
BMP Source	1. FERC Guidelines 2. FEIS, JPA, Appendix C, Project Description 3. JPA Appendix 1B, ECRP 4. JPA Appendix F, Affected Waters, Section 2.1.8.3 5. JPA Appendices 2C, 2D 6. JPA Appendix H, Compensatory Mitigation Plan 7. Site Specific Crossing Perscriptions- Perennial Streams on NFS Lands (NSR, 2014) Representatives of the Forest Service may require additional measures necessary to meet agency standards under the terms of the Right-of-Way Grant.		

Table 2-54 compares project effects to the historic range of variability for erosional processes, ecological succession and vegetative condition, flow regimes, stream temperature and aquatic habitat complexity.

TABLE 2-54

Project Effects and Relevant Ecological Processes Described in the Little Butte Creek Fifth-Field Watershed Assessment

Ecological Processes Relevant to the Project	Historic Range of Variability	Pacific Connector Effects
Erosional Processes	The primary natural event that affects water quality and fisheries is thick snow packs in the TSZ that are rapidly melted by warm rain storms. During the 1955, 1964, 1974, and 1997 rain-on-snow events, several earthflows and debris flows reactivated, mainly in the canyon sideslopes landform. Several new slides also occurred in the steep canyon sideslopes terrain. These storms, especially the 1964 and 1997 events, caused both natural and management related slides to transport sediment to nearby streams (BLM and Forest Service 1997, p. 58) The lower elevation Klamath-Siskiyou Province portion of the watershed is driven more by winter rainfall, streambank erosion and occasional rain-on-snow events at mid elevations. Where high-intensity rainfall events overlapped recent fire events, surface erosion and landslide activity could increase dramatically. Infiltration rates are relatively lower, and hence, surface erosion rates are relatively higher when compared to the pumice dominated High Cascades Province. Surface erosion potential for disturbed soils is high. Reestablishment of effective ground cover significantly reduces surface erosion rates (BLM and Forest Service 1997, p 59). Fire return intervals range from 1 to 25 years in the lower elevation interior valleys and lower elevation forests, to 25 to 100 years in lower elevation mixed conifer forests (BLM and Forest Service 1997, p. 34). Erosional processes in the upper elevation High Cascades portion of the Little Butte Creek watershed (Forest Service) are driven by snowmelt and occasional rain-on-snow events. Pumice soils have high infiltration rates, but steeper slopes can be prone to landslides when saturated from snow melt. Summer thunderstorms are not unusual in Little Butte Creek watershed and can deliver intense but localized rain events. These events can result in pulses of sediment particularly if associated with recent fires.	On NFS lands (generally High Cascades Province) the project is located on ridge tops or on the flat pumice-dominated Dead Indian Plateau. The project does not cross steep canyon sideslope landforms that are prone to landslides. No unstable earthflow terrains are crossed (GeoEngineers, 2009). Application of BMPs described in the Stream Crossing Risk Assessment (GeoEngineers 2013), including maintenance of effective ground cover and revegetation according to the ECRP, are expected to minimize sediment transport to streams. Stream channel crossings are widely separated and unlikely to aggregate sediment downstream. Sediment produced by the project during construction using dam-and-pump construction methods is expected to be minor and short-term (see Section 1.3.2). Given the fire history of the area, and erosional processes, these effects are well within the range of natural variability for the Little Butte Creek watershed.
Ecological Succession/ Vegetative Condition	The Little Butte Creek watershed is very diverse, ranging from interior valley plant communities dominated by agriculture, grassland and oak woodlands to high elevation alpine forests. In the lower elevation Klamath-Siskiyou Province, higher frequency, low to moderate intensity fires created a mosaic of vegetation types with occasional stand-replacing fires during droughts. At higher elevations, fire frequency decreased and intensity increased resulting in more stand-replacement type events. On the Dead Indian Plateau gentler slopes limited the spread of stand-replacing fires when compared to steeper slopes. Fire Suppression and timber management have reduced and fragmented late successional stands that reduced patch size, shifted species dominance to white fir and increased early and mid seral proportions of the	The project would clear 207.17 acres and modify 69.51 acres of NFS land which accounts for 0.46% of the NFS in the Little Butte Creek watershed. Approximately 7.66 acres of Riparian Reserve vegetation would be cleared on NFS lands. This is 0.09% of the Riparian Reserves on NFS lands in the watershed. Of this, approximately 3.70 acres are LSOG forest. The clearing of LSOG and mid seral vegetation are long-term changes in vegetative condition. Given the fire history (see Section 2.5.5.2, Changes in Watershed Condition) of the watershed, this is well within the range of natural variability for the Little Butte Creek watershed.

TABLE 2-54 **Project Effects and Relevant Ecological Processes Described in the Little Butte Creek Fifth-Field Watershed Assessment**		
Ecological Processes Relevant to the Project	**Historic Range of Variability**	**Pacific Connector Effects**
	drainage. Late successional and old growth acres in both upland and riparian areas are below historic averages. Vegetative condition throughout the Little Butte Creek watershed has been significantly altered by timber management activities.	
Flow Regime	Prior to the introduction of irrigation in the Little Butte Creek watershed, summer stream flows were directly related to the amount and timing of precipitation events. Years of high rainfall and large spring snow packs resulted in summer flows that provided adequate water supplies for aquatic dependent species. Drought years produced low flows and likely there were some dry stream channels by the end of the summer. Irrigation withdrawals that began in the late 1800s and became more extensive in the early 1900s greatly reduced summer stream flow throughout the watershed. Historically, major flood events were generally the result of rain-on-snow events (BLM and Forest Service 1997, p. 147). The completion of Fish Lake dam in 1915 modified the winter streamflow regime in North Fork Little Butte Creek. Fish Lake stored the winter runoff and moderated the peak flows occurring downstream in North Fork Little Butte Creek. Irrigation withdrawals have significantly reduced summer flows, particularly in the lower part of the watershed. Extensive road building, timber harvest, and land clearing in Little Butte Creek watershed have raised the potential for increasing the magnitude and frequency of peak flows in the tributaries and main stem. Openings in the TSZ are of particular concern as they tend to produce higher stream flows during rain-on-snow events (BLM and Forest Service, 1997).	Large areas of vegetation removal in the TSZ and increased road networks/road densities within watersheds are known to increase peak-flows during rain-on-snow events. Most of the Pacific Connector route in Little Butte Creek watershed is in the TSZ where rain on snow events occur. Analysis of vegetation patterns in the Little Butte Creek watershed assessment (p. 88) showed that the Little Butte Creek subwatersheds were all above the established recovery thresholds and were considered hydrologically recovered. This means that an increase in peak flows from vegetation change would have to be large enough to drop a subwatershed below recovery thresholds before a significant increase in peak flows is likely. The project crosses six different subwatersheds. The largest impact in any single subwatershed is the Upper South Fork of Little Butte Creek; approximately 1% of the subwatershed is affected by the project. There is only one stream crossing in the Upper South Fork, so hydrologic connectivity with the project is very limited. Given the limited extent of the project in any single subwatershed, the relative lack of hydrologic connectivity and the hydrologically recovered vegetative condition of the watershed, it is highly improbable that the project would alter flow conditions or have an affect on flows. See also DEIS section 4.3.4.
Stream Temperature	Historically, stream temperatures were likely lower than today. Water quality in the Little Butte Creek watershed was probably very good prior to Euro-American settlement: low summer water temperatures, acceptable chemical and biological parameters, and low sediment/turbidity levels. This was due to the wide, diverse riparian zones, low width/depth ratios, greater summer flows, and low sediment input. Land clearing activities in the late 1800s and early 1900s resulted in a reduction of riparian vegetation that allowed more solar radiation to reach streams. This likely resulted in increased water temperatures. Irrigation withdrawals, during this same time period, lowered stream flows and contributed to increased stream temperatures.	There are two stream crossings on NFS lands in the Little Butte Creek watershed where Riparian Reserve vegetation would be cleared. One crossing is an intermittent channel and one crossing is on a perennial stream. The intermittent stream crossing is not expected to affect water temperatures because it is likely to be dry or become discontinuous by the time that warmer water temperatures become an issue in late summer. A site specific temperature evaluation of the perennial crossing at the South Fork of Little Butte Creek at MP 162.45 showed no change in water temperature (NSR 2009). (See Section 1.3.1.3 and EIS Chapter 4.4). Based on this evaluation, no discernable effect on stream temperatures would be expected.
Aquatic Habitat Stream Channel Complexity	Beaver dams and natural geomorphic processes created complex, sinuous channels with low width to depth ratios and high pool frequencies. Sediment inputs were dominated by pulses of landslide deposits associated with floods from peak flow events (Everest and Reeves, 2007). The loss of beaver dams due to fur trapping in the 1830s to 1840s resulted in scouring of channel beds and banks, reduction in the number of stream reaches with multiple channels, increased width/depth ratios, and	During construction, the project would alter the bed and banks of stream channels and move LWD and boulders as necessary for construction. After construction, these sites would be restored to their preconstruction condition and stabilized as needed by placement of boulders, LWD, and erosion control structures as specified in the ECRP and Wetland and Waterbody Plan. Therefore, no long term effects to aquatic habitat and channel complexity are expected. Effects would be limited to the project scale, and are minor and short-

TABLE 2-54 **Project Effects and Relevant Ecological Processes Described in the Little Butte Creek Fifth-Field Watershed Assessment**		
Ecological Processes Relevant to the Project	**Historic Range of Variability**	**Pacific Connector Effects**
	increased fine sediment deposition in pools. Channelization resulted in entrenched channels with greater width/depth ratios. Decreases in sinuosity accompanied by increased stream gradients and reduced bedload transport capability were a consequence of the larger width/depth ratios (BLM and Forest Service 1997).	term (typically 1 to 5 days per crossing). Additionally, 1.5 miles of LWD in-stream projects are a part of the mitigation plan (see Section 2.5.5.6).

Compliance with Land Management Plans

Table 2-55 describes RRNF/NWFP Standards and Guidelines relevant to the ACS and project compliance with this management direction in the Little Butte Creek watershed.

TABLE 2-55 **Compliance with Applicable Land Management Plan Direction**	
RRNF/NWFP Standard and Guideline	**Project Compliance**
LH-4: Issuing leases, permits, right-of-way and easements.	Terms and conditions to ensure compliance with ACS objectives have been incorporated into the BLM Right-of-Way Grant in the form of 28 exhibits to the POD. These plans include the Wetland and Waterbody Crossing Plan, the Erosion Control and Revegetation Plan, the Hydrostatic Test Plan, the right-of-way Clearing Plan, the TMP, and others.
RA-4: Locating water withdrawal sites.	Pacific Connector has developed a Hydrostatic Test Plan (see the POD) that would minimize any potential short-term effects on stream flows from water discharge events from the project's hydrostatic testing operations. No potential hydrostatic test water sources under Forest Service or BLM jurisdiction occur within the Little Butte Creek watershed, therefore the biological, physical, and chemical integrity of these systems would remain unaffected from hydrostatic withdrawal activities.
RF-2: Road Construction Standards and Guidelines	The existing transportation system in the Little Butte Creek watershed would be adequate for construction of the project. No new temporary or permanent access roads are planned in the Little Butte Creek watershed.
RF-4: New culverts, bridges and other stream crossings.	No new road crossings of streams are proposed in the watershed. Crossings would be maintained to prevent diversions. See TMP specifications and TMP Section 2.2.3 and TMP Exhibit F, Section F.9.e which require culvert and bridge replacements to meet agency standards and agency approval of plans.
RF-5: Minimizing sediment delivery from roads.	Road maintenance specifications T-831, T-842, T-811 and T-834, which are designed to minimize sediment delivery to aquatic habitats, would be implemented during project construction. Several road improvement projects and road decommissioning are proposed in the Little Butte Creek watershed. These are expected to reduce sediment delivery from roads, in some places significantly.
RF-6: Maintaining fish passage.	Fish passage would be maintained at all road crossings where project-related road repairs are implemented.
RF-7: Transportation Management Plan development.	The TMP meets all of the requirements of RF-7.

TABLE 2-55 **Compliance with Applicable Land Management Plan Direction**	
RRNF/NWFP Standard and Guideline	**Project Compliance**
WR-3: Proper use of planned mitigation and restoration.	Application of BMPs and aggressive erosion control measures, restricted construction windows, and numerous other impact minimization measures have been incorporated into the POD to prevent habitat degradation. These measures are not being used as a substitute for otherwise preventable habitat degradation or as surrogates for habitat protection.
Management direction for Survey and Manage Species in the NWFP ROD was replaced by the 2001 ROD and Standards and Guidelines for Amendments to the Survey and Manage, Protection Buffer, and other Mitigation Measures Standards and Guidelines as Modified by the 2011 Settlement Agreement in Conservation Northwest v. Sherman, Case No. 08-CV-1067-JCC (W.D. Wash.)	The project affects Survey and Manage species within the Little Butte Creek watershed. Such effects are inconsistent with land management plan direction forthe Forest Service. Regardless, the project does not threaten the persistence of any Survey and Manage species (see appendix F). Waiving application of Management Recommendations for Survey and Manage species in the watershed would not prevent attainment of any ACS objective.
Retain late-successional forest patches in landscape areas where little late-successional forest persists. This management action/direction will be applied in fifth-field watersheds (20 to 200 square miles) in which federal forest lands are currently comprised of 15% or less late-successional forest (The assessment of 15% will include all federal land allocations in a watershed). Within such an area, protect all remaining late-successional forest stands. Protection of these stands could be modified in the future, when other portions of the watershed have recovered to the point where they could replace the ecological roles of these stands.	Federal lands in the Little Butte Creek watershed are currently 24% LSOG and exceed this threshold.
Standards and Guidelines for Facilities in Restricted Riparian (MA 26) areas: Helispots and transmission corridors should be located outside this management area. (RRNF LRMP 4-308)	MA 26, Restricted Riparian does not allow utility corridors to cross this land allocation. The project right-of-way crosses a part of the Restricted Riparian Land Allocation at the South Fork of Little Butte Creek. A forest plan amendment is necessary. Amendment RRNF-5 allows the project to cross approximately 3.63 acres of the Restricted Riparian Land Allocation.
Standards and Guidelines in the RRNF Lands and Resource Management Plan (RRNF LRMP 4-41, 4-83, 4-97, 4-123, 4-177, 4-307).	No more than 10% of an activity area should be compacted, puddled or displaced upon completion of project (not including permanent roads or landings). No more than 20% of the area should be displaced or compacted under circumstances resulting from previous management practices including roads and landings. Permanent recreation facilities or other permanent facilities are exempt. The project cannot meet this standard, and a project specific amendment of the RRNF LRMP is necessary. RRNF-6 allows the project to exceed restrictions on detrimental soil conditions from displacement and compaction within the project right-of-way on an estimated 60 acres.

Compliance with Standards and Guidelines for Key Watersheds

The Little Butte Creek watershed above the confluence of the North and South Forks was delineated as a Tier 1 Key Watershed in the NWFP. Applicable Standards and Guidelines for Key Watersheds and project consistency is shown in table 2-56.

TABLE 2-56 **Standards and Guidelines for Key Watersheds**		
Standard and Guideline	**Project Consistency**	**Mitigation Plan**
Reduce existing system and nonsystem road mileage, with no net increase in road miles	No new roads would be constructed by the project. The construction corridor would be obliterated after construction.	Decommissioning of 57.5 miles of road would on NFS lands would result in a net decrease of road miles and reduce road density in the Tier 1 Key Watershed.
No new roads would be constructed in inventoried Roadless Areas.	No part of the project is in an inventoried Roadless Area.	None
Watershed Analysis/Assessment must be completed prior to management activities.	Watershed Analysis/Assessment has been completed for all watersheds crossed by the project on NFS lands.	Off-site mitigations are consistent with watershed assessment recommendations

Relationship of Proposed Forest Service Land Management Plan Amendments to the ACS

The RRNF LRMP contains Standards and Guidelines that cannot be met by the project. Two of these Standards and Guidelines have a nexus with the ACS in that they provide protection for aquatic resources that are more restrictive than the NWFP. Site-specific amendments of these Standards and Guidelines are proposed to make provision for the project. This discussion addresses whether those plan amendments would prevent attainment of the ACS.

RRNF-5. Amends Management Area (MA) 26 (Restricted Riparian)

This Standard and Guideline in the RRNF LRMP prohibits development of energy transmission facilities in the Restricted Riparian land allocation. The purpose of this Standard and Guideline is to protect unique riparian habitats associated with perennial streams for wildlife, fishery, and other beneficial uses and to protect perennial streams from detrimental changes in water temperature, blockages of water courses, and deposits of sediment. The Restricted Riparian land allocation occurs on all lakes, perennial streams, and wetlands within 100-feet of the riparian feature or to the extent of associated riparian vegetation. The project right-of-way crosses one perennial stream, the South Fork of Little Butte Creek, and one wetland associated with Daley Creek, an intermittent stream. The crossing of the South Fork of Butte Creek occurs at MP 162.45 in the Upper South Fork Little Butte Creek subwatershed and affects approximately 2.36-acres of riparian habitat. The crossing of the wetland associated with intermittent Daley Creek occurs at MP 166 in the Beaver Dam Creek subwatershed and clears approximately 0.9-acres of riparian habitat.

Possible environmental consequences associated with a Forest Plan amendment of MA 26 to allow crossing of Restricted Riparian zones include the following.

Stream Temperature: One perennial stream, the South Fork of Little Butte Creek at MP 162.45 is crossed by the project right-of-way. Oregon State water quality standards (Oregon Administrative Rules 340-041-0028) state that all nonpoint sources taken together at the point of maximum impact may not exceed 0.3 ºC (0.5 ºF). The Rogue Basin TMDL (2006) allocates the human use allowance to be 0.3 ºC increase at the point of maximum impact (i.e., downstream of tributaries impacted by pipeline construction). In addition, all of the stream crossings in the Little Butte Creek watershed are designated as core cold water habitat (OAR 340-041 figure 271A). The OAR (340-041-0028) states that streams designated with a fish use of core cold water habitat may not exceed 16.0 ºC (60.8 ºF) as measured by the seven-day-average maximum stream temperature.

At the request of the Forest Service, NSR conducted a site-specific evaluation of impacts of shade removal on water temperature at the proposed crossing of the project right-of-way at the South Fork of Little Butte Creek (NSR, 2009). This analysis concluded the project crossing on the South Fork of Little Butte Creek was not likely to increase water temperature. Daley Creek is an intermittent stream and is dry during warm summer months most years, so water temperature at the Daley Creek crossing is not likely to be affected by the project.

Pacific Connector used predictive modeling on a representative cross-section of crossings along the project alignment, spanning the ecoregions, HUCs, width classes, and aspect classes present from Coos Bay to Malin, Oregon, including stream crossings on NFS lands. Model results show a maximum predicted increase of 0.16°C over one 75-foot clearing. Thermal recovery analysis shows that temperatures return to ambient within a maximum distance of 25-feet downstream of the project right-of-way, based on removal of existing riparian vegetation over a cleared right-of-way width of 75-feet. These findings are consistent with NSR 2009. Pacific Connector also assessed the cumulative impact of right-of-way clearing on stream temperatures. The cumulative effects of the project on the thermal regime in the Coos, Coquille, South Umpqua, Rogue, Klamath, and Lost River basins is expected to be exceptionally minor and well below detection in the field given that the loss of effective shade mitigation would occur, and that the predictive modeling of SSTEMP predicts that the local impacts are small in magnitude and spatially limited (GeoEngineers 2013f: 26).

Sediment: There is one stream crossing in the RRNF where sediment deposition is a potential issue. See table 2-53 for a description of crossing risk and associated BMPs for water quality. Pacific Connector's ECRP is consistent with BMPs designed to ensure that beneficial uses of water are protected from excessive sediment deposition. Erosion control measures include:

- Potential compaction on the project right-of-way is mitigated (e.g., scarification, subsoiling, ripping, Paraplow/wing-tipped ripper, etc.) and a roughened seedbed is created to minimize runoff and promote infiltration.
- Waterbars are installed at appropriate intervals based on slope gradient to divert runoff to stable areas and to minimize concentrated flows and potential erosion hazards.
- The project right-of-way is replanted with native grasses, trees, and shrubs (with the exception no trees within the 30-foot operational easement).
- Slash is redistributed across the project right-of-way to provide cover and long-term nutrient cycling.
- No maintenance roads would be established along the project right-of-way. Additionally, with the measures in the TMP, the project's use of the existing road system would improve the existing conditions, because the applicant would be required to improve/maintain the existing road system.
- Compliance with site-specific restoration plan prepared by Forest Service and submitted by the applicant for the South Fork Little Butte Creek crossing at MP 162.45.

Additional BMPs (table 2-53) that may be used on-site as needed include:

- Typical erosion and sediment control BMPs including erosion control blankets, silt fence, etc.
- Bank graded/terraced to 3:1
- Geotextile reinforced slope
- Fiber rolls
- Stream barbs/flow deflectors
- Toe rock placement
- Riprap placement
- Biotechnical “vegetation” riprap
- Tree revetments

Sediment effects are expected to be minor and short-term with dam-and-pump construction and application of BMPs as described in Section 1.3.1.2 and would not prevent attainment of ACS objectives.

Blockages of Water: The only perennial stream crossed in the Little Butte Creek watershed is the South Fork Little Butte Creek at MP 162.45. The project would not create any blockage of water (other than those short-term blockages that occur during construction with dam-and-pump) because the pipeline would be buried and constructed in a manner that the stream bed and banks would be restored to original contours.

Protection of Riparian Habitat for Fish and Wildlife: Assuming that the extent of MA 26 matches the extent of the Riparian Reserve on South Fork Little Butte Creek, the project would clear a total of 3.26-acres of vegetation within MA 26 of which 1.24-acres is LSOG. The applicant-filed mitigation plan includes the following on NFS lands in the Little Butte Creek watershed:

- 4.3-miles of road decommissioning in riparian habitats. This would allow restoration of approximately 10.4-acres of riparian vegetation that is currently occupied by roads.

- Replanting of native riparian vegetation within 100-feet of waterbodies or the extent of Riparian vegetation crossed on federal lands. This reestablishes riparian vegetation in the project right-of-way.

- Creation of 1,200-snags on 600-acres of NFS lands of which approximately 126-acres are in Riparian Reserves. This replaces snags cut in association with the project right-of-way.

- Placement of CWD on 600-acres, of which an estimated 126-acres are in Riparian Reserves. This replaces CWD removed during construction of the project and contributes to riparian habitats where placed in Riparian Reserves.

- Placement of large wood in stream channels associated with stream crossings and on 1.5-miles of the South Fork, Little Butte Creek.

- Replacement of large woody debris in the project right-of-way.

These measures restore components of riparian habitat on more acres of MA 26 than are affected by the project. The loss of 1.24-acres of LSOG vegetation in MA 26 at MP 162.45 is a long-term change in vegetative condition; however, given the fire history of the Little Butte Creek watershed (table 2-49) this degree of change is well within the range of natural variability for the watershed.

Conclusion: Based on this evaluation, it is unlikely that waiving the prohibition of utility corridors crossing MA 26 Restricted Riparian would prevent attainment of ACS objectives in the Little Butte Creek watershed.

RRNF 6. Site-Specific Amendment to Waive Limitations on Detrimental Soil Conditions within the Pacific Connector Right-of-Way in All Management Areas:

Standards and Guidelines in the RRNF LRMP (RRNF LRMP 4-41, 4-83, 4-97, 4-123, 4-177, 4-307) states:

> No more than 10% of an activity area should be compacted, puddled or displaced upon completion of project (not including permanent roads or landings). No more than 20% of the area should be displaced or compacted under circumstances resulting from previous management practices including roads and landings. Permanent recreation facilities or other permanent facilities are exempt.

This Standard and Guideline was developed to limit adverse impact to soils from timber sales and other developments so that the basic productivity of the land was maintained. Degraded soil conditions may occur in cleared project areas. On NFS lands in the Little Butte Creek watershed, approximately 75% (207 acres) of the project right-of-way would be cleared. Degraded soil conditions may result from displacement and compaction following completion of project construction and rehabilitation. Compaction can largely be addressed by subsoil ripping, but displacement would be unavoidable because of the nature of the project. Existing LRMP Standards and Guidelines allow up to 10% of the project right-of-way or 27-acres to result in a degraded soil condition on completion of a project. Thus, the proposed amendment allows an estimated additional 180-acres or 0.3% of the NFS lands in the Little Butte Creek watershed to be in a degraded soil condition on completion of the project.

Severe disturbances such as soil mixing or displacement without mitigation would reduce long-term site productivity by displacing the duff layer and soil surface (A horizon), thus reducing the soil's ability to capture and retain water and nutrients. Sites with long-term detrimental soil conditions may have interrupted hydrologic function and poor site productivity. Compacted and/or displaced soils may increase runoff resulting in sediment erosion and therefore have lower rates of vegetative recovery.

Environmental consequences associated with 180-acres of additional detrimental soil conditions above LRMP thresholds include:

- **A potential increase in sediment mobilization**. The following measures have been incorporated into the project design or mitigation plans to limit sediment erosion.
    - The project alignment was selected to avoid areas with high geologic hazards. No landslides have been identified that pose a threat to the project. The project does not cross unstable earthflow terrains identified in the Little Butte Creek watershed.
    - Effective erosion control measures and BMPs are required as shown in the ECRP (see Section 1.3 for a discussion of erosion control measures). Additionally, the project would comply with LRMP Standards and Guidelines for maintenance of effective ground cover (see Section 1.3.1.2).

- Offsite mitigation measures that would help to offset these effects on NFS lands in the Little Butte Creek watershed include 57.51-miles of road decommissioning. Assuming a 14-foot average road width, 57.51-miles of proposed road decommissioning would reduce compaction and revegetate approximately 90-acres that are currently native road surfaces in the Little Butte Creek watershed. This substantially compensates for areas that may in a detrimental soil condition (see Section 2.5.4.7).

- The Forest Service would require soil remediation as needed with biosolids or other organic materials in areas with potential revegetation difficulty within the project right-of-way. The use of biosolids used in concert with wood chips has been shown to be an effective mitigation for impacts to soil productivity from mixing and displacement (Orton, 2007).

- Soil conditions from detrimental sediment impacts are expected to be minor and short term as the result of the linear nature of the project and its dispersal effects, ground cover maintenance, BMPs application, ridge top location, few stream crossings, and application of offsite mitigations. The amendment of the LRMP is unlikely to exceed the soil disturbance thresholds on 145-acres, resulting in the mobilization of sediment preventing attainment of ACS objectives in the Little Butte Creek watershed.

- **A potential localized increase in peak flows:** Changes in peak flows may occur where there are large changes in vegetative condition in the TSZ within a watershed. The Forest Service concluded in the Little Butte Creek watershed assessment that peak flows in the headwater streams would decrease slightly as the area continued to recover hydrologically. Reduced harvest and restoration efforts under current land allocations would accelerate the recovery process. Roads would continue to affect peak flows. At the time of publication, the watershed assessment estimated conservatively that 72% of the vegetation in the South Fork of Little Butte Creek in the TSZ was hydrologically recovered and that 75% of the vegetation in the TSZ throughout the basin was hydrologically recovered. This is above the threshold of 70% for increasing peak flows by removing vegetation in the timber types on the Dead Indian Plateau (BLM and Forest Service, 1997: 88). The project affects 0.94% of Upper South Fork of Little Butte Creek subwatershed and 0.25% of the entire watershed when all ownerships are considered (table 2-46). Therefore, where changes in peak flows are likely, clearing associated with the project would not move either the South Fork Little Butte Creek or the subwatersheds of the Little Butte Creek watershed above the threshold. The FERC also concluded that the probability of project-caused increases in peak flows was minimal because of the small proportion of any single subwatershed that is affected by the project right-of-way. Additionally, there are two widely separated stream-corridor intersects that are miles apart. This limited hydrologic connectivity makes it highly improbable that the project could affect peak flows even in the most severe conditions (also see also EIS Section 4.4).

  Amending the LRMP to allow detrimental soil conditions on 145-acres is unlikely to result in any change in flows that would prevent attainment of ACS objectives. This is due to limited hydrologic connectivity, the dispersed nature of impacts, the hydrologically recovered condition of the watershed, and limited project impacts.

- **A potential loss of site productivity, which may slow vegetative recovery**: Soils derived from High Cascades volcanic units on the Dead Indian Plateau may be low in productivity.

Mechanically decompacting the soil to a minimum depth of 20-inches and reestablishing soil organic matter would be a critical first step in rehabilitating the soil toward a more natural condition. Soil rehabilitation would also require recovery of the soil biology, which requires restoration of the soil organic matter over time. Project mitigation measures would be used to decompact the project right-of-way, fertilize disturbed areas, reestablish native vegetation (i.e., limiting the area directly over the pipe to grasses and shrubs), and scatter slash and CWD back across the site to provide for long-term nutrient cycling as required in the ECRP. Additionally, the Forest Service would require soil remediation with biosolids in any areas that are likely to have revegetation issues due to soil productivity. Soil remediation with biosolids is a proven method of restoring soil productivity (Orton, 2007; NSR 2015). Any loss of soil productivity would be widely dispersed. Also , decommissioning 57.5-miles of roads (estimated to be 111-acres, assuming a 16-foot road base) on NFS lands would contribute to offsetting any loss of soil productivity.

It is highly unlikely that reduced soil productivity would prevent attainment of the ACS objectives. The very limited area of detrimental soil conditions that may persist in Riparian Reserves due to the dispersed nature of this potential impact, soil remediation measures using woodchips and biosolids and on-site and off-site mitigation measures will reduce this likelihood.

Conclusions: Amendments RRNF-5 (MA 26 Restricted Riparian) and RRNF-6 (detrimental soil conditions) have minor effects at the site scale. It is highly unlikely that those effects would prevent attainment of ACS objectives.

Offsite Mitigation

Environmental Effects of Proposed Mitigation Actions

Offsite mitigation is intended to provide supplemental actions for projects that cannot be completely mitigated with on-site design features in order to ensure land management plan objectives are achieved. These projects also contribute to the "Maintain and Restore" objectives of the ACS. The Forest Service and Pacific Connector have entered into Agreements in Principle to accomplish off-site mitigation work in the Little Butte Creek watershed as shown in tables 2-57 and 2-59. Mitigation measures were developed from the recommendations of watershed assessments, Late Successional Reserve Assessments and the 2011 Northern Spotted Owl Recovery Plan. Proposed mitigation measures in the Little Butte Creek watershed with a nexus to the ACS include:

- **LWD Instream.** Placement of LWD in streams adds structural complexity to aquatic systems by creating pools and riffles, trapping fine sediments and can contribute to reductions in stream temperatures over time (Tippery, Jones et al. 2010). This is responsive to Aquatic Conservation Strategy objectives 2, 3, 4 and 5.

- **Road Decommissioning.** Decommissioning roads can substantially reduce sediment delivery to streams (Madej, 2000; Keppeler et al., 2007). Proposed road decommissioning would increase infiltration, reduce surface runoff, and reduce sediment production from road-related surface erosion in the watershed where the impacts from the project occur. This mitigation is responsive to ACS objectives 2, 3, 4 and 5 and Standards and Guidelines for Key Watersheds (Forest Service and BLM 1994b: B-11, C-7).

- **Stream Crossing Repair.** Old culverts may block fish passage either by poor design or by failure over time. Removing these blockages and replacing them with fish-friendly designs can allow fish and other aquatic organisms to access previously unavailable habitat. This is responsive to ACS Objectives 1, 2, 3 and 9 (Forest Service and BLM, 1999b, Lanigan et al., 2012).

- **Fuels Reduction.** There will be direct impacts to the existing interior, affecting the interior habitat. The project will result in additional fragmentation and preclude the recovery of fragmented habitat for those stands adjacent to the pipeline corridor. Maintenance of pipeline corridor will provide a continued vector for predators, early seral species and non-native species. The project will also result in a direct loss in biological services provided by mature forest characteristics for many decades past the life of this project. Both mature stands and developing stands will be removed during pipeline construction. Density management of forested stands will assist in the recovery of late-seral habitat, impact from fragmentation, reduction in edge effects and enhance resilience of mature stands. Accelerating development of mature forest characteristics will shorten the impacts of those biological services loss due to pipeline construction. Thinning of young stands is a recognized treatment within LRSs if designed to accelerate development of late-successional habitat characteristics (NWFP ROD C-12). ROD Pages B-11 ACS Objectives , C-11 and C-17. **Specialized Habitats.** The Little Butte Creek watershed provides habitat for species that are narrowly specialized. Restoration of these habitats is responsive to ACS objective 9.

    - **Mardon skipper butterflies.** The Dead Indian Plateau is one of the few places in the world where Mardon skipper butterflies are found. The project operational corridor that would be maintained in low-growing vegetation provides an opportunity to establish desired habitat for this species.

    - **Short Horned Grasshoppers.** The project is adjacent to a known site for short-horned Grasshoppers. This species is on the Region 6 Regional Forestors Sensitive Species list. The pipeline requirement of a permanent open corridor provides a unique opportunity to develop habitat.

Watershed Conditions and Related Mitigations on NFS Lands

The project crosses portions of the Lower North Fork, Upper North Fork, Lower South Fork, Middle South Fork, Upper South Fork and Beaver Dam Creek subwatersheds on NFS Lands in the Little Butte Creek watershed. All of the NFS lands in the Little Butte Creek watershed are classified as a Tier 1 Key Watershed. Standards and Guidelines for Tier 1 Key Watersheds overlay all other land allocations.

Mitigations in LSRs are included in this ACS assessment because the LSR network is also an important component of the ACS. The Standards and Guidelines under which LSRs are managed provide increased protection for all stream types. Because these reserves possess late-successional characteristics, they offer core areas of high quality stream habitat that would act as refugia and centers from which degraded areas can be recolonized as they recover (i.e., Riparian Reserves).

These reserves may be particularly important for endemic or locally distributed fish species and stocks (Forest Service and BLM 1994b: B-12). Standards and Guidelines for new developments in LSRs allow those developments provided the impact is minimized and mitigated such that the impact is neutral to beneficial for the LSR in question.

Aquatic Conditions and Issues

Portions of the Little Butte Creek watershed have high road densities that have negatively affected watershed condition and wildlife habitat (BLM and Forest Service, 1997). Key issues identified in the Little Butte Creek watershed assessment for aquatic habitats include temperature, habitat modification and sedimentation. Over the last century, many streams with high aquatic habitat potential have become simplified; and therefore, have a reduced capacity to provide quality habitat. Riparian stands have decreased health and vigor, resulting in increased time to develop large tree structures for wildlife, stream shade, and future instream wood.

Placement of LWD in streams adds structural complexity to aquatic systems, traps fine sediments and can contribute to reductions in stream temperatures over time (Tippery et al. 2010). Over the last century, many streams with high aquatic habitat potential have become simplified; and therefore, have a reduced capacity to provide quality habitat. Riparian stands have decreased health and vigor, resulting in increased time to develop large tree structure for wildlife, stream shade, and future instream wood. Placement of LWD in streams adds structural complexity to aquatic systems, traps fine sediments and can contribute to reductions in stream temperatures over time. The BLM recently completed the placement on three miles of Spencer Creek below this reach. Addition of this segment would complete the stream rehabilitation on the reach of Spencer Creek where the project occurs. Logs from the PCGP Right of Way will be used for the project. An estimated 75 pieces are needed. A helicopter will be used to place the logs.

Additional restoration recommendations to address these conditions include road decommissioning, riparian planting and thinning (BLM and Forest Service 1997: Executive Summary, p. 10).

Terrestrial Conditions and Issues

The South Cascades Late Successional Reserve Assessment (1998) estimated that LSR 227 was approximately 16% LSOG habitat at the time of the assessment, but had the capacity to be 75% late seral (Forest Service et al.: 51, 113). In order to achieve that objective, the assessment recommended a number of stand-level activities to accelerate the development of late-successional stand conditions including young stand thinning, creation of snags and recruitment of large woody debris (Forest Service 1998: 189-194). Opportunities also exist for management of unique habitats.

Table 2-57 describes mitigation measures for the Forest Service that are intended to be responsive to these issues.

TABLE 2-57

Proposed Mitigation Measures on NFS Lands in the Little Butte Creek Watershed in the Rogue River National Forest

Mitigation Group	Project Name	Project Rationale	Land Allocation	Quantity
Aquatic and Riparian Habitat	SF Little Butte Creek LWD	Over the last century, many streams in the watershed with high aquatic habitat potential have become simplified, and therefore, have a reduced capacity to provide quality habitat. Riparian stands have decreased health and vigor, resulting in increased time to develop large tree structure for wildlife, stream shade, and future instream wood. Placement of LWD in streams adds structural complexity to aquatic systems, traps fine sediments and can contribute to reductions in stream temperatures over time.	Riparian Reserve, LSR	1.5 Miles
Aquatic and Riparian Habitat	Little Butte Creek Stream Crossing Decommissioning	Restoring stream crossings reconnects aquatic habitats by allowing the passage of aquatic biota and restoring riparian vegetation. Over time, these actions reduce sediment and restore shade. Restoration of these crossings includes riparian planting as a mitigation which would help offset the impact of shade removal at pipeline right-of-way crossings.	Riparian Reserve	32 Sites
Road sediment reduction	Little Butte Creek Road Decommissioning	A construction right-of-way 75-- to 95-feet wide with additional work areas would be cleared. Of this, a 30-foot-wide route along the pipeline route would be maintained in early successional habitat. This strip of land, in a forested ecosystem, provides a barrier for movement of small animals between the remaining forest blocks and degrades neighboring habitat through edge effects and fragmentation. This is of special concern in riparian ecosystems where movement of wildlife species is concentrated. Decommissioning and planting selected roads in conjunction with precommercial thinning treatments (see other mitigations) would block up forested habitat and reduce edge effects and fragmentation in a period of about 40 years. Removal of culverts and roadbeds in riparian reduces sedimentation to the waters. This mitigation meets ACS objectives 2, 4, 5, 8 and 9. Little Butte Creek watershed is a key watershed and road reduction is a major objective (NWFP ROD C-7). Note that this would be most effective if done in conjunction with the thinning proposed. This mitigation also offsets the impacts of soil compaction and displacement within the project right-of-way.	Riparian Reserve, LSR	57.5 Miles
Stand Density Fuel Break	Little Butte Creek LSR Precommercial Thin	There would be direct impacts to existing interior, developing interior habitat. The project would result in additional fragmentation and preclude the recovery of fragmented habitat for those stands adjacent to the project right-of-way. Maintenance of the project right-of-way would provide a continued vector for predators, early seral species and non-native species. Also, the project would result in a direct loss in biological services provided by mature forest characteristics for many decades past the life of this project. Both mature stands and developing stands would be removed during pipeline construction. Density management of forested stands would assist in the recovery of late-seral habitat, impact from fragmentation, reduction in edge effects and enhance resilience of mature stands. Accelerating development of mature forest characteristics would shorten the impacts of those biological services loss due to pipeline construction. Thinning of young stands is a recognized treatment within LRSs if designed to accelerate development of late-successional habitat characteristics (NWFP ROD C-12; ROD Pages B-11 ACS Objectives, C-11 and C-17).	LSR	618 Acres

TABLE 2-57 **Proposed Mitigation Measures on NFS Lands in the Little Butte Creek Watershed in the Rogue River National Forest**				
Mitigation Group	**Project Name**	**Project Rationale**	**Land Allocation**	**Quantity**
Terrestrial Habitat Improvement	Little Butte Creek Mardon Skipper Butterfly	The Dead Indian Plateau region is one of three known sites for Mardon skipper butterflies in the world. It is also adjacent to a known site for short-horned grasshoppers. Both species are on the Forest Service Sensitive Species list. The pipeline requirement of a permanent open corridor provides a unique opportunity to develop habitat for these skippers and grasshoppers. Planting the project right-of-way with plants preferred by these Sensitive Species has the potential to increase the habitat and local range for these two species. Rehabilitation of disturbed sites is required under various BMP guidelines. Use of specific plant species has no additional problems. Results would be immediate in stabilizing the local habitat and location would be in the pipeline.	LSR	20 Acres
Terrestrial Habitat Improvement	Little Butte Creek LSR LWD Placement	Mitigate for the loss of recruitment of LWD to adjacent stands and within the construction clearing zone. The project would forgo the development of large down wood for the life of the project and for decades after. Downed wood is a critical component of Mature Forest ecosystems. Large wood replacement would partially mitigate for the barrier effect of the corridor by creating structure across the corridor for use by small wildlife species. Placement in wood deficient areas adjacent to the corridor allows for scattering of stockpiled wood, reducing localized fuel loads while improving habitat in deficient stands. Larger logs maintain moisture longer and are less likely to be fully consumed by fire. Managing for the proposed levels provide for a greater assurance of species abundance (DecAID; ROD C-11). Acres that can be treated are necessarily limited by material available from the project right-of-way.	LSR	511 Acres
Terrestrial Habitat Improvement	Little Butte Creek LSR Snag Creation	Mitigate immediate and future impacts to snag habitat from the clearing of the pipeline right-of-way. The project prevents development of large snags during the life of the project and for decades after. Project construction would result in loss of snag habitat on approximately 775 acres of project right-of-way construction (includes safety zone buffer). This project would add to those cumulative impacts. As snags are a critical component of LSR spotted owl habitat, replacement is needed. Snag requirements are specifically outlined in the Forests' LMPs and NWFP. Forests require analysis and mitigation under most management activities. There would be a 10-year delay as snag decay develops. Snag management is required in the RRNF LMP (4-20), with levels set under the various management directions. Snag Management is discussed in the NWFP for LSRs on C-14 and 15 of the ROD (items 4 and 7). Snag management levels are based on the Forest's Plant Association Guidelines. Snags are also discussed in the South Cascades LSR Assessment (Chap. 3).	LSR	622 Acres
Reallocation of Matrix Lands to LSR	LSR 227 Addition	This is the Little Butte Creek portion of amendment RRNF 7 which would reallocate 512-acres from the Matrix land allocation to the LSR land allocation. This action contributes to the "neutral to beneficial" standard for new developments in LSRs by adding acres to the LSR land allocation to offset the long-term loss of acres of acres and habitat from the construction and operation of the project.	LSR	25 Acres

Relationship of Offsite Mitigations Related to the ACS and Watershed Assessment or Late Successional Reserve Assessment Recommendations

This section describes the relationship between the recommendations of the Southwest Oregon LSR Assessment (Forest Service et al. 1998), the Little Butte Creek watershed assessment (BLM and Forest Service 1997) and LRMP of the RRNF as amended by the NWFP and mitigation measures in LSR 227 and the Tier 1 Key Watershed portion of Little Butte Creek located on the RRNF.

Recommendation - Road Decommissioning. Reduction in road density was identified as a method to improve watershed conditions (Forest Servcie and BLM 1997 p. 182, 191, 205, appendix F, K). High priority areas identified in the Little Butte Creek watershed assessment and proximity to the effects of the project right-of-way were used to develop road decommissioning proposals.

- **Project Mitigation – Road Decommissioning.** The mitigation purpose of the road decommissioning project is to offset potential watershed effects from construction and to reduce impacts on wildlife habitat from edge effects and fragmentation associated with the project right-of-way. In 2010 the Forest Service completed a forest-wide transportation planning project to identify roads that are necessary for the National Forest's designated transportation system. As a result of that decision and other access considerations, 57.5-miles of roads on NFS lands in the Little Butte Creek watershed were identified that are no longer needed for access and can be decommissioned. There are 6.7 -miles of roads and 32 stream crossings in Riparian Reserves (tables 2-58 and 2-59). Current road density in LSR 227 is 3.3-miles per square mile. With the proposed road decommissioning, that would be reduced to 2.5-miles per square mile, a 24% reduction in road density measured in miles of road per square mile of LSR. Reduction in road density within a quarter mile, half mile and one mile of the project right-of-way are shown in the table 2-60.
    - **Road Decommissioning Effects on Watershed Function.** Impacts of roads on watershed values are well-documented (Trombulak and Frissell 2000; Switalski, Bissonette et al. 2004). Decommissioning roads can substantially reduce sediment delivery to streams (Madej 2000; Keppeler, Cafferata et al. 2007). The proposed road decommissioning would increase infiltration of precipitation, reduce surface runoff, and reduce sediment production from road-related surface erosion in the watershed where the effects from the project occur. Assuming a 20-foot average road width, 57.5 -miles of proposed road decommissioning would revegetate approximately 140 acres that are currently native road surfaces in the Little Butte Creek watershed.
    - **Riparian Restoration.** The project crosses one intermittent and one perennial stream on NFS lands in the watershed affecting 5.27 acres of riparian vegetation (table 2-48). Decommissioning roads in Riparian Reserves and at stream intersections has the effect of restoring connectivity within aquatic ecosystems and allowing riparian vegetation to become reestablished in riparian areas now occupied by road beds (Switalski, Bissonette et al. 2004). Approximately 6.72-miles of proposed road decommissioning on NFS lands in the Little Butte Creek watershed would occur in Riparian Reserves. A total of two stream crossings as shown below in tables 2-58 and 2-59 would be restored by proposed road decommissioning. As vegetation becomes reestablished at these crossings, it is expected that road-related sediment transport to aquatic ecosystems would be reduced (Madej 2000;Keppeler, Cafferata et al. 2007). This also supports ACS objectives 2, 3, 4, and 5, in the Little Butte Creek Tier 1 Key Watershed by reducing compaction and by revegetating approximately 14.3-acres of decommissioned roadbeds within Riparian Reserves.

TABLE 2-58

Comparison of Project Effects and Proposed Road Decommissioning on NFS Lands, Little Butte Creek Tier 1 Key Watershed

Rogue River NF	Miles in Watershed	Miles in Riparian Reserves	Acres in Riparian Reserves	Acres in Degraded Soil Condition/ Acres Restored a/	Stream Crossing
Project Right-Of-Way	13.71	0.25	5.27	60-137 degraded	1 Class II3 1 Class IV
Proposed Decommissioned Roads	57.5	6.72	14.3	138 Restored	1 Class II, 1 Class III 29 Class IV

a/ Based on 14 foot road width. Figure 2.5-4 uses a midpoint of 104 acres for potentially degraded soils.

TABLE 2-59

Stream Crossings in Decommissioned Roads by Subwatershed and Stream Class on NFS Lands, Little Butte Creek

6th Field Subwatershed	Class II	Class III	Class IV
Beaver Dam Subwatershed		1	7
Middle South Fork Subwatershed			6
Upper North Fork Subwatershed			8
Upper South Fork Subwatershed	1		9
Total	1	1	30

TABLE 2-60

Changes in Road Density with Implementation of Mitigation Plan, Little Butte Creek Tier 1 Key Watershed

Rogue River NF	Current Condition (miles/square mile)	With Road Decommissioning (miles/square mile)	Change in Road Density with Decommissioning (miles/square mile)
NFS Lands in LBC KWS	3.27	2.67	-0.6
LSR 227 in Little Butte Creek KWS	3.87	3.09	-0.78
Within 1 mile of pipeline	4.18	2.77	-1.41
Within 1/2 mile of pipeline	4.12	2.71	-1.41
Within 1/4 mile of pipeline	3.91	2.56	-1.35

Source: Forest Service GIS Analysis, (see Chapter 3))

Recommendation—Soil Productivity. Manage for an abundance of CWD in various decaying conditions in forested areas across the landscape (BLM and Forest Service 1997: 182).

Recommendation—Vegetation. Provide for well-distributed CWD across the landscape for maintaining the ecological functions of the species dependent on coarse wood (BLM and Forest Service 1997: 187). Maintaining the maximum levels of CWD consistent with reasonable fuel loadings appears to have considerable potential for enhancing site quality. Mid-seral stands with no CWD may have yields 12% lower than stands with sufficient CWD (BLM and Forest Service 1997: 75).

Recommendation—Terrestrial Wildlife Species and Habitat. Maintain adequate numbers of snags and amounts of CWD (see Vegetation Section) for those species that require these special habitats for breeding, feeding, or sheltering (BLM and Forest Service 1997: 190).

- **Project Mitigation – Upland Placement of Large Woody Debris.** Large woody debris placement in plantations is proposed to accelerate the development of LSOG characteristics by restoring this habitat component to plantations where large woody debris is lacking. Large wood would be placed in approximately 511 -acres of plantations that are also receiving stand density management treatment. Approximately 126 of those acres are in Riparian Reserves. The large wood would be from trees cut from the project right-of-way. Sites selected for fallen woody material placement would be within 0.5-mile of the project right-of-way. As with the other off-site mitigations, placement of the mitigation activities close to the project right-of-way can benefit species that are affected by the vegetation changes within the right-of-way and would make these mitigations more effective. Sites would be in early-successional stands that are currently deficient in fallen wood (as defined by Plant Association Group for Cascades White Fir forests). The large wood placement is expected to account for some of the range in variability found across the landscape. For logs 11- to 20- inches in diameter, densities would vary from 8 to 33 logs per acre. For logs over 20 -inches in diameter, densities would vary from 3 to 12 logs per acre. Logs would be approximately 40 -feet in length, and the specified diameter (i.e., 11- to 20 -inches and over 20 -inches) refers to the stem diameter at the midpoint of the 40-foot log.

- **Project Mitigation – Snag Creation.** Snag creation is proposed as a mitigation to replace snags lost in the project right-of-way for habitat for cavity-nesting birds and denning sites for mammals (e.g., bats, bears, fishers, etc.). Snags would be lost from the project right-of-way to facilitate pipeline construction or to mitigate safety hazards for construction workers. Approximately 1,200 snags would be created by blasting tops from live trees (preferably trees with existing decay that makes them more suitable for cavity-nesting birds and/or as denning sites) or by inoculating living trees with heart rot decay fungi. Sites selected for snag creation would be within 0.5 -mile of the project right-of-way to develop snag habitat within (or near) the home ranges of cavity excavators being displaced by the project right-of-way. Sites would be in mid-successional stands or around the edges of early-successional stands that are currently deficient in snags as defined by Plant Association Group for Cascades White Fir forests. Stand data for these plant associations (which is an indication of undisturbed forest snag levels) shows that these stands have an average of about four snags per acre in the range of 11- to 20- inches in diameter and an additional four snags per acre greater than 20 -inches in diameter. If the tree diameters in the stands prevent snag creation in the greater than 20-inch-diameter size class, additional snags in the smaller size class (11- to 20 -inches in diameter) would be created to make up for the deficit. For sites bordering early-successional stands, snags would be created within 100 -yards of the stand boundary at the same trees per acre levels described above.

Recommendation—Vegetation. Enhance the structural diversity of vegetation classes by precommercial thinning treatments at staggered intervals and favoring trees of different heights and species at the time of treatment (BLM and Forest Service 1997: 188).

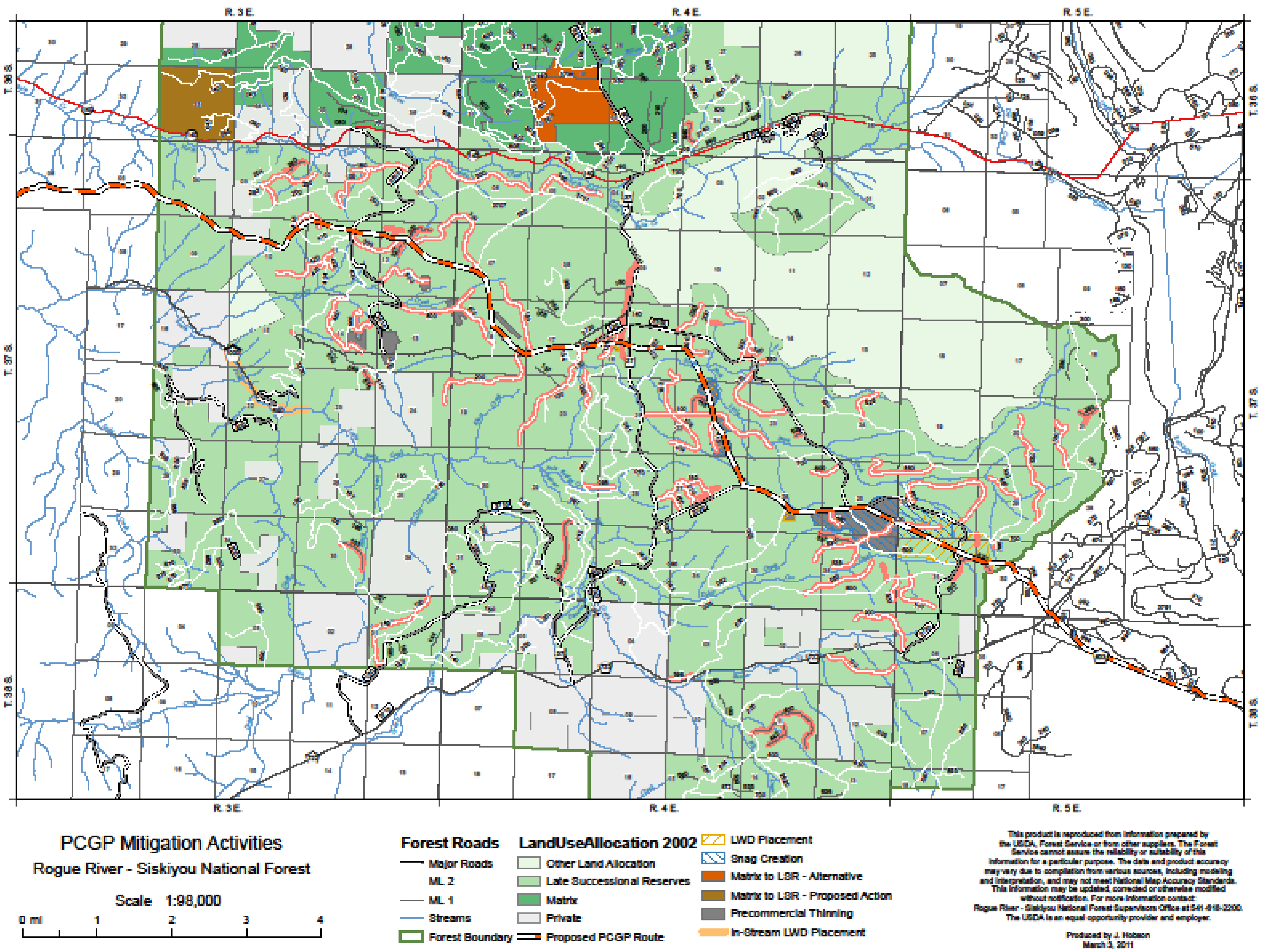
- **Project Mitigation- Stand Density Management:** Stand density management is proposed for overstocked plantations to accelerate the development of late-successional and old-growth forest characteristics in LSR 227. This accelerated development would also reduce fragmentation and reduce edge effects and would help maintain the ability of these stands to respond to changed environmental conditions from either natural or human-caused disturbances. Fuels treatments for the slash generated by stand density management are decided on a case-by-case basis and rely on slash loading information as well as proximity to roads and other factors. Slash treatments may be as simple as lop and scatter to get the fuels in contact with the ground for more rapid decomposition, or they may involve piling and burning or removal of slash from the site. All 600 acres are within 0.5- mile of the project right-of-way and 126 -acres are within Riparian Reserves. Placing the off-site mitigation activities near to the project right-of-way increases their effectiveness by impacting lands within, or near, the home ranges of individual animals being affected by the pipeline habitat changes.

Recommendation - Stream Structure. Large wood in streams contributes to the form and structure of a stream's channel and can control the distribution of aquatic habitats, stability of streambeds and streambanks, and routing of sediments and water through the system. Properly placed large wood traps and slows the movement of sediment and organic matter through the stream system. Large wood is particularly critical for the steep tributaries because it can create a stepped stream profile, with stream energy dissipated in relatively short, steep sections of the channel (BLM and Forest Service 1997: 92).

- **Project Mitigation – In-Stream Placement of LWD:** In addition to restoration of LWD in Riparian Reserves and at channel crossings, large woody debris would be placed in 1.5- miles of the South Fork Little Butte Creek below the project. This would contribute significantly to reducing sediment in the affected reach and downstream, and would add pool and riffle structure to the stream by narrowing the channel and trapping gravels.

Proposed mitigation activites in the Little Butte Creek watershed are shown on Figure 2-11.

Figure 2-11 Proposed Mitigation Projects, Rogue River National Forest Little Butte Creek



Summary. The applicant-filed off-site mitigation plan includes a number of actions that substantively contribute to the "maintain and restore" criteria of the ACS objectives at the site, subwatershed and watershed scale.

- Decommissioning 57.5-miles of roads, of which 4.3-miles (14.3-acres) lie in Riparian Reserves on NFS lands and 13.0-miles of roads, of which approximately 3.5 -acres lie in Riparian Reserves on BLM lands. This significantly reduces sediment sources and would allow restoration of vegetation in Riparian Reserves on approximately 14.3 -acres on NFS lands and 3.5- acres on BLM lands that are currently occupied by roads. This is responsive to ACS objectives 1, 2, 3, 4, and 5 and road density objectives in Key Watersheds.

- Road improvements including resurfacing on 21.85-miles of roads on BLM lands. This reduces sediment contributions from gravel roads and increases resilience to damage from winter rains. This is responsive to ACS objective 5.

- Creation of 1,200 snags on approximately 622 -acres of NFS lands, of which an estimated 126 -acres are within Riparian Reserves. This replaces snags cut in association with the project right-of-way. This is responsive to ACS objectives 1, 8 and 9.

- Placement of CWD on 622- acres, of which 126- acres are within Riparian Reserves. This replaces CWD removed during construction of the project and contributes to riparian habitats within Riparian Reserves. This is responsive to ACS objectives 1, 8 and 9. Stand Density Management (Precommercial Thinning) on approximately 600 -acres of NFS lands, of which a portion estimated to be 126- acres occurs in Riparian Reserves. This has the effect of accelerating the development of larger trees and increasing stand diversity. [22] This is responsive to ACS objectives 1, 8 and 9.

- Placement of LWD on 1.5 -miles perennial fish-bearing streams on NFS lands. This replaces LWD that is removed from the project right-of-way. This is responsive to ACS objectives 1, 2, 3, 4, 5, 7 and 8.

- Installation of a screened diversion at an irrigation ditch in Lost Creek. This is responsive to ACS objective 2.

Cumulative Effects

Activities on NFS Lands

The Forest Service manages about 25% of the Little Butte Creek watershed. Projects on NFS lands that would contribute to cumulative effects with the project are shown in table 2-61.

[22] Prorated by average percent of area occupied by Riparian Reserves in the Little Butte Creek watershed.

TABLE 2-61 **Current and Reasonably Foreseeable Future Actions on NFS and BLM Lands in the Little Butte Creek Watershed**					
Unit	**Fifth-Field Watershed**	**6th Field Watershed**	**Project Name**	**Project Description**	**Affected Resource**
RRNF	Little Butte Creek	Lower NF Little Butte Creek	2004 Deadwood Complex EA (Allotment Management Plan Update for Five Allotments)	400 acres of grazing on the South Butte Allotment	Hydrologic condition, water quality, cumulative watershed effects, aquatic species and habitats
RRNF	Little Butte Creek	Lower NF Little Butte Creek	2009 Fish Lake and Rancheria Allotment Management Plan Update	1,000 -acres of grazing on the Fish Lake Allotment	Hydrologic condition, water quality, cumulative watershed effects, aquatic species and habitats
RRNF	Little Butte Creek	Lower South Fork Little Butte Creek	2004 Deadwood Complex EA (Allotment Management Plan Update for Five Allotments)	2,000- acres of grazing (900 acres on the South Butte Allotment, and 1,100- acres on the Conde Allotment)	Hydrologic condition, water quality, cumulative watershed effects, aquatic species and habitats
RRNF	Little Butte Creek	Upper North Fork Little Butte Creek	2004 Deadwood Complex EA (Allotment Management Plan Update for Five Allotments)	5,300- acres of grazing on the South Butte Allotment	Hydrologic condition, water quality, cumulative watershed effects, aquatic species and habitats
RRNF	Little Butte Creek	Upper North Fork Little Butte Creek	2009 Fish Lake and Rancheria Allotment Management Plan Update	6,500 -acres of grazing on the Fish Lake Allotment	Hydrologic condition, water quality, cumulative watershed effects, aquatic species and habitats
RRNF	Little Butte Creek	Little South Fork Little Butte Creek	2013 Big Elk Cinder Pit CE (DM would be published within next 6 months)	Excavation of cinders from 5- acres of land in an existing cinder quarry	Quarry
RRNF	Little Butte Creek	Middle South Fork Little Butte Creek	2004 Deadwood Complex EA (Allotment Management Plan Update for Five Allotments)	14,100- acres of grazing (7,000- acres on the South Butte Allotment, 4,900- acres on the Deadwood Allotment, and 2,200- acres on the Conde Allotment)	Hydrologic condition, water quality, cumulative watershed effects, aquatic species and habitats
RRNF	Little Butte Creek	Upper South Fork Little Butte Creek	2004 Deadwood Complex EA (Allotment Management Plan Update for Five Allotments)	8,700- acres of grazing on the South Butte Allotment	Hydrologic condition, water quality, cumulative watershed effects, aquatic species and habitats
RRNF	Little Butte Creek	Beaver Dam Creek	2004 Deadwood Complex EA (Allotment Management Plan Update for Five Allotments)	16,800- acres of grazing (3,400- acres on the South Butte Allotment, 13,400- acres on the Deadwood Allotment	Hydrologic condition, water quality, cumulative watershed effects, aquatic species and habitats
MD_BLM	Little Butte Creek	Lick Creek	Salty Gardner DNA, FY2014-2015	540- acres of hazardous fuels treatment	WUI, upland vegetation, neo-tropical birds
MD_BLM	Little Butte Creek	Salt Creek	Bieber Salt Forest Management FY 2016, Salty Gardner DNA FY 2014-2015	756 -acres of upland vegetation treatment, 721 acres of hazardous fuels treatment	Owls, NRF habitat, fish, upland and riparian vegetation, road sedimentation, road density, water quality, sensitive soils
MD_BLM	Little Butte Creek	Lower NF Little Butte Creek	Bieber Salt Forest Management FY 2016, Salty Gardner DNA FY 2014-2015	763- acres of upland vegetation treatment, 932- acres of hazardous fuels treatment	Owls, NRF habitat, fish, upland and riparian vegetation, road sedimentation, road density, water quality, sensitive soils

These activities are expected to be consistent with the Standards and Guidelines and objectives of the RRNF land management plans. Restoration thinning and hazardous fuels reductions are expected to contribute to improvements in watershed conditions by reducing stand density and reducing the probability of stand-replacing fire. Road improvements and decommissioning are expected to reduce road-related sediment transport to aquatic systems.

Activities on BLM and Private Lands

The BLM accounts for about 23%, and private lands comprise about 52% of the Little Butte Creek watershed. Projects on BLM lands that might contribute cumulative effects to the project are shown in table 2-61. Private lands in the watershed are expected to be managed according to current land use patterns consistent with the County General Plan and existing federal and state statutes including the Oregon Forest Practices Act and the Clean Water Act.

Cumulative Effects

The project right-of-way comprises about 0.46% of the NFS lands and 0.25% of the Little Butte Creek watershed (table 2-46 . The small proportion of the landscape affected by the project, ongoing land management on private lands, the regulatory framework between the BLM, ODEQ and ACOE applicable to the project and project location and routing make it highly unlikely that the portion of the Pacific Connector project on federal lands, when considered with other past, present and reasonably foreseeable future actions would change watershed conditions in the Little Butte Creek watershed in any significant, discernable or measureable way. See also EIS Chapter 4.14, Cumulative Effects.

Project Effects Compared by ACS Objective

Table 2-62 compares the project impacts to the objectives of the ACS for the Little Butte Creek watershed. NFS lands where the ACS applies comprise approximately 59,900.38- acres or 25.10% of the Little Butte Creek watershed (table 2-45). Riparian Reserves comprise approximately 8,096.50- acres (about 3.39% of the entire watershed) on NFS lands. Watershed conditions and recommendations are found in the Little Butte Creek watershed assessment (BLM and Forest Service 1997). A total of 10.22- acres or 0.13% of the Riparian Reserves in the watershed would be affected on:

- One perennial stream channel crossing
- One intermittent stream channel crossings
- One intermittent stream and one wetland where Riparian Reserves are clipped, but the associated waterbodies are not crossed by the project

TABLE 2-62

Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Little Butte Creek

ACS Objective	Project Impacts
Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.	Riparian Reserves are watershed-scale features. The project would affect about 10.22- acres or about 0.13% of Riparian Reserves on NFS lands in the Little Butte Creek watershed (table 2-47). There is one intermittent and one perennial stream channel crossed in the Little Butte Creek watershed on NFS lands. Impacts to aquatic systems are expected to be short-term and minor and limited to the project scale because of application of BMPs and erosion control measures (see Section and 1.4.1). Large woody debris cleared in construction of the project would be used to stabilize and restore stream crossings. Off-site mitigation measures including 57.5 miles of road decommissioning, approximately 1.5 -miles of instream projects, snag creation and coarse woody debris placement are expected to improve watershed conditions in the Little Butte Creek watershed

TABLE 2-62 **Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Little Butte Creek**	
ACS Objective	**Project Impacts**
	(see p. 2-149 158, tables 2-57, 2-58, 2-59, 2-60). While there are long-term changes in vegetation in Riparian Reserves from construction clearing of the project right-of-way, these would be minor in scale and well within the range of natural variability given the disturbance history of the watershed (see p. 2-105-109, table 2-40).
Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life-history requirements of aquatic and riparian-dependent species.	The project is not expected to affect spatial or temporal connectivity in the Little Butte Creek watershed because the pipeline would be buried in all aquatic habitats crossed, consistent with the requirements of the exhibits specified in the Wetland and Waterbody Crossing Plan. At each crossing, bed and bank disturbances from equipment crossing and trenching are small (<15 -feet -wide). After construction, all disturbed areas would be returned to their approximate preconstruction contours and drainage patterns. The temporary construction right-of-way would be restored and revegetated with native grasses, forbs, conifers, and shrubs, as outlined in the ECRP. After construction, key habitat components such as LWD and boulders would be restored onsite and the bed and banks would be returned to preconstruction conditions. By implementing these measures, lateral and longitudinal connectivity at the site scale would be maintained, although in the short-term during construction, connectivity may be disrupted. Except for a few days during the construction of the crossings, access to areas necessary for life-histories of aquatic and riparian dependent species would not be obstructed. By restricting stream crossing operations to the ODFW in-stream work window, possible impacts to sensitive life stages of aquatic biota would be minimized. Road decommissioning that occurs within Riparian Reserves (approximately 18- acres) would contribute to restoration of aquatic connectivity. The residual levels of disturbance are anticipated to be well within the range of natural variability in the Klamath-Siskiyou Province and the High Cascades Province. (see p. 2-136-141, table 2-54)
Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.	Impacts to the bed and banks of aquatic features would be minor and limited to the site of construction because the pipeline would be buried, and the actual area of bank and stream bottom disturbance is small at each crossing (<15- feet -wide). This level of disturbance is comparable to a bank slough (see Section 1.4.1.) or a culvert installation and well within the range of natural variability that for watersheds of the Klamath-Siskiyou Province and the High Cascades Province (see p. 2-136-141, table 2-54)). After construction, key habitat components such as LWD and boulders would be restored onsite and the bed and banks would be returned to preconstruction conditions, consistent with the exhibits to the POD. By implementing these measures, the physical integrity of the aquatic system at the site scale would be maintained.
Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.	Minor amounts of sediment would be mobilized during construction. These impacts are expected to be short-term and limited to the general area of construction (see Section 1.4.1). No long-term impacts on water quality are expected because of application of the ECRP that includes maintenance of effective ground cover and BMPs during construction (see Section 1.4.1.1). Effective shade would be removed at the crossing of the South Fork Little Butte Creek at MP 162.45. A site-specific shade analysis (NSR 2009) found no temperature impacts at the site or at the stream network scale at this crossing.
Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.	The Little Butte Creek watershed sediment regime was historically characterized by pulse-type depositions of coarser sediments from landslides and surface erosion following major disturbances such as fires and high-intensity winter storms (BLM and Forest Service, 1997). The current sediment regime in the watershed has replaced these pulse-type disturbances with more chronic erosion and deposition of fine sediments primarily from urban and agricultural land use, timber harvest and roads. Project construction and operation is not likely to alter this sediment pattern nor is it likely to exacerbate these conditions because of implementation of measures in the ECRP (see Section 1.4.1) including maintenance of effective ground cover, water bars to dissipate overland flows and maintenance of sediment barriers until revegetation is successful. Sediment impacts from construction are expected to be similar to those described in Section 1.4.1.2. A pulse of sediment could be observed following the first seasonal rain, but that this is likely to dissipate within a few hundred feet and would be

TABLE 2-62 **Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Little Butte Creek**	
ACS Objective	**Project Impacts**
	indistinguishable from background levels. Any sediment impacts are expected to be well within the range of natural variability for the Klamath-Siskiyou Province and the High Cascades Province (see p. 2-134 140, table 2-54). Proposed mitigation projects including road decommissioning would contribute to reduction of sediments and restoration of aquatic functions at the watershed scale (see p. 2-148- 158 Table 2-57).
Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.	The project is unlikely to affect peak flows in the Little Butte Creek watershed because of the dispersed nature of impacts, the current hydrologically recovered conditions in the watershed, the relatively small proportion of the watershed affected (0.25%), and the relative lack of connectivity to aquatic systems (see Table 2-54, p. 2-139). Decommissioning roads (57.5- miles) as part of the offsite mitigation plan would contribute substantively the restoration of flow patterns by restoring hydrologic connectivity at stream crossings that are decommissioned (see p. 2-148-158, Table 2-57).
Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.	The project clips one small wetland on NFS land but does not cross it. Application of the ECRP including maintenance of effective ground cover and BMPs during construction will be applied (see Section 1.4.1.1). In addition, decommissioning 57.5- miles of roads, 18- acres of which are in Riparian Reserves (see p. 2-148-158, Table 2-57) would contribute substantially to restoring floodplain functions where these projects occur.
Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation; nutrient filtering; and appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse, woody debris sufficient to sustain physical complexity and stability.	The project impacts on riparian vegetation in the Little Butte Creek watershed would be minor. Approximately 10.22- acres or 0.13% of the Riparian Reserves in the watershed are potentially affected by the project (table 2-48). Existing herbaceous and brush cover would be maintained in Riparian Reserves to the extent practicable. Following construction, replanting with native species would facilitate reestablishment of vegetation communities. Large woody debris and boulders from the project right-of-way would be returned to disturbed riparian areas. Coarse woody debris placement and snag creation on 126- acres in Riparian Reserves, along with revegetation on 18 acres of Riparian Reserves in roads that would be decommissioned would help to reestablish species composition and structural diversity of plant communities in Riparian Reserves (see p. 2-148-158, Table 2-57)).
Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.	The project impacts on riparian vegetation in the Little Butte Creek watershed would be minor. Approximately 10.22- acres or 0.13% of the Riparian Reserves in the watershed are potentially affected by the project. Following construction, replanting with native species would facilitate reestablishment of vegetation communities. Large woody debris and boulders from the project right-of-way would be returned to disturbed riparian areas. Coarse wood placement and snag creation on 126- acres in Riparian Reserves, along with revegetation on 18- acres of Riparian Reserves in roads that would be decommissioned would help to reestablish species composition and structural diversity of plant communities in Riparian Reserves. The project would waive application of Management Recommendations for Survey and Manage species in the watershed but would not prevent attainment of the ACS objectives because the viability of riparian-dependent Survey and Manage species would not be threatened. (see Appendix F5).

Summary

The Little Butte Creek watershed is the largest and the most complex watershed crossed by the project. With 13.75- miles of corridor, and 207.17- acres of clearing on NFS lands, this watershed has the most NFS land area affected of all watersheds crossed by the project. The watershed is geologically and ecologically complex with both Klamath-Siskiyou Province and the High Cascades Province landscapes. It is ecologically diverse and important, providing some of the most productive coho salmon streams in the Upper Rogue Basin. Little Butte Creek watershed is a Tier 1 Key Watershed above the confluence of the North and South Forks of Little Butte Creek, and roughly 88% of the NFS lands in the watershed are managed as LSR (see table 1-1, 1-2). Against this backdrop, compliance with the ACS is an important measure of project impacts.

Pacific Connector has modified the project to respond to the ACS objectives and has incorporated measures consistent with the Riparian Reserve Standards and Guidelines. The assessment demonstrates that short-term impacts associated with the project would occur to streambanks, and substrates at the site scale. Change in vegetative condition from clearing of forest within the project right-of-way is a long-term impact. These impacts, however, are well within the range of natural variability given the disturbance processes that function in the watershed (see p. 2-134 – 141, Table 2-54). This is especially apparent when considering the total amount of Riparian Reserves that are located within the Little Butte Creek watershed (8,096.50- acres) and the amount of clearing (10.22- acres) in Riparian Reserves (0.13% of the Riparian Reserves in the watershed) (table 2-47). Also, because of the linear characteristic of the pipeline, the Riparian Reserve crossings would be spread out across the landscape.

Off-site mitigation measures including over 66- miles of road decommissioning (57.5 miles are within Key Watershed), 1.5- miles of LWD instream projects, identified by the Forest Service, would supplement onsite minimization, mitigation, and restoration actions. These proposed offsite mitigation measures are responsive to recommendations in the Little Butte Creek watershed assessment (1997) and the South Cascades Late-Successional Reserve Assessment (1998). Mitigations associated with the project are responsive to watershed assessment recommendations and would improve watershed conditions where they are applied (see p. 2-148-158, Table 2-57, 2-58).

Three site-specific amendments of the RRNF LRMP related to the ACS are proposed to make provisions for the project (see p. 143-148):

- Proposed amendment RRNF-5 would allow the project to cross the MA-26 Restricted Riparian land allocation at one location on the South Fork of Little Butte Creek. This amendment would not prevent attainment of ACS objectives. A site-specific temperature assessment (NSR, 2009) showed there would be no temperature increase from shade removal at this location Effective ground cover and sediment barriers would be maintained and the implementation of the ECRP is expected to control surface erosion and reestablish native vegetation.

- Proposed amendment RRNF-6 would allow the project to exceed detrimental soil conditions within the construction corridor. This would not prevent attainment of ACS objectives. The project would require soil remediation as needed with biosolids or other organic materials in areas with potential revegetation difficulty, soil decompaction, maintenance of effective ground cover, application of BMPs, and application of offsite mitigations. Therefore, any sediment impacts from detrimental soil conditions are expected to be minor and short- term and the methods described above would be expected to effectively moderate detrimental soil conditions. Implementation of measures in the ECRP is expected to effectively control surface erosion and restore native vegetation (see DEIS section 4.3.4).

- Proposed amendment of the RRNF LRMP to waive protection measures for Survey and Manage species would not prevent attainment of ACS objectives because the persistence of riparian dependent survey and manage species would not be threatened (See Appendix F5).

The project is otherwise consistent with Standards and Guidelines for activities in Riparian Reserves for the RRNF.

The routing of the pipeline through NFS lands, coupled with the relatively small area of NFS land affected by project construction (0.46% of NFS lands in the fifth-field watershed), makes it highly improbable that project impacts could affect watershed conditions. The lack of intersections with aquatic systems serves to further minimize possible impacts (see Section 2.2.2.1). Although there are project-level impacts from short-term sediment and long-term change in vegetative condition at stream crossings, these would be minor in scale (see Section 2.2.2.4).

No project-related impacts that would prevent attainment of ACS objectives have been identified (see Section 2.5.5.8). All relevant project impacts are within the range of natural variability for watersheds in the Klamath-Siskiyou and High Cascades Provinces, although some of these processes have been altered from their natural condition (see Section 2.2.2.4).

2.2.3 Klamath River Basin

2.2.3.1 Geographic Setting

The Klamath River is notable because only the Klamath and Columbia Rivers cross the Cascade Mountains. The Klamath Basin geography, topography, hydrology, and biology are unique from other watersheds in the Pacific Northwest. Water in the Klamath River, unlike other watersheds in the Pacific Northwest, originates in relatively flat, open valleys east of the Cascades before crossing the Trinity and Coast Ranges in a steep river canyon and intercepting cold water inputs from the Scott, Salmon, and Trinity Rivers. Irongate Dam is the dividing line between the Upper and Lower Klamath subbasins. The Klamath River flows through mountainous terrain from the Oregon-California State line to the reaches downstream from Iron Gate Dam. Downstream from Iron Gate Dam, and for most of the river's length to the Pacific Ocean, the river maintains a relatively steep, high-energy channel.

The Klamath River originates just downstream from Upper Klamath Lake in southern Oregon and flows 253 miles southwest through northern California to the Pacific Ocean. The Upper Klamath Basin has five main lakes: Crater Lake, Upper Klamath Lake, Lower Klamath Lake, Clear Lake, and Tule Lake. The Lower Klamath Basin, with its border beginning at Iron Gate Dam, is almost 200 miles long and contains the four major Klamath River tributaries: the Shasta, Scott, Salmon, and Trinity Rivers. The basin is generally rural, with a total population of approximately 120,000. Its largest communities are Klamath Falls, Oregon, and City of Yreka, California.

The Pacific Connector project lies in the Upper Klamath subbasin. The upper Klamath subbasin encompasses approximately 8,000 square miles and is located in south-central Oregon and northeastern California. The Oregon part of the subbasin (more than 5,600 square miles) lies primarily in Klamath County with smaller parts in Jackson and Lake Counties. The California part of the subbasin (more than 2,300 square miles) lies in Modoc and Siskiyou Counties. The upper Klamath subbasin spans parts of the Sierra-Cascade Mountains to the west and the Basin and Range geologic region to the east. Down faulted valleys and fault block mountains of the Basin and Range region terminate against the Cascade Mountains. In the upland areas of the Klamath subbasin to the north, the Wood and Williamson Rivers originate from the eastern flank of Mount Mazama (Crater Lake). To the east, the Sprague and Lost Rivers flow westward from more arid parts of the basin. The California portion of the basin to the south is characterized by closed lake basins that are more typical of the Basin and Range region.

2.2.3.2 Climate and Hydrology

The Upper Klamath Subbasin climate is characterized by hot, dry summers and wet winters with moderate to low temperatures. At its higher elevations (above 5,000 feet), the Upper Klamath subbasin receives rain and snow during the late fall, winter and spring. Peak stream flows generally occur during snowmelt runoff in late spring/early summer. After the runoff period, flows drop in the late summer/early fall. Annual basin precipitation amounts range from 15 inches at valley floors to more than 40 inches in the Cascade Mountains. Sixty to seventy percent of the precipitation occurs from October through March. An average of about four inches of rain falls during the period from April through September. The portion of the Upper Klamath Subbasin affected by the PCGP is all in the High Cascades Province and is dominated by pumice soils. Infiltration rates and water storage capacity of pumice plateau landscapes are high, although water retention in surface soils is very low in summer. Late summer streamflows are sustained by the slow release of snowmelt from large wetland complexes such as Buck Lake.

The Klamath Basin is home to 19 native fish species. The Klamath Basin once produced large runs of steelhead, Chinook salmon, coho salmon, green sturgeon, eulachon, coastal cutthroat trout, and Pacific lamprey. Runs of these anadromous fish (fish that migrate from salt water to spawn in fresh water) contributed substantially to tribal, commercial, and recreational fisheries. Irongate dam (35 miles below the Pacific Connector project) currently blocks all anadromous fish passage. The Department of Interior has proposed to remove Irongate and other dams that block anadromous fish on the Klamath River in 2020.

Coho salmon, which currently listed as “Threatened” under the Endangered Species Act, are currently widely distributed in the Klamath River downstream from Iron Gate Dam (RM 190). Before the construction of the dams, coho salmon were apparently common and widely distributed throughout the watershed, probably in both mainstem and tributary reaches up to and including Spencer Creek (Reclamation 2013).

Spencer Creek is the only fifth-field watershed crossed by the Pacific Connector project in the Klamath Basin where the ACS applies. Spencer Creek is 35 miles above Irongate dam. It flows into the Klamath River at the upper end of the reservoir created by the JC Boyle dam.

2.2.3.3 Spencer Creek Fifth-Field Watershed, HUC 180102206

Overview

The portion of the Spencer Creek watershed crossed by the project is a Tier 1 Key Watershed (see Section 1.1.3). Key watersheds contribute directly to conservation of at-risk anadromous salmonids and resident fish species by providing high quality habitat. A network of Tier 1 Key Watersheds ensures that refugia for at-risk species are widely- distributed across a landscape to provide requisite connectivity.

The Spencer Creek watershed is part of the Upper Klamath subbasin in the High Cascades Province[23]. The 54,160 -acre Spencer Creek watershed is located in Klamath County, approximately 20 miles west of Klamath Falls (figure 1-1) and north of the Klamath River. The watershed originates at the crest of the southern Oregon Cascades Range, flows southeast, and empties into the Klamath River at the upper end of the JC Boyle Reservoir which is part of PacifiCorps' Klamath River hydroelectric project. Elevations range from approximately 8,200-feet at the top of Aspen Butte to 4,000- feet at the mouth of Spencer Creek at JC Boyle Reservoir. Prior to construction of the Klamath River hydroelectric project, coho and Chinook salmon and Pacific lamprey used the lower reaches of Spencer Creek for spawning and rearing. If the Klamath Dams including the JC Boyle Dam are removed as planned, Spencer Creek would once again provide spawning habitat for Chinook and coho salmon (Bureau of Reclamation, 2012).

Unique watershed features include Buck Lake, a large, shallow snowmelt wetland that lies in the upper end of the watershed. This lake is a significant contributor to the ecological systems within the watershed. Buck Lake was drained in the 1940s and no longer fully functions as a perennial wetland but it does have seasonal wetland characteristics. The northeastern part of the watershed lies within the Mountain Lakes Wilderness Area where no significant past management activities, with the exception of fire suppression, have occurred. Private lands in the lower part of the watershed are managed for timber production and open range grazing.

The watershed is bisected by the Dead Indian Memorial Highway which runs generally east-west and the Clover Creek county road which runs generally northwest-southeast and parallels Spencer Creek for several miles. A small unincorporated community is located at the junction of the Clover Creek Road and the Dead Indian Memorial Highway.

The portion of Spencer Creek watershed traversed by the project is typical of the High Cascades Province. Soils dominating the landscape are characterized by high snowmelt infiltration and low summer water retention. Streamflows are dominated by spring snowmelt. Streams often develop braided channels where they encounter pumice flats changing the stream gradient and may become intermittent, surfacing again downstream. Low gradients, porous soils, and deep alpine glacial till in some areas combine to create a system with low stream densities (0.3 -mile of perennial streams per square mile, and 0.9- mile of intermittent streams per square mile) (BLM et al., 1995: 4-4-155).

Vegetation in the watershed is primarily a mixed conifer forest dominated by white fir and large stands of lodgepole pine. Private lands have been managed intensively for timber production and grazing and are dominated by younger aged stands and early seral brush communities. Fire suppression has resulted in overly dense white fir understory vegetation and accumulations of dead fuel. Under drought conditions, these fuels may cause large, high-intensity stand-replacing fires. At the time the watershed analysis was prepared, 25% of the federal land within the Spencer Creek watershed was late successional forest and 29% was mid seral stage forest. The percentages of seral stages on NFS land are shown in table 2-65

[23] Provinces discussed in this document are based on both ecological and geological conditions and therefore do not match those recognized by the Oregon Department of Geology and Mineral Industries and the Oregon State Board of Professional Geologists and Geophysicists. The Klamath-Siskiyou Province is known by professional geologists as the Klamath Mountains Province and the Western Cascades and the High Cascades are two mountain ranges within the Cascades Mountains Province. See https://www.oregongeology.org/learnmore/geologicsightseeing.htm

Figure 2-12 shows the ownership pattern of the watershed. Relatively contiguous NFS lands (40% of all ownerships) dominate the upper watershed. Scattered BLM lands (16% of all ownerships) and interspersed private lands (44% of all ownerships) dominate the lower watershed. Increases in conifer populations as well as fire suppression have led to the loss of aspen stands throughout the Inland West. Further losses have occurred because aspen parklands have been converted to meadows for livestock grazing, with others degraded from logging and continual intense recreational use. Within the Spencer Creek watershed, aspen patches reportedly occurred around Buck Lake, along wet areas, and along streams and meadows near Spencer Creek however only remnants of those stands now remain (BLM et al., 4-27).

Buck Lake, Upper Spencer Creek, Clover Creek and Lower Spencer Creek subwatersheds make up the Spencer Creek watershed (table 2-63). The Spencer Creek watershed has approximately 110 -miles of fish bearing and intermittent streams which depend on healthy functioning riparian areas for key habitat input factors. One short stretch of lower Clover Creek is fish- bearing from its connection to Spencer Creek, but becomes intermittent during late summer in most years. In addition, over 2,000 -acres of wetland area in and around Buck Lake and along Spencer Creek have important effects on water quality and hydrologic function. Buck Lake is privately owned, and was drained to provide pasture for cattle, however it remains an important area for aquatic function in Spencer Creek. Approximately 1,672.49 -acres of Riparian Reserves occur NFS lands in the Spencer Creek watershed. There are roughly 5,319.16- acres of designated [1]LSR and 10,083.65- acres of [2]Matrix lands within the Spencer Creek watershed.

Location and Routing

The project crosses a broad ridge from the Little Butte Creek watershed in the Rogue Basin to the Klamath Basin and the Spencer Creek watershed at MP 168.00. The project right-of-way crosses the Dead Indian Memorial Highway at MP 168.84 and continues cross-country to MP 169.54 where it intersects the Clover Creek Road, a two-lane paved Klamath County road. The project runs directly adjacent to the Clover Creek Road for the next 17- miles, crossing portions of the Upper Spencer Creek, Clover Creek and Lower Spencer Creek subwatersheds, exiting the watershed at MP 183.02.

The total length of the corridor in the watershed is approximately 15.13- miles. Approximately 6.05- miles of the project would be on NFS lands. Of those, 3.92- miles would be in the Buck Lake subwatershed and 2.13- miles would be in the Upper Spencer Creek subwatershed (table 2-64. The project crosses NFS lands between MP 168 and 169.37 and then intermittently between MP 169.37 and MP 175.37, the project would be on NFS lands adjacent to the Clover Creek Road. The project was originally proposed to run parallel to the Clover Creek Road 400- feet to the west. The project was moved adjacent to the Clover Creek Road, at the request of the Forest Service, to avoid creating a second corridor that may adversely affect wildlife values and create an unmanageable strip between the road and the project. Of the 15.13- miles of project corridor in the Spencer Creek watershed, approximately 13- miles are adjacent to the Clover Creek road where stream crossings and clearing riparian vegetation have already occurred. By utilizing this existing corridor the project avoids creating a second clearing that would further fragment Riparian Reserves and wildlife habitat. This routing also places the Clover Creek road between the project right-of-way and the Riparian Reserve associated with Spencer Creek.

A total of 207.76- acres would be affected by the project, including 193.63- acres cleared and 14.13- acres modified. On NFS lands, approximately 80.16- acres would be cleared and 11.56- acres would be modified. This accounts for approximately 0.41% of the NFS lands in the watershed (table 2-64.

No LSR lands would be affected by the project in the Spencer Creek watershed. Most effects to NFS lands are on Matrix lands where 81.11- acres are affected, including 71.06 -acres cleared and 10.05- acres modified (0.36% of NFS lands). There are four intermittent stream channel and two wetland crossings on NFS lands. Four Riparian Reserves of intermittent streams and two wetlands are clipped, but the associated waterbody is not crossed by the project right-of-way (table 2-66). Approximately 8.63- acres of Riparian Reserves or about 0.04% of the Riparian Reserves on NFS lands in the watershed would be cleared (table 2-65). About 4.58 acres of Riparian Reserves on NFS lands would be cleared in LSOG forest. All of the crossings in Spencer Creek are rated as "blue" or low risk of construction impacts (table 2-67).

Figure 2-12 PCGP Routing and Subwatershed Boundaries, Spencer Creek Watershed

TABLE 2-63

Land Ownership and Forest Service Land Allocations (acres) in Spencer Creek 5th field Watershed (HUC 1801020601)

	Land Ownership (acres)					Forest Service Land Allocation (acres)		
Sixth-Field Watershed	**Sixth-Field Watershed (acres) a/**	**NFS Land**	**BLM**	**Total NFS and BLM**	**Other**	**LSR**	**Riparian Reserves b/**	**Matrix**
Buck Lake	15,182.26	6,398.22	3,597.12	9,995.34	5,186.92	1,227.03	480.32	4,702.31
Clover Creek	14,094.78	8,461.83	1,182.13	9,643.96	4,450.82	2,169.71	581.25	2,986.44
Lower Spencer Creek	13,265.30	264.23	2,540.91	2,805.14	10,460.16	0.00	0.00	261.92
Upper Spencer Creek	11,704.41	7,198.75	1,431.11	8,629.86	3,074.55	1,922.42	610.92	2,132.98
Watershed Total	**54,246.75**	**22,323.03**	**8,751.27**	**31,074.30**	**23,172.45**	**5,319.16**	**1,672.49**	**10,083.65**

a/ All data derived from Stantec-based GIS layers.
b/ May occur within other NFS land allocations.

TABLE 2-64

Project Corridor (miles) and Project Area (acres) in Spencer Creek Fifth-Field Watershed (HUC 1801020601) by Land Ownership

	Land Ownership							
	NFS Lands				Entire Sixth Field Watershed			
		Project Area (acres)				Project Area (ares) b/		
Sixth-Field Watershed a/	**Corridor Length (miles)**	**Cleared**	**Modified**	**% of NFS Land Impacted**	**Corridor Length (miles)**	**Cleared**	**Modified**	**% of Sixth-Field Watershed Impacted**
Buck Lake	3.92	53.05	10.60	0.99	5.08	69.43	13.13	0.54
Clover Creek	0.00	0.00	0.00	0.00	3.45	43.39	0.00	0.31
Lower Spencer Creek	0.00	0.00	0.00	0.00	2.51	31.12	0.00	0.23
Upper Spencer Creek	2.13	27.11	0.96	0.39	4.09	49.69	1.18	0.43
Watershed Total	**6.05**	**80.16**	**11.56**	**0.41**	**15.13**	**193.63**	**14.31**	**0.38**

a/ All data derived from Stantec-based GIS layers
b/ Includes NFS, BLM, and other ownerships

TABLE 2-65

Project Area (acres) on NFS Lands in the Spencer Creek Fifth-Field Watershed (HUC 1801020601) by Land Allocation

	Designated LSR b/				Matrix				Riparian Reserves b/			
	Project Area (acres)		% of Total LSR on NFS Land		Project Area (acres)		% of Total Matrix on NFS Land		Project Area (acres)		% of Total Riparian Reserves on NFS lands c/	
Sixth-Field Watershed a/	**Cleared**	**Modified**	**Cleared**	**Modified**	**Cleared**	**Modified**	**Cleared**	**Modified**	**Cleared**	**Modified**	**Cleared**	**Modified**
Buck Lake	0.00	0.00	0.00	0.00	47.96	9.71	1.02	0.21	4.74	0.74	0.99	0.15
Clover Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lower Spencer Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upper Spencer Creek	0.00	0.00	0.00	0.00	23.10	0.34	1.08	0.02	3.89	0.61	0.64	0.10
Watershed Total	**0.00**	**0.00**	**0.00**	**0.00**	**71.06**	**10.05**	**0.70**	**0.10**	**8.63**	**1.35**	**0.52**	**0.08**

a/ All data derived from Stantec-based GIS layers.
b/ Includes mapped and unmapped LSR on NFS lands.
c/ Riparian Reserve acres overlap with LSR and Matrix land allocations.

TABLE 2-66

Riparian Reserve Effects Spencer Creek Fifth-Field Watershed HUC 1801020601

Jurisdiction	MP	Waterbody	Description	Waterbody Type	Crossed a/	Width of Crossing (feet)	Wetland Acres Crossed	Clipped b/	RR_Conifer_LSOG	RR_Hardwood_LSOG	RR_Mixed_Conifer_Hardwood_LSOG	Total_LSOG (80+)	RR_Conifer_MS	RR_Hardwood_MS	RR_Mixed Conifer Hardwood MS	Total Mid-Seral (40-80)	RR_Conifer_ES	RR_Shrub_ES	RR_Grasslands	Total Early Seral (0-40)	Stream Channel or Wetland Area	Net Riparian Reserve Cleared	Uncleared Storage Area in RR	Total Direct Impact in RR (Cleared plus UCSA)	Roads and Other Altered Habitats c/	Gross Riparian Reserves	Fish Bearing	Anadromy d/
									Riparian Reserve Vegetation Cleared in Construction Corridor and TEWAs by Age Class (Acres)																			
Buck Lake Subwatershed HUC 180102060102																												
WNF	168.31	ASI161	RR of lateral stream clipped	I	No	0.00		Yes				**0.00**				**0.00**		0.20		**0.20**		**0.20**		**0.20**	0.17	0.37	No	No
WNF	171.06	Spencer Creek EW085	Wetland swale, culverted under road	W	Yes	154.82	0.26	No				**0.00**				**0.00**				**0.00**		**0.00**		**0.00**		0.00	No	No
WNF	171.06	Trib. to Spencer Cr and wetland EW085	small intermittent stream with associated wetland culverted under road	I	Yes	4.05		No	0.34			**0.34**	0.57			**0.57**			0.17	**0.17**	0.29	**1.37**		**1.37**	0.18	1.55	No	No
WNF	171.35	AW184	Large wetland complex south of Clover Creek Rd.	W	No	0.00	0.00	Yes	0.67			**0.67**				**0.00**				**0.00**		**0.67**		**0.67**		0.67	No	No
WNF	171.57	Trib. to Spencer Cr.	2' wide stream that fans out into a wetland/stream complex. (Incorrectly classified as a perennial stream)	I	Yes	4.05		No				**0.00**				**0.00**		0.33		**0.33**		**0.33**		**0.33**		0.33	No	No
WNF	172.03	GW008	Spiraea wetland	W	No	0.00	0.00	Yes	0.23			**0.23**				**0.00**				**0.00**		**0.23**		**0.23**		0.23	No	No
WNF	172.45	EW105	Adjacent to EW107 (Acres of RR included in EW 107)	W	Yes	0.00	0.16	No				**0.00**				**0.00**				**0.00**		**0.00**		**0.00**		0.00	No	No
WNF	172.48	Trib. to Spencer Creek EW107 and wetland EW 105	Wetland/Stream	I	Yes	64.25		No	0.94			**0.94**				**0.00**				**0.00**	0.16	**1.10**		**1.10**		1.10	No	No
Subtotal Buck Creek Subwatershed		**Crossed:** **3 Int. Channel RR** **2 Wetland RR**	**Clipped:** **1 Int. Channel RR** **2 Wetland RR**	**8**	**5**		**0.42**	**3**	**2.18**	**0.00**	**0.00**	**2.18**	**0.57**	**0.00**	**0.00**	**0.57**	**0.00**	**0.53**	**0.17**	**0.70**	**0.45**	**3.90**	**0.00**	**3.90**	**0.35**	**4.25**		

TABLE 2-66

Riparian Reserve Effects Spencer Creek Fifth-Field Watershed HUC 1801020601

Jurisdiction	MP	Waterbody	Description	Waterbody Type	Crossed a/	Width of Crossing (feet)	Wetland Acres Crossed	Clipped b/	Riparian Reserve Vegetation Cleared in Construction Corridor and TEWAs by Age Class (Acres)														Uncleared Storage Area in RR	Total Direct Impact in RR (Cleared plus UCSA)	Roads and Other Altered Habitats c/	Gross Riparian Reserves	Fish Bearing	Anadromy d/
									RR_Conifer_LSOG	RR_Hardwood_LSOG	RR_Mixed_Conifer_Hardwood_LSOG	Total_LSOG (80+)	RR_Conifer_MS	RR_Hardwood_MS	RR_Mixed Conifer Hardwood MS	Total Mid-Seral (40-80)	RR_Conifer_ES	RR_Shrub_ES	RR_Grasslands	Total Early Seral (0-40)	Stream Channel or Wetland Area	Net Riparian Reserve Cleared						
Upper Spencer Creek Subwatershed HUC 180102060104																												
WNF	173.35	Trib to Spencer Creek	RR of lateral stream clipped	I	No			Yes	1.32			**1.32**				**0.00**				**0.00**		**1.32**		**1.32**		1.32	No	No
WNF	173.68	Trib to Spencer Creek	RR of lateral stream clipped	I	No			Yes				**0.00**	0.40			**0.40**				**0.00**		**0.40**		**0.40**		0.40	No	No
WNF	173.74	ESI106aTrib. to Spencer Creek	4' wide, snowmelt intermittent l stream	I	Yes	8.17		No				**0.00**	0.83			**0.83**				**0.00**		**0.83**	0.08	**0.91**	0.02	0.93	No	No
WNF	173.84	Trib to Spencer Creek	RR of lateral stream clipped	I	No			Yes				**0.00**	0.50			**0.50**				**0.00**		**0.50**		**0.50**	0.35	0.85	No	No
Subtotal Upper Spencer Creek Subwatershed		**Crossed:** **1 Int. Channel**	**Clipped:** **3 Int. Channel RR**	**4**	**2**			**3**	**3.23**	**0.00**	**0.00**	**3.23**	**1.73**	**0.00**	**0.00**	**1.73**	**0.00**	**0.00**	**0.17**	**0.17**	**0.03**	**5.16**	**0.08**	**5.24**	**0.47**	**5.71**	**1**	**0**
Total Spencer Creek		**Crossed:** **4 Int. Channels** **2 Wetlands**	**Clipped:** **4 Int. Channel RR** **2 Wetland RR**	**12**	**7**		**0.42**	**6**	**5.41**	**0.00**	**0.00**	**5.41**	**2.30**	**0.00**	**0.00**	**2.30**	**0.00**	**0.53**	**0.00**	**0.87**	**0.48**	**9.06**	**0.08**	**9.14**	**0.82**	**9.96**	**1**	**0**

a/ "Crossed" indicates that the pipeline trench crosses the waterbody or wetland.
b/ "Clipped" indicates that the pipeline corridor crosses a portion of the Riparian Reserve, but the pipeline trench does not cross the associated waterbody.
c/ Roads and other altered habitats such as rock pits sometimes occur within Riparian Reserves. These features do not have riparian features, and are not considered as part of the Riparian Reserve vegetated area.
d/ "Anadromy" means that a stream contains anadromous fish, or that it is a tributary directly influences an anadromous stream.

TABLE 2-67

Stream Crossing Turbidity and Crossing Risk Assessment

Fifth-Field Watershed	Sixth Field Subwatershed	MP	Type a/	Description a/	Bankfull Width (ft) b/	Width of Crossing (ft) a/	Channel Gradient (%) b/	Channel Incision (ft) b/	Bank Character b/	Streambed Material b/	Turbidity Rating c/	Site Response Rating d/	Construction Impact Rating d/	Overall Rating e/
Spencer Creek	Buck Lake	171.06	I	Small, 10 feet wide stream associated with wetland swale	12	154.82	3.3	0.75	Erodible	silt	M	L	M	BLUE
Spencer Creek	Buck Lake	171.57	I	2' wide stream that fans out into a wetland/stream complex		4.05					L	I	I	BLUE
Spencer Creek	Buck Lake	172.45	I	Wetland/Stream	5	64.25	1.98		Highly erosion resistant	gravel	M	L	M	BLUE
Spencer Creek	Upper Spencer Cr.	173.74	I	4' wide, snowmelt ephemeral stream		8.17					I	I	I	BLUE

Sources:
a/ Table 2A-3a, Resource Report 2, Water Use and Quality, PCGP 2013
b/ Table A-2, Stream Crossing Risk Analysis, GeoEngineers 2011
c/ Table B-1, Turbidity, Nutrients and Water Quality Analysis, GeoEngineers 2011
d/ Table A-1, Stream Crossing Risk Analysis, GeoEngineers 2011
e/ Figure 4, Stream Crossing Risk Analysis, GeoEngineers 2011

Existing Conditions

Original Watershed Analysis Findings

The BLM prepared the watershed analysis for the Spencer Creek watershed in 1995 in consultation with the Forest Service, U.S. Environmental Protection Agency, and U.S. Fish and Wildlife Service. Watershed conditions are as follows:

- There are 290- miles of roads in the watershed on NFS and BLM lands, which equals approximately 4 -miles per square mile. In most areas, this density exceeds the 1.5- miles per square mile recommendation of the Spencer Creek Coordinated Resource Management Plan and both Forest Service and BLM land management plans (BLM et al., 1995: 4-124), resulting in excess levels of sediment. There are 150 stream crossings and 23- miles of roads within 100- feet of stream channels in the watershed (BLM et al., 4-150). Roads and areas of compaction decrease soil productivity, prolong the vegetative recovery process, and increase runoff potential. Road densities also exceed the recommended level for several wildlife species of concern, including deer and elk.

- Road densities and harvest have reduced near-term LWD recruitment and streamside canopy closure in many areas. In addition, there has been an increase in the amount of solar radiation and stream warming due to a reduction in shade and an increase in sediment deposition.

- Spencer Creek and associated tributaries frequently do not meet State of Oregon Water Quality Standards for salmonid-bearing streams of the Klamath Basin. Spencer Creek may continue to exceed maximum summer water temperatures above 68°F (ODEQ Standard for redband trout streams) because the mainstem originates as outflow from a shallow wetland area (Buck Lake). Riparian disturbance and low-flow influenced diurnal fluctuations may be a major cause for not meeting State of Oregon Standards for temperature in Spencer Creek (BLM et al., 1995: ES-4).

- The exceedance of the temperature standard may be related to two major management changes in the watershed: increased disturbance of the riparian zone due to management practices and the draining and water diversion channeling of Buck Lake for livestock grazing (BLM et al. 1995: 4-143).

- The road system design in the Spencer Creek watershed has resulted in water being routed into the stream channel, possibly contributing to increases in peak flows (BLM et al. ,1995: ES-4).

- Three changes in habitat condition were determined to be chronic and problematic for native fish in Spencer Creek: fine sediment, high temperature and low flows. The significant causal mechanisms for reduced habitat quality are road crossings, streamside timber harvest, and channelization and grazing at Buck Lake (BLM et al., 1995: ES-4).

- Fire suppression has removed the natural disturbance regimes that would have acted to create openings and increase LWD input rates (BLM et al.,1995 4-158).

- Twenty-five percent of the Federal land within the Spencer Creek watershed is late successional forest and 29 percent is midseral stage forest.(BLM et al.:1995 4-86).

Changes in watershed Condition

The following projects responsive to the recommendations in the Spencer Creek watershed analysis have been completed by the Forest Service (table 2-68).

TABLE 2-68

Changes in Watershed Condition since publication of the Spencer Creek Watershed Analysis

Project Name	Administrative Unit	Treatments Completed
Lakewoods WUI	Klamath RD, Winema NF	**Purpose:** Recreation management, Vegetation management (other than forest products), Fuels management, Special use management **Activities:** Forest vegetation improvements, Fuel treatments (non-activity fuels). Fuels thinning/piling/burning.
Spencer Creek Fences	Klamath RD, Winema NF	**Purpose:** Wildlife, fish, Rare Plants, Grazing Management. **Activities:** Species habitat improvements, grazing structural improvements.
Spencer Creek Fence Project – Part II	Klamath RD, Winema NF	**Purpose:** Wildlife, fish, Rare Plants, Grazing Management. **Activities:** Species habitat improvements, grazing structural improvements.
Clover Creek Fish Passage Culvert	Klamath RD, Winema NF	**Activities:** Replace undersized culvert on through fill with arch fish passage culvert. T38S R5E Sec. 3 SE/SE (Keno Access Road)
Spencer Creek Fish Passage	Klamath RD, Winema NF	**Activities:** Removed two channel spanning rock check dams set by dispersed recreation users to restore fish passage at the Spencer Creek dispersed camping site at outlet of Buck Meadows.
Spencer Creek Dispersed Campground	Klamath RD, Winema NF	**Activities:** Large section of the campground immediately adjacent to Spencer Creek was closed to vehicle access with boulder barriers allowing bar, compacted areas to fully revegetate. Dispersed camping area was fenced to exclude cattle from Buck-Indian Allotment allowing area to revegetate.
Fremont-Winema National Forests Motorized Travel Management Project Environmental Assessment	Klamath RD, Winema NF	The decision applies to all NFS lands managed by the Forest, including the Spencer Creek watershed. Result of the decision is to improve water quality by reducing impacts from existing roads.

Current Watershed Conditions

Spencer Creek is 303(d) listed by the State of Oregon for biological criteria, sedimentation, and temperature (ODEQ 2010 database). Ongoing restoration efforts in Spencer Creek have improved watershed conditions at the locations where those projects occurred, however the issues of fine-grained sediment and stream temperature described in the watershed assessment remain valid. This is reflected in the Forest Service Condition Class Rating for the Buck Creek subwatershed that states it is "Functioning At Risk." Water quality ratings were "Not Properly Functioning" (see Attachments: Section 3.3.2). Spencer Creek is highly productive spawning and rearing habitat for rainbow/redband trout despite the temperature and fine-grained sediment issues. Spencer Creek temperatures are low during spring (<15°C) and are generally below 18°C, but can exceed 20°C for extended periods of time during summer months (BOR, 2013). Aquatic and riparian monitoring as part of the NWFP noted improving watershed condition trends in all of the subwatersheds of Spencer Creek (see Attachment: Section 3.3.3).

Natural Disturbance Processes

Disturbance processes for the Spencer Creek watershed are consistent with those described for the High Cascades Province in Section 2.1.4. The disturbance agent that had the most historic influence on ecosystems within the mixed conifer and ponderosa pine zone was fire (Agee 1993, cited in BLM et al., 1995). Studies cited in the Spencer Creek watershed analysis found an average fire-return interval that probably ranged from 10-60 years. Fires tended to be frequent and of moderate to low intensity that created a mosaic of burned and unburned areas.

Both Native American and lightning ignitions were important sources of fire. Native Americans burned these forests regularly and altered the successional development of the vegetative communities. Within both the mixed conifer and ponderosa pine zone the intensity of these historic fires was usually low because the frequent fires repeatedly removed understory ladder fuels and consumed the forest floor fuels.

Within the Spencer Creek watershed, historic insect epidemics from bark beetles (*Dendroctunus* spp., *Ips* spp., and *Scolytus ventralis*) moderately influenced the forests within this zone. Root rots and diseases (*Heterobasidion annosum*, *Armillaria ostoyae*, and *Leptographium wageneri*; blackstain) likely caused small-scale disturbances within the watershed in this zone (Scharpf 1993). Indian paint fungus (*Echinodontium tinctorium*) was also an important small-scale disturbance within this zone. No significant windthrow events are known to have occurred within the watershed except for minor events involving a small number of trees.

Most precipitation falls as snow in the Spencer Creek watershed, and snowmelt dominates the hydrograph. In most years, snow melts slowly and percolates into the soil without generating peak discharge events. Warm spring rains can add to snowmelt peaks and, on average, do so two or three years out of every ten (BLM et al., 1995). Though rare, high-intensity rain-on-snow events do occur in the Spencer Creek watershed and can generate large peak flows. Historically, Buck Lake buffered these flows to some degree.

During large infrequent peak flow events, the stream spreads out in overflow channels or is directed toward the upper banks under bankfull conditions resulting in high erosion rates. Geomorphically, these processes form a pool riffle structure in this fluvial system. Due to the high gradient, the frequency of pool-riffle sequencing was approximately three to seven channel widths, increasing in frequency with a higher gradient. Large woody debris was a major factor in quantity of pools. Large woody debris deposits also created pools upstream and slowed velocity, allowing for the deposition of gravels. Beaver dams also helped to create this pool-riffle structure. Both of these features create areas of sediment deposition.

The amount and proportion of fine-grained sediments entering Spencer Creek, and floodplain areas is low in recent geologic time. The wetland at Buck Lake, floodplain, LWD, beaver dams and pools all functioned to capture and store fine-grained sediments. Therefore, the quantity and quality of productive spawning gravels was high. Well-sorted bedload sediments contributed to a diverse and resilient macroinvertebrate community (BLM et al., 1995: 156). Geomorphically over recent geologic time, water quality in the Spencer Creek watershed was likely high. Water quantity was more likely a limiting factor for salmonids and other aquatic biota.

Project Effects and Natural Range of Variability

There are two areas of concern related to the effects of the project in the Spencer Creek watershed based on the Spencer Creek watershed analysis including whether those effects would be outside the range of natural variability for affected resources in the watershed.

1. Whether the clearing for the project would cause excessive erosion and sediment deposition that would adversely impact any of the affected streams. Sediment levels throughout the Spencer Creek system are limiting and excess or chronic fine-grained sediment deposition in streams is a significant cause for concern.

GeoEngineers completed a stream crossing turbidity, construction risk and site response analysis (see Section 1.3). Evaluations for stream channel crossings in the Spencer Creek watershed are summarized in table 2-67. Best Management Practices that would be applied at each crossing, grouped by "blue" (low risk) and "yellow" (moderate risk) construction impact risk ratings are shown in table 2-68. All of the crossings in Spencer Creek are rated as "blue" or low risk for construction impacts.

All stream crossings on NFS lands in the Spencer Creek watershed are intermittent, snow-melt driven streams. Best Management Practices from the "Blue" category in table 2-68 would be applied at these channel crossings. The upper three crossings (MP 171.06, 171.57, 172.48) drain into wetland features directly below the Spencer Creek road, or into the large Buck Lake complex of channels. The lower crossing (MP 173.74) is an intermittent tributary of Spencer Creek.

In all crossings:

- Silt fencing would be installed and maintained until effective ground cover is reestablished. Silt fences are greater than 90% efficient at trapping silt (Robichaud et al, 2000).
- Effective ground cover would be in place prior to the onset of seasonal precipitation (table 2-69).
- Rapid reestablishment of vegetation would be emphasized.

These are all proven and effective erosion control and water quality BMPs. The measures are expected to be effective based on site-specific evaluations and field reviews (GeoEngineers, 2011). If the project is constructed, sediment impacts are expected to be minor, short -term and consistent with the evaluation in Section 1.3.1. Long- term adverse consequences to water quality from soil erosion are not expected to occur due to effective ground cover (table 2-14 , implementation of the ECRP which includes revegetation of disturbed areas, and installation of waterbars to disperse water.

While on-site erosion control measures are expected to be effective, the presence of wetland features below three of the crossings (MP 171.06, 171.57, 172.48) provide additional backup for filtering of any fine sediment that may enter stream systems from these crossings.

2: Whether removal of effective shade may increase water temperatures in streams.

There are four stream crossings on NFS lands in the Spencer Creek watershed where Riparian Reserve vegetation would be cleared. All are intermittent channels. Channel crossings of intermittent streams are not expected to affect water temperatures because these streams would likely be dry or become discontinuous by the time that warmer water temperatures become an issue in late summer (see Section 1.3.1.3).

Pacific Connector used predictive modeling on a representative cross-section of crossings along the project route, spanning the ecoregions, HUCs, width classes, and aspect classes present from Coos Bay to Malin, Oregon, including stream crossings on NFS lands. Model results show a maximum predicted increase of 0.16°C over one 75-foot clearing. Thermal recovery analysis shows that temperatures return to ambient within a maximum distance of 25- feet downstream of the project right-of-way, based on removal of existing riparian vegetation over a cleared right-of-way width of 75- feet. These findings are consistent with the NSR report (2009). Pacific Connector also assessed the cumulative impact of right-of-way clearing on stream temperatures. The project cumulative effects to the thermal regime in the Coos, Coquille, South Umpqua, Rogue, Klamath, and Lost River basins is expected to be exceptionally minor and well below detection in the field given that mitigation for loss of effective shade would occur, and that predictive modeling using SSTEMP shows that the local impacts are small in magnitude and spatially limited, (GeoEngineers 2013f: 26).

Table 2-70 provides the predicted project effects and relevant ecological processes in Spencer Creek.

TABLE 2-69

Pacific Connector Proposed BMPs for Use at Waterbody Crossings

	Best Management Practices for Project Typical "Blue" Crossings and for all other crossings.	**Best Management Practices for Moderate Risk "Yellow" Crossings**	**Best Management Practices for High Habitat Risk "Green" Crossings**
Crossing MP	**171.06, 171.57, 172.45, 173.74**	None	None
Streambed	• Dry ditch crossings (5) • Backfill to match existing streambed gradation, composition as much as possible • Profile restored to existing profile and grade • Stratified backfill for fish-bearing streams	• Dry ditch crossings (5) • Backfill with native material (3,4) • Backfill to match existing streambed gradation, composition as much as possible (4) • Profile restored to existing profile and grade (4) • Stratified backfill for fish-bearing streams (1) • Structural fill placement (2)	• Dry ditch crossings (5) • Backfill with native material (3,4) • Backfill to match existing streambed gradation, composition as much as possible (4) • Profile restored to existing profile and grade (4) • Stratified backfill for fish-bearing streams (1)
Streambanks	• Revegetation with native plant materials (3, 4,6) • Revegetation with native trees to within 15- feet of the pipeline parallel to the alignment • Widened riparian corridor (federal lands, willing landowners) (3, 6) • Use of fast growing native tree species to accelerate shading) • Placement of large wood and boulders where appropriate • Maintenance of effective cover	• Typical erosion and sediment control BMPs including erosion control blankets, silt fence, etc. • Narrowed construction disturbance (75- feet) corridor where feasible (2,3,4) Narrowed permanent management corridor (2,3,4) • Revegetation with native plant materials (3, 4,6) • Bank graded/terraced to 3:1 (2,3) • Geotextile reinforced slope (5) • Fiber rolls (3) • Stream barbs/flow deflectors (5) • Toe rock placement (3) • Riprap placement (3) • Biotechnical "vegetation" riprap (3) • Tree revetments (3)	• Typical erosion and sediment control BMPs including erosion control blankets, silt fence, etc. • Narrowed construction disturbance (75 feet) corridor where feasible (2,3,4) Narrowed permanent management corridor (2,3,4) • Revegetation with native plant materials (3, 4,6) **Additional Measures** • Rootwad enhancement of bank stabilization

TABLE 2-69

Pacific Connector Proposed BMPs for Use at Waterbody Crossings

	Best Management Practices for Project Typical "Blue" Crossings and for all other crossings.	Best Management Practices for Moderate Risk "Yellow" Crossings	Best Management Practices for High Habitat Risk "Green" Crossings
Riparian Vegetation	• Revegetation with native trees to within 15- feet of the pipeline parallel to the alignment (1, 3, 5, 6) • Revegetation with native woody riparian shrubs and trees (3) • Widened riparian corridor (federal lands (3, 6) • Use of fast-growing native tree species to accelerate shading (3)	• Revegetation with native trees to within 15- feet of the pipeline parallel to the alignment (1, 3, 5, 6) • Revegetation with native woody riparian shrubs and trees (3) • Widened riparian corridor (federal lands (3, 6) • Use of fast-growing native tree species to accelerate shading (3)	• Revegetation with native trees to within 15- feet of the pipeline parallel to the alignment (1, 3, 5, 6) • Revegetation with native woody riparian shrubs and trees for willing landowners (3) Widened riparian corridor (federal lands, willing landowners) (3, 6) • Use of fast-growing native tree species to accelerate shading (3) **Additional Measures** • Emphasis on prevention and monitoring for invasive weeds and weed control during revegetation establishment.
Aquatic Habitat	• Stratified backfill for fish-bearing streams (1,2,4, 6) • Placement of large wood where appropriate (2, 4, 6)	• Stratified backfill for fish-bearing streams (1,2,4, 6) • Placement of large wood where appropriate (2, 4, 6)	• Stratified backfill for fish-bearing streams (1,2,4, 6) • Placement of large wood where appropriate (2, 4, 6) **Additional Measures** • Rootwad enhancement of bank stabilization
BMP Source	1. FERC Guidelines 2. FEIS, JPA, Appendix C, Project Description 3. JPA Appendix 1B, ECRP 4. JPA Appendix F, Affected Waters, Section 2.1.8.3 5. JPA Appendices 2C, 2D 6. JPA Appendix H, Compensatory Mitigation Plan Representatives of the BLM and Forest Service may require additional measures necessary to meet agency standards under the terms of the Right-of-Way Grant.		

TABLE 2-70

Project Effects and Relevant Ecological Processes Described in the Spencer Creek Fifth-Field Watershed Assessment

Ecological Processes Relevant to the Project	Historic Range of Variability	Pacific Connector Effects
Erosional Processes	The Spencer Creek watershed is within the High Cascades Province that includes a pumice soils landscape with high infiltration rates. Erosional processes in the watershed are dominated by spring snowmelt. Landform processes such as landslides, debris flows, and rill and gully erosion are, for the most part, rare and isolated on steep slopes of Aspen Butte, Mt. Carmine and Crater Mt. (BLM et al. ,1995, p. 4-157). Warm spring rains may occasionally (2-3 years out of 10) cause accelerated snowmelt and higher flows, but these rarely result in channel forming events. Infrequent high-intensity rain on snow peak flow events caused pulses of sediments, primarily from bank erosion that created complex pool and riffle aquatic environments. Beaver dams/pools and large wetland complexes (e.g., Buck Lake) created sinks that trapped fine sediments. These processes in the watershed have been altered primarily by roads, which serve as a chronic source of fine grained sediment. Also, draining Buck Lake and irrigation/drainage ditch maintenance contribute sediment. Erosion from timber harvest and skid trails have little effect on channel conditions (BLM et al. ,1995, p. 4-153)	The project does not cross any steep slopes that are prone to landslide or gully erosion. The project location in the Spencer Creek watershed is all on gentler landscapes where water tends to percolate into the ground. On these terrains, hillslope roughness is sufficient to slow water velocity causing any mobilized sediment to “drop out” before reaching streams (BLM et al. 1995, p. 4-153). Erosion control measures are expected to be effective in minimizing sediment sources and transport. Any effects of the project are expected to be within the range of natural variation for the Spencer Creek watershed.
Ecological Succession/Vegetative Condition	Historically, the Spencer Creek watershed had a high frequency of fire occurrence that created a complex mosaic of stands that had an open stand structure. Large, high-intensity fires were rare.	The project affects 91.72- acres (0.41%) of NFS lands in the Spencer Creek watershed (table 2-64). Approximately 8.63- acres of Riparian Reserve vegetation would be cleared on NFS lands (table 2-65) which accounts for 0.04% of the total NFS lands in the watershed. Of this, approximately 4.58- acres are LSOG forest. The clearing of LSOG and mid seral vegetation are long-term changes in vegetative condition. Given its fire history (see Section 2.6.1.3), this is well within the range of natural variability for the Spencer Creek watershed.
Flow Regime	Flow regimes in the Spencer Creek watershed were largely driven by the snowmelt cycle, and less so by changes in vegetation associated with fires because fires were frequent and of low to moderate intensity. Large wetland features buffered minor changes in flows.	The project affects 0.41% on NFS lands and 0.38% of all lands in the watershed (table 2-66). Given the vegetation mosaic in the watershed, the high infiltration rates of soils, the large buffering capacity provided by adjacent wetlands and the small proportion of the watershed affected by the project it is highly unlikely that the project would alter flow regimes in any way. See also EIS Section 4.4.

TABLE 2-70 **Project Effects and Relevant Ecological Processes Described in the Spencer Creek Fifth-Field Watershed Assessment**		
Ecological Processes Relevant to the Project	**Historic Range of Variability**	**Pacific Connector Effects**
Stream Temperature	The aspect of the perennial portion of Spencer Creek is primarily southeast. This exposure provides high incidence of solar radiation compared to many drainages in the High Cascades Province which tend to run east or west. This makes this portion of the stream channel susceptible to increases in water temperatures from loss of shade. Buck Lake likely caused some warming from increased solar radiation. Historic tree composition and valley form indicate that approximately 75% of the perennial streams (excluding Buck Lake) probably had 40 to 70% canopy closure. The remaining 25%, areas with broad flood plains and meadows, is presumed to have had a mixture of cottonwoods, willows, and scattered lodgepole pine patches. Water temperatures in these reaches were probably never in excess of levels considered detrimental to fish populations. Areas susceptible to very low flows were probably subject to short term high temperatures and high diurnal fluctuations in water temperature (BLM et al. 1995:4-155). Stream temperatures have been altered primarily by shade removal associated with roads and timber harvest and by changes in channel morphology that have resulted in high width to depth ratios and a lack of large wood. Spencer Creek is currently 303(d) listed for water temperature.	There are four intermittent stream crossings in the Spencer Creek watershed where Riparian Reserve vegetation would be cleared. Channel crossings of intermittent streams are not expected to affect water temperatures because these streams would likely be dry or become discontinuous by the time that warmer water temperatures become an issue in late summer (see Section 1.3.1.3). Also, the upper three crossings (MPs 171.16, 171.57, and 172.45) drain into the Buck Lake wetland complex where exposure to solar radiation would mask any temperature increase.
Aquatic Habitat and Stream Channel Complexity	Channel complexity in Spencer Creek was likely high because of LWD present in stream channels and beaver activity. Channel structure was sinuous with high pool to riffle ratios and gravels that were relatively free of fine-grained sediments.	During construction, the project would alter the bed and banks of stream channels and move LWD and boulders as necessary for construction. After construction, these sites would be restored to their preconstruction condition and stabilized as needed by placement of boulders, LWD and erosion control structures as specified in the ECRP and Wetland and Waterbody Plan; therefore, no long term effects to aquatic habitat and channel complexity are expected. Effects would be limited to the project scale, and are minor and short-term (typically 1 to 2 days per crossing).

Compliance with Standards and Guidelines

Table 2-71 describes WNF/NWFP Standards and Guidelines relevant to the ACS and the project's compliance with this management direction in the Spencer Creek watershed.

TABLE 2-71 **Cross References between ACS-Relevant NWFP Standards and Guidelines and BLM District RMP Management Direction**	
WNF/NWFP Standard/Guideline	**Project Compliance**
LH-4: Riparian Reserves	Terms and conditions to ensure compliance with ACS objectives have been incorporated into the POD prepared by the applicant in conjunction with the BLM, Forest Service, and Reclamation and submitted as part of the Right-of-Way Grant application. The POD includes 28 exhibits including the Wetland and Waterbody Crossing Plan, the Erosion Control and Revegetation Plan, the Hydrostatic Test Plan, the right-of-way Clearing Plan, the TMP, etc.
RA-4: Riparian Reserves - General Riparian Area Management	Pacific Connector has developed a Hydrostatic Test Plan (see the POD) that would minimize any potential short-term effects on stream flows from water discharge events from the project's hydrostatic testing operations. No potential hydrostatic test water sources occur within the Spencer Creek watershed, therefore the biological, physical, and chemical integrity of these systems would remain unaffected from hydrostatic withdrawal activities.
RF-2: Riparian Reserves - Road Management	The existing transportation system in the Spencer Creek watershed would be adequate for construction of the project. No new temporary or permanent access roads are planned in the Spencer Creek watershed.
RF-4: Riparian Reserves - Road Management	No new road crossings of streams are proposed in the watershed. Crossings would be maintained to prevent diversions. Specific specifications in the TMP Section 2.2.3 and Exhibit F, Section F.9.e require culvert and bridge replacements to meet agency standards and agency approval of plans.
RF-5: Riparian Reserves - Road Management	Road maintenance specifications in the TMP require implementation of T-831, T-842, T-811 and T-834, which are maintenance specifications designed to minimize sediment delivery to aquatic habitats, would be implemented during project construction. Several road decommissioning are proposed in the Spencer Creek watershed. These are expected to reduce sediment delivery from roads, in some places significantly.
RF-6: Riparian Reserves - Road Management	Fish passage would be maintained at all road crossings where project-related road repairs are implemented.
RF-7: Riparian Reserves - Road Management	The TMP submitted by the applicant and accepted by the Forest Service meets all of the requirements of RF-7.
WR-3: Riparian Reserves - Watershed and Habitat Restoration	Application of BMPs and aggressive erosion control measures, restricted construction windows, and numerous other impact minimization measures have been incorporated into several exhibits to the POD to prevent habitat degradation. These measures are not being used as a substitute for otherwise preventable habitat degradation or as surrogates for habitat protection.
Retain late-successional forest patches in landscape areas where little late-successional forest persists. This management action/direction will be applied in fifth-field watersheds (20- to 200- square miles) in which federal forest lands are currently comprised of 15% or less late-successional forest. (The assessment of 15% will include all federal land allocations in a watershed.) Within such an area, protect all remaining late-successional forest stands.	Federal lands in the Spencer Creek watershed are currently 26% LSOG and exceed this threshold.
FS 1. Management Recommendations for Survey and Manage Species. Management direction for Survey and Manage Species in the NWFP ROD was replaced by the 2001 ROD and Standards and Guidelines for Amendments to the Survey and Manage, Protection Buffer, and other Mitigation Measures Standards and Guidelines as Modified by the 2011 Settlement Agreement in Conservation Northwest v. Sherman, Case No. 08-CV-1067-JCC (W.D. Wash.).	The project affects Survey and Manage species within the Spencer Creek watershed. However, the project does not threaten the persistence of any Survey and Manage species (see appendix K). Regardless, this is inconsistent with the land management plan for the Forest Service and an amendment to the plan is required. Waiving application of Management Recommendations for Survey and Manage species in the watershed would not prevent attinament of any ACS objective.

TABLE 2-71 **Cross References between ACS-Relevant NWFP Standards and Guidelines and BLM District RMP Management Direction**	
WNF/NWFP Standard/Guideline	**Project Compliance**
WNF 4 - The forest wide general Standard and Guideline requires detrimental soil conditions not exceed 20% of the total acres within the activity area (Forest Plan page 4-73) a	The project cannot meet this standard, and an amendment of the WNF LRMP is needed. This amendment allows the project to exceed restrictions on detrimental soil conditions from displacement and compaction on an estimated 30- acres within the project right-of-way. Detrimental soil conditions occur when soil is compacted, puddled, displaced over an area greater than 100- square-feet, or are severely burned.
WNF 5 - Management Area 8 – Riparian Areas requires the cumulative total area of detrimental soil conditions in riparian areas shall not exceed 10% of the total riparian acreage within an activity area (Forest Plan page 4-137).	The project cannot meet this standard. This amendment allows the project to exceed restrictions on detrimental soil conditions from displacement and compaction on an estimated 4- acres within the project right-of-way that lies within Management Area 8 Riparian Area. Detrimental soil conditions occur when soil is compacted, puddled, displaced over an area greater than 100-square -feet, or are severely burned.

Compliance with Standards and Guidelines for Key Watersheds

The Spencer Creek watershed was delineated as a Tier 1 Key Watershed in the NWFP. Applicable Standards and Guidelines for Key Watershed and the project's consistency is shown in table 2-72.

TABLE 2-72 **Standards and Guidelines for Key Watersheds**		
Standard and Guideline	**PCPG Consistency**	**Mitigation Plan**
Reduce existing system and nonsystem road mileage, with no net increase in road miles	No new roads would be constructed by Pacific Connector. The project right-of-way would be obliterated after construction.	Decommissioning of approximately 29.22 miles of road would on NFS lands would result in a net decrease of road miles and reduce road density in the Tier 1 Key Watershed.
No new roads would be constructed in inventoried Roadless Areas.	No part of the project is in an inventoried Roadless Area.	None
Watershed Analysis/Assessment must be completed prior to management activities.	Watershed Analysis/Assessment has been completed for all watersheds crossed by the project on NFS lands.	Off-site mitigations are consistent with watershed analysis recommendations

Relationship of Proposed Forest Service Land Management Plan Forest Plan Amendment to the ACS

The WNF LRMP contains Standards and Guidelines that cannot be met by the project. Two of these Standards and Guidelines have a nexus with the ACS because they provide protection for aquatic resources that are more restrictive than the NWFP. Site-specific amendments of these standards and guidelines are proposed to make provision for the project. This discussion addresses whether those plan amendments would prevent attainment of the ACS.

WNF-4 and WNF-5: Amendments of Detrimental Soil Standards

These Standards and Guidelines restrict the amount of an area that may be in a degraded soil condition as a result of a management activity. They are considered together here because the assessment is the same for both standards.

> The forest wide general Standard and Guideline requires detrimental soil conditions not exceed 20% of the total acres within the activity area (Forest Plan page 4-73) and Management Area 8 – Riparian Areas requires the cumulative total area of detrimental soil conditions in riparian areas shall not exceed 10% of the total riparian acreage within an activity area (Forest Plan page 4-137). Detrimental soil conditions occur when soil is compacted, puddled, displaced over an area greater than 100 -square -feet, or are severely burned.

Degraded soil conditions may occur in cleared project areas. On NFS lands in the Spencer Creek watershed, approximately 87% (80 acres) of the project right-of-way would be cleared. Degraded soil conditions may result from displacement and compaction following completion of project construction and rehabilitation. Compaction can be addressed by subsoil ripping, but displacement would be unavoidable because of the nature of the project. Existing Forest Plan Standards and Guidelines allow up to 10% (9- acres) of the project right-of-way in MA-8 Riparian Areas or 20% (18- acres) in the project right-of-way outside of MA-8 to be in a degraded soil condition on completion of a project. Thus, the proposed amendment allows an estimated additional 62- or 71- acres (0.27 or 0.32% of NFS lands in the Spencer Creek watershed) to be in a degraded soil condition on completion of the project.

Without rehabilitation, severe disturbances such as soil mixing or displacement would reduce long-term site productivity by displacing the duff layer and soil surface (i.e., A horizon), thus reducing the soil's ability to capture and retain water and nutrients. As a result, sites with long-term detrimental soil conditions may have interrupted hydrologic function and poor site productivity. Compacted and/or displaced soils may increase runoff and sediment transport and have lower rates of vegetative recovery.

Environmental consequences associated with 62 - or 71- acres (about 0.27 or 0.32% of NFS lands in the watershed) of additional detrimental soil conditions include:

- **A potential increase in sediment mobilization.** The following measures have been incorporated into the project design or mitigation plans to limit sediment mobilization and transport.
    - The project alignment was selected to avoid areas with high geologic hazards. No landslides have been identified that pose a threat to the project. The project does not cross unstable earthflow terrains identified in the Spencer Creek watershed.
    - Effective erosion control measures and BMPs are required as shown in the ECRP (see Section 1.3 for a discussion of erosion control measures). Additionally, the project would comply with LRMP Standards and Guidelines for maintenance of effective ground cover (see Section 1.3.1.2).
    - The Spencer Creek watershed analysis documented that skid trails and harvest units rarely contribute sediment to channels because the roughened soil surface and inherently high infiltration rates limit sediment transport (BLM et al. 1995: 4-153). The project right-of-way, upon completion, would have conditions similar to a harvest unit; therefore, similar results would be expected.

- Offsite mitigation measures that would help to offset these effects on NFS lands in the Spencer Creek watershed include approximately 29.22 miles of road decommissioning. Assuming a 14-foot average road width, 29.22 miles of proposed road-decommissioning would reduce compaction and revegetate approximately 50- acres that are currently native road surfaces in the Spencer Creek watershed. This action substantially offsets any areas that may remain in a detrimental soil condition (an estimated 20- to 57 acres) in the project right-of-way.

- Any sediment impacts from detrimental soil conditions are expected to be minor and short-term as a result of the dispersal of effects by the linear nature of the project, maintenance of effective ground cover, the required application of BMPs, minimal stream crossings, and application of offsite mitigations. Amending the LRMP is unlikely to exceed the soil disturbance thresholds on 62- or 71- acres resulting in the mobilization of sediment that would prevent attainment of ACS objectives in the Spencer Creek watershed.

- **A potential localized increase in peak flows.** Changes in vegetation from fires, altering wetland functions, clearing vegetation and roads are known to affect peak flows. Loss of wetland functions and roads were identified in the Spencer Creek watershed analysis as the primary factors affecting peak flows. Changes in vegetation from timber harvest appear to have little effect on peak flow processes (BLM et al., 1995: 4-147). The project as a whole affects about 91.72- acres or 0.41% of the NFS lands in the Spencer Creek watershed. Detrimental soil conditions are likely to exist on 80- acres or about 0.35% of NFS lands in the watershed. These effects would be spread over 6 -miles of corridor in two separate subwatersheds. It is unlikely there would be any change in peak flows as a result of construction of the project or detrimental soil conditions given the snowmelt-driven hydrograph and high soil infiltration rates in the watershed.

  It is unlikely that amending the forest plan to allow detrimental soil conditions on an additional 62- or 71- acres would result in any change in flows that would prevent attainment of ACS objectives.

- **A potential loss of site productivity, which may slow vegetative recovery.** Soils derived from High Cascades volcanic units may be low in productivity. Mechanically decompacting the soil to a minimum depth of 20- inches and reestablishing soil organic matter would be a critical first step in rehabilitating the soil toward a more natural condition. Soil rehabilitation would also require recovery of the soil biology, which requires restoration of the soil organic matter and time. Project mitigation measures would be used to decompact the project right-of-way, fertilize disturbed areas, reestablish native vegetation (by limiting the area directly over the pipe to grasses and shrubs), and scatter slash and CWD back across the site to provide for long-term nutrient cycling as required in the ECRP. Any loss of soil productivity would be widely dispersed in the project right-of-way. Additionally, decommissioning 29.22- miles of roads (estimated to be 50 - acres of running surface) on NFS lands would contribute to offsetting any loss of soil productivity by restoring vegetative cover and organic material and reestablishing drainage on currently bare and compacted soils.

  Slash and CWD would be scattered back across the project right-of-way to provide organic material on completion of the constructive phase. In areas where revegetation may be difficult because of soil conditions, the Forest Service would require soil remediation with wood chips and biosolids to reestablish soil productivity.

In conclusion, Amendments WNF-4 (Detrimental Soil Conditions) and WNF-5 (Detrimental Soil Conditions in Riparian Areas) have allowed minor effects at the site- scale. It is unlikely that those effects would prevent attainment of ACS objectives in the Spencer Creek watershed.

Off-Site Mitigations on NFS Lands

Offsite mitigation is to provide supplemental actions for projects that cannot be completely mitigated with on-site design features in order to ensure land management plan objectives are achieved. These projects also contribute to the "Maintain and Restore" objectives of the ACS. The Forest Service and Pacific Connector have entered into Agreements in Principle to accomplish off-site mitigation work in the Spencer Creek watershed as shown in table 2-73.

Mitigation measures were developed from the recommendations of watershed assessments, Late Successional Reserve Assessments and the 2008 Northern Spotted Owl Recovery Plan. Proposed mitigation measures in the Spencer Creek watershed with a nexus to the ACS include:

- **LWD Instream.** Placement of LWD in streams adds structural complexity to fluvial systems by creating pools and riffles, trapping fine-grained sediments and can contribute to reductions in stream temperatures over time (Tippery, Jones et al. 2010). This is responsive to Aquatic Conservation Strategy objectives two through five.
- **Road -Decommissioning.** Decommissioning roads can substantially reduce sediment delivery to streams (Madej 2000; Keppeler, Cafferata et al. 2007). Proposed road decommissioning, where the project impacts occur, would reduce surface runoff, increase infiltration and reduce sediment production from road-related surface erosion in the watershed. This mitigation is responsive to ACS objectives two through five and Standards and Guidelines for Key Watersheds (Forest Service and BLM 1994b: B-11, C-7).
- **Fish Passage/Culvert Replacement.** Old culverts may block fish passage either by poor design or by failure over time. Removing these blockages and replacing them with fish-friendly designs can allow fish and other aquatic organisms to access previously unavailable habitat. This is responsive to ACS objectives one through three and nine.
- **Stand Density Reduction.** Use of fuels reduction and stand density management are appropriate tools to reduce the risk of high-intensity, stand-replacing fires in these forests. Management activities that reduce the risk of natural disturbance adjacent to KOAC is also appropriate (Forest Service and BLM, 1994b: C-11). Results of the Spencer Creek watershed analysis included recommendations for fuels reduction projects on most landscapes. Stand density reductions in riparian zones have the dual benefit of reducing the risk of stand-replacing fire, while also accelerating the development of late successional stand conditions by accelerating growth of remaining trees. This is responsive to ACS objective eight and nine.

TABLE 2-73

Proposed Offsite Mitigation Projects on NFS Lands

Agency	Project Type	Project Name	Quantity	Unit	Project Rationale	Land Allocation
FS	Aquatic	Riparian Planting	0.5	Mile	This is a meadow site along a 0.5- mile reach of Spencer Creek just upstream of Buck Lake (T38S R5E sec 11) that has lost streamside vegetation and has compacted soils. There is an overall need to restore health and vigor to riparian stands by maintaining and improving riparian reserve habitat. Shade provided by the plantings would contribute to moderating water temperatures in Spencer Creek. Root strength provided by new vegetation would increase bank stability, decrease erosion and sediment depositions to Spencer Creek and provide habitat for species that use riparian habitats. This is responsive to Aquatic Conservation Strategy objectives 3, 4, 5, 8 and 9.	Riparian Reserves
FS	Aquatic	Spencer Creek LWD	1	Mile	Over the last century, a 1-mile reach of Spencer Creek (T38S R6E sec 18) with high aquatic habitat potential has become simplified, and therefore, has a reduced capacity to provide quality habitat. Riparian stands have decreased health and vigor, resulting in increased time to develop large tree structure for wildlife, stream shade, and future instream wood. Placement of LWD in streams adds structural complexity to aquatic systems, traps fine sediments and can contribute to reductions in stream temperatures over time (Tippery, Jones et al. 2010). The BLM completed placement last year on 3- miles of Spencer Creek below this reach. Addition of this segment would complete the stream rehabilitation on the reach of Spencer Creek where the project occurs. Logs from the project right-of-way would be used for the project. An estimated 75 pieces are needed. A helicopter would be used to place the logs. This is responsive to Aquatic Conservation Strategy objectives 2, 3, 4 and 5.	Riparian Reserves
FS	Aquatic	Interpretive Sign	1	Project	Continued recreational dam building occurs at this location resulting in negative impacts to stream morphology and riparian habitat impacting fish and the only known Upper Klamath Basin population of Giant Pacific Salamander. There is a need to educate the public as to the detrimental effects of this dam building action and this would best be served by installation of an informational sign to reach those parties utilizing the site.	Riparian Reserves

TABLE 2-73

Proposed Offsite Mitigation Projects on NFS Lands

Agency	Project Type	Project Name	Quantity	Unit	Project Rationale	Land Allocation
FS	Aquatic/Terrestrial	Road Decommissioning	29.22	Miles	Reduction in road density is a central recommendation of the Spencer Creek WA. The objective of road decommissioning for this project is to reduce road density and accelerate the revegetation of the decommissioned roads with trees to reduce negative impacts of roads on wildlife habitat and aquatic environments. Some natural-surface roads have poor drainage that can lead to erosion and increased sediment in nearby streams (Trombulak and Frissell 2000). Road obliteration can improve drainage and to reduce chronic sediment input to the stream systems (Madej 2000; Switalski, Bissonette et al. 2004; Tippery, Jones et al. 2010). This mitigation also offsets the impacts of soil compaction and displacement within the project right-of-way by reducing compaction in the decommissioned roadbeds. Table 2-74 and figure 2-18 compares miles of roads decommissioned with impacts of the project right-of-way on Riparian Reserves, acres in degraded soil condition and number of stream crossings. Likely benefits of road decommissioning include increased infiltration of precipitation, reduced surface runoff, and reduced sediment production from surface erosion (Switalski, Bissonette et al., 2004). Where roads are decommissioned within riparian areas, riparian vegetation may be reestablished. Approximately 5.2- miles or 12.6- acres of proposed decommissioning occur within Riparian Reserves (table 2-74 , figure 2-18) Approximately 29.22 - miles of roads are currently open that can be decommissioned. Table 2-75 and figure 2-19 below shows the reduction in road density associated with implementation of the proposed mitigation plan. Road densities decrease at all scales with this mitigation. The greatest reductions in road density occur within ¼- mile of the project right-of-way, showing that mitigations are associated with the impact of the project where the impacts from the project occur. Overall, this accomplishes a reduction in road density of 24% (table 2-75 , figure 2-19) Assuming a 14- foot average road width, 29.22 - miles of proposed road- decommissioning would revegetate approximately 50 - acres that are currently native road surfaces in the Spencer Creek Watershed. This mitigation is responsive to ACS objectives two through five and Standards and Guidelines for Key Watersheds (Forest Service and BLM 1994b p. B-11, C-7).	Riparian Reserves
FS	Aquatic/Terrestrial	Allotment Fencing	6.5	Miles	Construct allotment fencing along the south side of the ROW through Forest Service administered lands (approx. 6.4- miles). This fence would serve to divide the Buck Indian Allotment into pastures north and south at Clover Creek Road. This fence would keep cattle from grazing newly revegetated areas in the project right-of-way, including areas where the project crosses Spencer Creek, thus helping to ensure that erosion control and revegetation objectives are met.	Riparian Reserves

TABLE 2-73 **Proposed Offsite Mitigation Projects on NFS Lands**						
Agency	**Project Type**	**Project Name**	**Quantity**	**Unit**	**Project Rationale**	**Land Allocation**
FS	Aquatic/Terrestrial	Harden Ford	1	Project	Stream crossing improvements would improve aquatic habitat/connectivity and reduce sedimentation. The road accessing this location has been closed on the BLM and USFS. The private landowner and cattle cross the ford to access pasture from private land. The raw, unstable banks at this crossing allow fine sediments to enter the stream. This ford needs to be hardened and the banks re-vegetated and protected from grazing. The USFS side from the upper Spencer Creek dispersed campground needs more boulders or method of blocking 4-wheelers.	Riparian Reserves
FS	Aquatic/Terrestrial	Spencer Creek Stream Crossing Decomissioning	1	Project	Restoring stream crossings reconnects aquatic habitats by allowing the passage of aquatic biota and restoring riparian vegetation. Over time, these actions reduce sediment and restore shade. Restoration of these crossings includes riparian planting as a mitigation which will help offset the impact of shade removal at pipeline right of way crossings.	Riparian Reserves

National Forest System Lands

The project crosses portions of the Buck Lake and Upper Spencer Creek subwatershed on NFS Lands in the Spencer Creek watershed. All of the NFS lands in the Spencer Creek watershed are classified as a Tier 1 Key Watershed. Standards and Guidelines for Tier 1 Key Watersheds overlay all other land allocations. Figure 2-13 shows mitigation proposed on NFS lands.

Aquatic Conditions and Issues

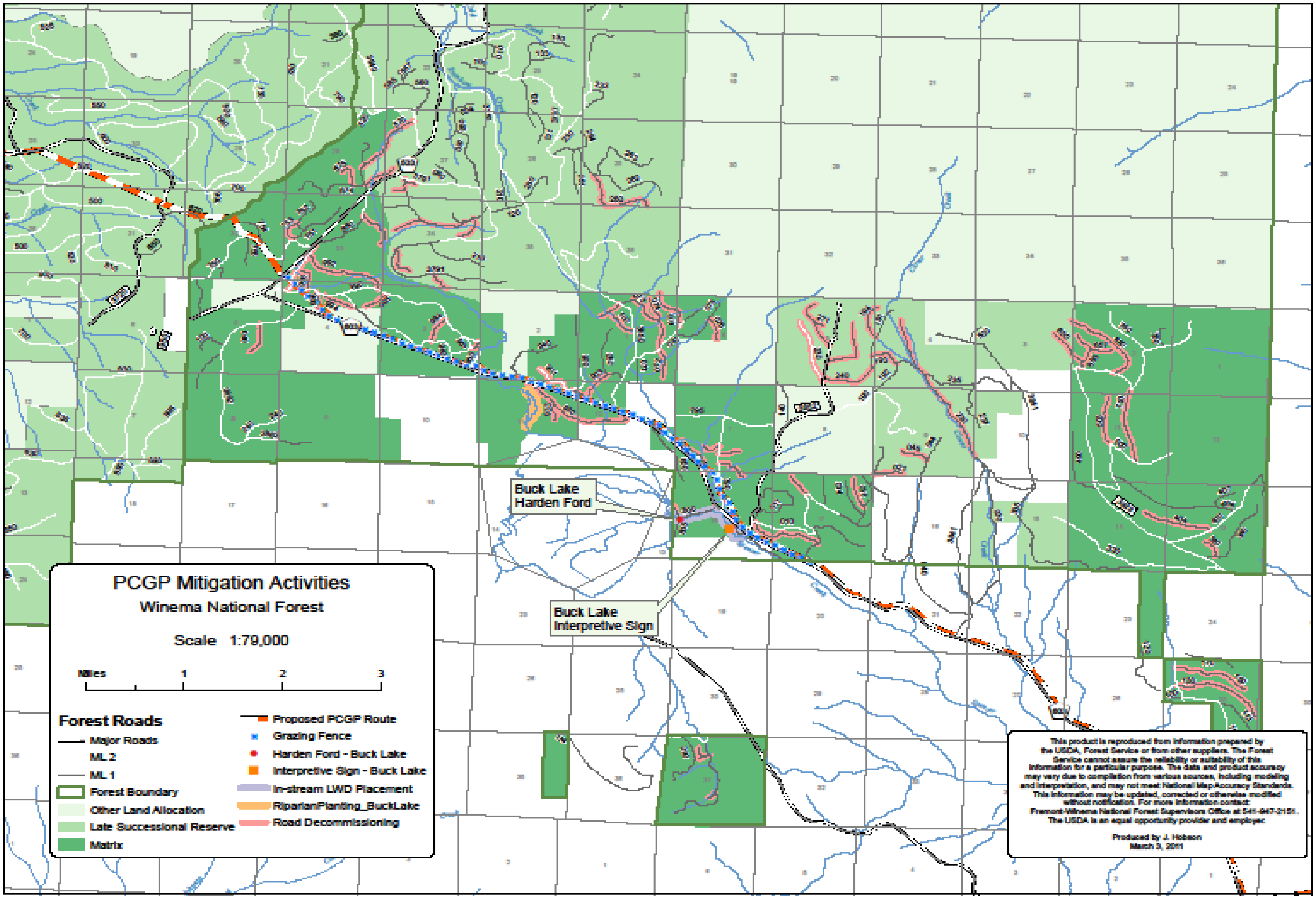
Spencer Creek is 303(d) listed by the State of Oregon for biological criteria, sedimentation, and temperature (ODEQ 2010 database). Roads are the primary source of fine-grained sediments that negatively impact aquatic habitats. There are 150 road crossings and 23 miles of road within 100 feet of stream channels within the watershed. Roads and areas of compaction decrease soil productivity, prolong the vegetative recovery process and increase runoff potential. Road densities and harvest have reduced near term large woody debris recruitment and stream side canopy closure in many areas. Streamside timber harvest and channelization and grazing at Buck Lake (mostly private property) have also affected aquatic resources. Fuel accumulation and dense white fir ladder fuels have increased the risk of high-intensity, stand-replacing fire in Riparian Reserves.

Terrestrial Conditions and Issues

Road density exceeds the recommended level for several wildlife species of concern, including deer and elk. Due to the distribution of blocks of late successional forest, habitat connections are minimal between large late-successional forest patches occurring within the watershed. This may restrict the movement and dispersal of some late-successional dependent wildlife species through the watershed. Fuel accumulation and dense white fir ladder fuels have increased the risk of high-intensity, stand-replacing fire.

Table 2-73 describes proposed mitigation measures on NFS lands that are responsive to these conditions and issues.

Figure 2-13 Mitigation Proposals on the Winema National Forest, Spencer Creek



Proposed Mitigation Projects

Table 2-74 compares project effects and proposed road decommissioning on NFS Lands in Spencer Creek. Table 2-75 describes changes in road density with implementation of mitigation projects.

TABLE 2-74

Comparison of Project Effects and Proposed Road Decommissioning on NFS Lands, Spencer Creek Tier 1 Key Watershed

	Miles in Watershed a/	Acres in Riparian Reserves b/	Acres in Degraded Soil Condition/Acres Restored c/	# Stream Crossings d/
Project Right-of-Way	15.14	8.31	39	3
Roads Decommissioned	21.45	12.6	36	25

Source:
a/ Table 2.6.3.1-2
b/ Table 2.6.3.1-3
c/ See Road Decommissioning Data Tables in Section 3.4. Acres in degraded soil condition are estimated at midpoint of range from 20-57 acres.
d/ Table 2.6.3.1-5

TABLE 2-75

Changes in Road Density with Implementation of Mitigation Plan, WNF Spencer Creek Tier 1 Key Watershed

Winema NF	Current Condition (miles/square mile)	With Road Decommissioning (miles/square mile)	Change in Road Density with Decommissioning (miles/square mile)
All Roads, Spencer Cr. KWS (NFS only)	2.64	2.02	-0.62
Within 1 Mile of Project	3.9	2.79	-1.11
Within 1/2 mile of Project	4.33	2.87	-1.46
Within 1/4 mile of Project	4.67	2.75	-1.92

Source: FS GIS Analysis, Road Density Analysis,

Cumulative Effects

Activities on NFS Lands

The Forest Service manages about 25% of the Spencer Creek watershed. Projects on NFS lands that would contribute to cumulative effects with the project are shown in table 2-76

TABLE 2-76

Current and Reasonably Foreseeable Future Actions on NFS Lands in the Spencer Creek Watershed

Unit	Fifth-Field Watershed	6th Field Watershed	Project Name	Project Description	Affected Resource
WNF	Spencer Creek	Buck Lake	Lakewoods WUI Harvest Project	Variety of fuels treatments surrounding the Lakewoods private land subdivision. Commercial harvest approximately 70- acres.	Vegetation; soil compaction; road system

TABLE 2-76 **Current and Reasonably Foreseeable Future Actions on NFS Lands in the Spencer Creek Watershed**					
Unit	**Fifth-Field Watershed**	**6th Field Watershed**	**Project Name**	**Project Description**	**Affected Resource**
WNF	Spencer Creek	Buck Lake; Upper Spencer Creek	Indian Grazing Allotment	Cattle grazing	Vegetation; water quality; fisheries
WNF	Spencer Creek	Buck Lake; Upper Spencer Creek; Clover Creek	Buck Cattle and Horse Allotment	Livestock grazing	Vegetation; water quality; fisheries
WNF	Spencer Creek	Buck Lake; Upper Spencer Creek; Clover Creek	Road Maintenance	Variety of routine road maintenance activities	Road system
WNF	Spencer Creek	Buck Lake; Upper Spencer Creek; Lower Spencer Creek; Clover Creek	Road Decommissioning as part of project mitigation	Decommission approximately 21.45-miles as "offsite" project mitigation	Water quality; fisheries; soil compaction; road system
WNF	Spencer Creek	Buck Lake; Upper Spencer Creek; Clover Creek	Fremont-Winema Invasive Plant Treatment EIS 2009	Ongoing invasive plant treatment project currently prescribes treatment of known infestations of invasive plants and would reduce the potential for invasive plant introduction and spread by allowing for timely treatment sites in or near the project area as	Vegetation
WNF	Spencer Creek	Buck Lake; Upper Spencer Creek; Clover Creek	project reclamation activities	All activities associated with reclamation of construction right of way; access roads; etc.	Vegetation; soil compaction; road system; water quality; fisheries

These activities are expected to be consistent with the Standards and Guidelines and objectives of the Forest Service land management plans. Restoration thinning and hazardous fuels reductions are expected to contribute to improvements in watershed conditions by reducing stand density and reducing the probability of stand-replacing fire. Road improvements and decommissioning are expected to reduce road-related sediment transport to aquatic systems.

Activities on non-Forest Service Lands

The BLM manages about 23% of the Spencer Creek watershed and private lands comprise about 52% of the Spencer Creek watershed. There are no projects proposed on BLM lands which would contribute to cumulative effects with the project. Private lands in the watershed are expected to be managed according to current land use patterns consistent with the County General Plan and existing federal and state statutes including the Oregon Forest Practices Act and the Clean Water Act.

Cumulative Effects

The project right-of-way comprises about 0.41% of the NFS lands and 0.38% of other lands in the Spencer Creek watershed (table 2-64). The small proportion of the landscape affected by the project, ongoing land management on private lands, the regulatory framework between the BLM, ODEQ and ACOE applicable to the project and project location and routing make it highly unlikely that the portion of the Pacific Connector project on federal lands, when considered with other past, present and reasonably foreseeable future actions would change watershed conditions in the Spencer Creek watershed in any significant, discernible or measureable way.

Project Effects Compared by ACS Objective

Table 2-77 compares the project impacts to the objectives of the ACS for the Spencer Creek watershed. NFS lands where the ACS applies comprise approximately 41% of the Spencer Creek watershed (table 2-63). Watershed conditions and recommendations are found in the Spencer Creek watershed analysis (BLM et al. 1995). The project would include and 6.05 miles on NFS lands. A total of 9.98 acres of Riparian Reserves or 0.60% of the Riparian Reserves in the watershed (table 2-65) would be affected on:

- Four intermittent stream channels and two wetlands crossed by the project.
- Four intermittent streams and two wetlands where Riparian Reserves are clipped but the associated stream channel or wetland is not crossed.

TABLE 2-77

Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Spencer Creek Watershed

ACS Objective	Project Impacts
Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.	Riparian Reserves are watershed-scale features. The project would clear about 8.63-acres or about 0.52% of Riparian Reserves on NFS lands in the Spencer Creek watershed (table 2-67). There are four intermittent stream channels crossed in the Spencer Creek Watershed. No perennial streams are crossed. Riparian Reserves associated with two forested wetlands and four intermittent streams are clipped. Impacts to aquatic systems are expected to be short-term or minor and limited to the project scale because of application of BMPs and erosion control measures (see Section 1.4.1.). Clearing of 4.58 -acres of LSOG vegetation in Riparian Reserves is a long-term change in condition, but is minor in scale, and within the range of natural variability given the disturbance processes in Spencer Creek (see p.2-176-2-181). Spencer Creek watershed remains above the 15% threshold on federal lands for LSOG vegetation established in the NWFP (p. 1-174). Large woody debris cleared in construction of the project right-of-way would be used to stabilize and restore stream crossings. Off-site mitigation measures including 29.2- miles of road decommissioning, one mile of instream projects, fencing and riparian planting projects are expected to improve watershed conditions in the Spencer Creek watershed. While there are long-term changes in vegetation in Riparian Reserves from construction clearing of the project right-of-way, these would be minor in scale and well within the range of natural variability given the disturbance history of the watershed (see p. 2-176-2-181).

TABLE 2-77

Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Spencer Creek Watershed

ACS Objective	Project Impacts
Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life-history requirements of aquatic and riparian-dependent species.	The project is not expected to affect spatial or temporal connectivity in the Spencer Creek watershed because the pipeline would be buried in all aquatic habitats crossed, consistent with the requirements of the exhibits specified in the POD (i.e., Wetland and Waterbody Crossing Plan). Additionally, all of the channels crossed in Spencer Creek are intermittent and are likely to be dry at the time of crossing. In the short-term, during construction, connectivity could be disrupted for 1-5 days. At each crossing, bed and bank disturbances are small (<15- feet -wide). After construction all disturbed areas would be returned to their approximate preconstruction contours and drainage patterns. The temporary project right-of-way would be restored and revegetated with native grasses, forbs, conifers, and shrubs, as outlined in the ECRP. After construction, key habitat components such as LWD and boulders would be restored onsite and the bed and banks would be returned to preconstruction conditions. By implementing these measures, lateral and longitudinal connectivity at the site scale would be maintained, although in the short-term, during construction, connectivity may be disrupted. With the exception of a few days during the construction of the crossing, access to areas necessary for life-histories of aquatic and riparian dependent species would not be obstructed. By restricting stream crossing operations to the ODFW in-stream work window, possible impacts to sensitive life stages of aquatic biota would be minimized. Road decommissioning that occurs within Riparian Reserves (approximately 9.63- acres) would contribute to restoration of aquatic connectivity (see p. 2-186-191). The residual levels of disturbance are anticipated to be well within the range of natural variability in the High Cascades Province (see p. 176-181).
Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.	Impacts to the stream bed and banks would be minor and limited to the site of construction because the pipeline would be buried, and the actual area of bank and stream bottom disturbance is small at each crossing (<15- feet -wide). This level of disturbance is comparable to a bank failure (see Section 1.4.1) and well within the range of natural variability for watersheds in the High Cascades Province (see p. 176-181). After construction, key habitat components such as LWD and boulders would be restored onsite and the bed and banks would be returned to preconstruction conditions, consistent with the exhibits to the POD (i.e., Wetland and Waterbody Crossing Plan). By implementing these measures, the fluvial integrity of the aquatic system at the site-scale would be maintained. Offsite mitigation measures (see Section 2.6.3.6) would substantively improve watershed conditions by decommissioning 29.22- miles of roads (50- acres total of which 12.6- acres are in Riparian Reserves), replanting willows along 0.5 -miles of perennial streams and restoring LWD in 1 mile of Spencer Creek (see p. 2-186-191, 2-73, Table 2.74.
Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.	Project stream crossings in the Spencer Creek watershed are expected to occur when intermittent stream channels are dry. Minor amounts of sediment would be generated during construction that may be mobilized during the onset of seasonal precipitation in the fall. These impacts are expected to be short -term and limited to the general area of construction (see Section 1.4.1). No long-term impacts on water quality are expected because of application of the ECRP including maintenance of effective ground cover (see Section 1.4.1) and BMPs during construction (see Sections 1.4.1.1) Offsite mitigation measures (see p. 2-186 – 191, table 2-73) address key issues identified in the watershed assessment and are expected to substantially improve watershed conditions.
Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of this sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.	The Spencer Creek watershed sediment regime was historically characterized by pulse-type depositions of coarser sediments from streambank erosion following major disturbances such as fires and high-intensity winter storms. More chronic erosion and deposition of fine-grained sediments primarily from roads, and to a lesser degree from land use has replaced these pulse-type disturbances in the current sediment regime in the watershed. The project construction and operation is not likely to alter this sediment pattern nor is it likely to exacerbate these conditions. Sediment impacts from construction are expected to be like those described in Section 1.4.1.2. Proposed mitigation projects including 29.5- miles of road -decommissioning would contribute to reduction of sediments and restoration of aquatic functions at the watershed scale. Any sediment impacts are expected to be well within the range of natural variability given the disturbance history of the Spencer Creek watershed (see p. 2-176-181).

TABLE 2-77 **Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Spencer Creek Watershed**	
ACS Objective	**Project Impacts**
Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.	The project is unlikely to affect flow patterns in the Spencer Creek watershed because of the dispersed nature of impacts, high infiltration rates and the relatively small proportion of the watershed affected (0.41%) (see p. 2-191, Table 2-64). Decommissioning roads (29.5- miles) as part of the offsite mitigation plan would contribute substantively the restoration of flow patterns by restoring hydrologic connectivity at stream crossings that are decommissioned (See p. 2-186 – 191, Table 2-73).
Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.	The project crosses two small wetland areas and clips the Riparian Reserve of another two forested wetlands. Trench plugs would be installed on each side of these wetlands as needed to block subsurface flows and maintain shallow, unconfined aquifer water table elevations, as required by FERC's Wetland and Waterbody Construction and Mitigation Procedures. By restricting crossings to the dry season (July 1 to Sept. 15), possible impacts on shallow ground water tables of these wetland areas are expected to be minor and short-term.
Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation; nutrient filtering; and appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse, woody debris sufficient to sustain physical complexity and stability.	The project impacts on riparian vegetation in the Spencer Creek watershed would be minor. Approximately 9.98 or 0.60% of the Riparian Reserves in the watershed are potentially affected by the project (table 2-65). Existing herbaceous and brush cover would be maintained in Riparian Reserves to the extent practicable. Following construction, replanting with native species would facilitate reestablishment of vegetation communities. Large woody debris and boulders from the project right-of-way would be returned to disturbed riparian areas. Revegetation of 12.6 -acres of Riparian Reserves in roads that would be decommissioned would help to reestablish species composition and structural diversity of plant communities in Riparian Reserves (p. 2-186 – 191, table 2-74)).
Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.	The project impacts on riparian vegetation in the Spencer Creek watershed would be minor. Approximately 9.98 -acres or 0.60% of the Riparian Reserves in the watershed are potentially affected by the project (see table 2-65). Following construction, replanting with native species would facilitate reestablishment of vegetation communities. Large woody debris and boulders from the project right-of-way would be returned to disturbed riparian areas. Revegetation on 12.6- acres of Riparian Reserves in roads that would be decommissioned would help to reestablish species composition and structural diversity of plant communities in Riparian Reserves. The project would waive application of Management Recommendations for Survey and Manage species in the watershed but would not prevent attainment of the ACS objectives because the viability of riparian-dependent survey and manage species would not be not threatened. (see appendix F5).

Summary and Conclusions

The Spencer Creek watershed is the easternmost and driest watershed that is crossed by the project in the High Cascades Province where the ACS applies. It is also a Tier 1 Key Watershed in the NWFP. Stream densities are much lower than watersheds west of the Cascades crest. Precipitation patterns show a strong declining gradient from 40- inches a year on the crest of the Cascades to less than 12- inches where Spencer Creek flows into the Klamath River. The pumice soils in the watershed have high infiltration rates and rarely exhibit overland flows and mass wasting seen in other watersheds crossed by the project. By locating the project adjacent to the Clover Creek Road for much of its length, impacts on wetlands and stream channels have been minimized when compared to the impacts of creating a new corridor.

Pacific Connector has modified the project to respond to the ACS objectives and has incorporated measures consistent with the Riparian Reserve Standards and Guidelines. The assessment demonstrates that short-term impacts would occur to streambanks, and substrates at the site- scale.

Change in vegetative condition from clearing the project right-of-way is a long-term impact that would occur on 8.63 -acres of Riparian Reserves. These impacts, however, are well within the range of natural variability given the disturbance processes that function in the watershed (see p. 2-176-181, Table 2-70). Also, because of the linear characteristic of the project, the Riparian Reserve crossings would be spread out across the landscape.

Off-site mitigation measures, identified by the Forest Service, would supplement on-site minimization, mitigation, and restoration actions. These proposed off-site mitigation measures are responsive to recommendations in the Spencer Creek Watershed Assessment (BLM et al. 1995) and would improve watershed conditions where they are applied (see p. 2-186-191, Table 2-73).

Three site-specific amendments of the Winema National Forest (WNF) LRMP that have a nexus with the ACS are proposed to make provision for the project (see p. 2-183-186).

- Proposed amendments WNF-4 and WNF-5 would allow the project to exceed detrimental soil conditions within the project right-of-way. This would not prevent attainment of ACS objectives because soil decompaction and remediation required in Riparian Reserves is expected to effectively moderate detrimental soil conditions. Implementation of measures in the ECRP is expected to effectively control surface erosion and restore native vegetation.

- Proposed amendment of the WNF LRMP to waive protection measures for Survey and Manage species would not prevent attainment of ACS objectives because the project does not threaten the persistence of any riparian-dependent species (see appendix F5).

The project is otherwise consistent with Standards and Guidelines for activities in Riparian Reserves for the WNF

The routing of the project through NFS lands, coupled with the relatively small area of NFS land affected (0.41% of NFS in the fifth-field watershed), makes it highly improbable that the project impacts could affect watershed conditions. Although there are project-level impacts (e.g., short-term sediment and long-term a change in vegetative condition at stream crossings), these would be minor in scale (see table 2-77).

No project-related impacts that would prevent attainment of ACS objectives have been identified. All relevant impacts are within the range of natural variability given the disturbance patterns and fire history of watersheds in the High Cascades Province (see p. 2-176-181, Table 2-70).

3.0 BIBLIOGRAPHY

Agee, J.K. 1993. Fire Ecology of Pacific Northwest Forests. Island Press, Covelo, CA.

Anderson, P.G., B.R. Taylor, and G.C. Balch. 1996. Quantifying the effects of sediment release on fish and their habitats. Can. Manuscript. Report of Fisheries and Aquatic Sciences. 2346: 110 p. + 3 Append.

Bartholow, J. 2002. Stream Segment Temperature Model (SSTEMP) Version 2.0. Revised 34 August 2002. U.S. Geological Survey, Fort Collins, CO.

Bauer, S., E. Salminen, P. Hoobyar and J. Runyon. Summary of the Watershed Health Indicators for the Oregon Coast Coho Evolutionarily Significant Unit. Oregon Watershed Enhancement Board, Salem, OR. January, 2008

Benda, L.E.; Miller, D.J.; Dunne, T. [et al.]. 1998. Dynamic Landscape Systems. In Naiman, R.J. and Bilby, R.E., eds. River Ecology and Management: Lessons from the Pacific Coastal Ecoregion. Springer-Verlag, New York, NY. pp 261-288. Cited in Everest and Reeves, 2007.

Broeker, L. 2010a. Potential for Natural-Occurring Mercury Mineralization to Enter the Aquatic Environment between M.P. 109 and East Fork Cow Creek, Williams' Pacific Connector Gas Pipeline Project. Resource report prepared for USDA Forest Service, Umpqua National Forest, Roseburg, OR. November 18, 2009; revised February 3, 2010.

Broeker, L. 2010b. Riparian Reserves and Unstable and Potentially Unstable Ground: "Finalized" Pipeline Alignment, East Fork Cow Creek Watershed, Pacific Connector, LP Gas Pipeline Project. Resource Report prepared for USDA Forest Service, Umpqua National Forest, Roseburg, OR. September 9, 2010.

Brown, G.W. 1970. Predicting the effect of clearcutting on stream temperature. J. Soil Water Conservation. 25(1):11-13. (Cited in North Fork Coquille Watershed Analysis)

Bureau of Land Management. 1995a. Central Big Butte Creek, Big Butte Watershed, Watershed Assessment. Bureau of Land Management, Medford District Butte Falls Resource Area. Medford, OR. 1995.

Bureau of Land Management. 1995b. Record of Decision and Resource Management Plan, Coos Bay District. U.S. Department of the Interior, Bureau of Land Management, Coos Bay District. North Bend, OR. May 1995.

Bureau of Land Management. 1995c. Klamath Falls Resource Area Record of Decision and Resource Management Plan and Rangeland Program Summary. U.S. Department of the Interior, Bureau of Land Management, Klamath Falls Resource Area. Klamath Falls, OR. June, 1995

Bureau of Land Management. 1995d. Record of Decision and Resource Management Plan, Roseburg District. U.S. Department of the Interior, Bureau of Land Management, Roseburg District. Roseburg, OR. June 1995.

Bureau of Land Management. 1995e. Record of Decision for the Medford District Resource Management Plan, U.S. Department of the Interior, Bureau of Land Management Medford District, Medford, OR. 1995

Bureau of Land Management. 1997a. Big Creek Watershed Analysis. [First iteration.] Bureau of Land Management, Coos Bay District, Myrtlewood Resource Area, North Bend, OR. May 1997

Bureau of Land Management. 1997b. Watershed Analysis: Middle Main Coquille, North Coquille Mouth, [and] Catching Creek. [Ver. 1.1.] Bureau of Land Management, Coos Bay District, Umpqua Resource Area, North Bend, OR. September 30, 1997.

Bureau of Land Management. 1998. Olalla-Lookingglass Watershed Analysis, Revised April 2, 1998. Bureau of Land Management, Roseburg District, South River Resource Area. Roseburg, OR. April 2, 1998

Bureau of Land Management. 1999a. Upper Middle Fork Coquille Watershed Analysis, Revised May 25, 1999. Bureau of Land Management, Roseburg District, South River Resource Area. Roseburg, OR. May 25, 1999.

Bureau of Land Management. 1999b. Trail Creek Watershed Assessment. Prepared by Western Watershed Analysts. Bureau of Land Management, Medford District. Medford, OR. June 1999.

Bureau of Land Management. 1999c. Middle South Umpqua Watershed Analysis, Revised November 30, 1999. Bureau of Land Management, Roseburg District, South River Resource Area. Roseburg, OR. November 30, 1999.

Bureau of Land Management. 1999d. Lower Big Butte Watershed Analysis. Bureau of Land Management, Medford District, Butte Falls Resource Area. Medford, OR. September 1999

Bureau of Land Management. 2000a. East Fork Coquille Watershed Analysis. [First iteration.] Bureau of Land Management, Coos bay District, Myrtlewood Resource Area, North Bend, OR. May 2000.

Bureau of Land Management. 2000b. Lower South Umpqua Watershed Analysis, Revised May 30, 2000. Bureau of Land Management, South River Resource Area. Roseburg, OR. May 30, 2000.

Bureau of Land Management. 2001. South Umpqua Watershed Analysis and Water Quality Restoration Plan, Second Iteration March 2, 2001. Bureau of Land Management, Roseburg District, South River Resource Area. Roseburg, OR. March 2, 2001.

Bureau of Land Management. 2002a. North Fork Coquille Watershed Analysis. [Second iteration July 20, 2001; includes edits through January 9, 2002] Bureau of Land Management, Coos Bay District, Umpqua Resource Area, North Bend, OR.

Bureau of Land Management. 2002b. Myrtle Creek Watershed Analysis and Water Quality Restoration Plan, Second Iteration October 2002. Bureau of Land Management, Roseburg District, South River Resource Area. Roseburg, OR. October 2002.

Bureau of Land Management. 2007. Watershed Analysis: Middle Fork Coquille Analytical (sic) Watershed. [Version 1.1.] Bureau of Land Management, Coos Bay District, Myrtlewood Resource Area, North Bend, OR. October 2007.

Bureau of Land Management. 2008. Water Quality Restoration Plan for the Big Butte Creek Fifth-Field Watershed. Bureau of Land Management, Medford District, Butte Falls Resource Area. Medford, OR. February 1, 2008.

Bureau of Land Management. 2008. Umpqua River Subbasin Water Quality Restoration Plan. Bureau of Land Management, Coos Bay District, Umpqua Field Office, North Bend, OR. December 2008

Bureau of Land Management. 2010. Catching-Beaver Watershed Analysis. Bureau of Land Management, Coos Bay District, Umpqua Resource Area, North Bend, OR. June 3, 2010.

Bureau of Land Management. 2011. Shady Cove-Rogue River Water Quality Restoration Plan. Bureau of Land Management, Medford District, Butte Falls Resource Area, Medford, OR. February 2011.

Bureau of Land Management. 2012. Shady Cove-Rogue River Project-Specific Watershed Analysis; Pacific Connector Gas Pipeline Project, Pacific Connector Gas Pipeline, LP. Prepared by Edge Environmental for the Bureau of Land Management, Medford District. Medford, OR. March 2012.

Bureau of Land Management and Forest Service. 1997. Little Butte Creek Watershed Assessment, Version 1.2. Bureau of Land Management, Medford District, Ashland Resource Area, Rogue River National Forest, Ashland Ranger District. Medford, OR. November 1997.

Bureau of Land Management and Siuslaw National Forest. 1998. South Coast/Northern Klamath Late-Successional Reserve Assessment. Bureau of Land Management, Coos Bay Roseburg, and Medford Districts, and Siuslaw National Forest, Mapleton Ranger District. North Bend, OR. May 1998

Bureau of Land Management and Forest Service 1999. South Umpqua-Galesville Late Successional Reserve Assessment RO 223. Bureau of Land Management, Medford District, Glendale, Field Office, Roseburg District, South River Field Office, Forest Service, Umpqua National Forest, Tiller Ranger District. Medford, OR. July 1999.

Bureau of Land Management and Oregon Department of Environmental Quality 2000. East Fork Coquille River Water Quality Restoration Plan ["Draft"]. Bureau of Land Management, Coos Bay District, Coos Bay, OR, and Oregon Department of Environmental Quality, Coos Bay Office, Coos Bay, OR. February 2000.

Bureau of Land Management and Oregon Department of Environmental Quality. 2001a. Big Creek Water Quality Restoration Plan. Bureau of Land Management, Coos Bay District, and Oregon Department of Environmental Quality, Coos Bay Office. October 2001.

Bureau of Land Management and Oregon Department of Environmental Quality. 2001b. North Fork Coquille Water Quality Restoration Plan. Bureau of Land Management, Coos Bay

District and Oregon Department of Environmental Quality, Coos Bay Office. November 2001.

Bureau of Land Management. 2008b. Umpqua River Subbasin Water Quality Restoration Plan, Coos Bay District BLM, Umpqua Field Office. North Bend, OR

Bureau of Land Management, USDA Forest Service, U.S. Environmental Protection Agency, and U.S. Fish and Wildlife Service. 1995. Spencer Creek Pilot Watershed Analysis. Lakeview District, Bureau of Land Management, Lakeview District and Klamath Falls Resource Area; USDA Forest Service, Winema National Forest; U.S. Environmental Protection Agency; and U.S. Fish and Wildlife Service. August 1995.

Bureau of Reclamation. 2012. Klamath Facilities Removal Final Environmental Impact Statement / Environmental Impact Report, Volume II Appendix C. Sacramento, CA, December 2012

Castro, J. M. 1997. Stream Classification in the Pacific Northwest: Methodologies, Regional Analyses, and Application. PhD. Dissertation for the degree of Doctor of Philosophy in Geography, Oregon State University, Corvallis, OR. January 17, 1997.

Correll, D.L. 1997. Buffer zones and water quality protection: general principles. Pages 7-20. In: Haycock, N.E., T.P. Burt, K.W.T. Goulding, and G. Pinay (editors). Buffer zones: Their Processes and Potential in Water Protection. Proceedings of the International Conference on Buffer Zones. September 1996. Quest Environmental. Harpenden, 26 England. 326 pages

Cristea, Nicoleta and Jack Janisch. 2007. Modeling the Effects of Riparian Buffer Width on Effective Shade and Stream Temperature. Environmental Assessment Program, Washington State Department of Ecology Olympia, Washington 98504-7710

Curtis, D. A., 1982. An evaluation of suspended sediment and turbidity in Cow Creek, Oregon. U. S. Geological Survey, Water Resource Investigations 82-364, Open File Report. Portland, OR 1982

Everest, Fred H., and Gordon H. Reeves. 2007. Riparian and Aquatic Habitats of the Pacific Northwest and Southeast Alaska: Ecology, Management History, and Potential Management Strategies. [General Technical Report PNW-GTR 692.] USDA Forest Service, Pacific Northwest Research Station. February 2007.

Federal Energy Regulatory Commission, Office of Energy Projects. 2009. Jordon Cove Energy and Pacific Connector Gas Pipeline Project, Final Environmental Impact Statement. Jordon Cover Energy Project, L.P. Docket No. CP07-444-000; Pacific Connector Gas Pipeline, L.P. Docket No. CP07-441-000. FERC / EIS 0223 F, Washington DC. May, 2009.

Forest Service 1990a. Land and Resource Management Plan, Rogue River National Forest. Forest Service, Pacific Northwest Region, Rogue River National Forest. Medford, OR. 1990.

Forest Service 1990b. Land and Resource Management Plan, Umpqua National Forest. Forest Service, Pacific Northwest Region, Umpqua National Forest. Roseburg, OR. 1990.

Forest Service 1990c. Land and Resource Management Plan, Winema National Forest. Forest Service, Pacific Northwest Region, Winema National Forest. Klamath Falls, OR 1990.

Forest Service. 1995a. Cow Creek Watershed Analysis. Forest Service, Umpqua National Forest, Tiller Ranger District, Roseburg OR. September 30, 1995

Forest Service 1995b. Upper Big Butte Creek Watershed Analysis. Rogue River National Forest, Butte Falls Ranger District. Medford, OR. December 1, 1995

Forest Service. 1996. Elk Creek Watershed Analysis. Forest Service, Umpqua National Forest, Tiller Ranger District. Roseburg, OR. October 16, 1996.

Forest Service 2011. Watershed Condition Framework: A Framework for Assessing and Tracking Changes to Watershed Condition. U. S. Department of Agriculture, Forest Service. FS-977, May 2011. Washington D. C.

Forest Service; U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service; USDA Bureau of Land Management; USDI Fish and Wildlife Service; USDI National Park Service; and Environmental Protection Agency. 1993. Forest Ecosystem Management: An Ecological, Economic, and Social Assessment. A Report of the Forest Ecosystem Management Assessment Team. Portland, Oregon. July 1993.

Forest Service and Bureau of Land Management 1994a. Record of Decision on Management of Habitat for Late-Successional and Old-Growth Forest Related Species within the Range of the Northern Spotted Owl. USDA Forest Service and USDI Bureau of Land Management. Portland, Oregon. 1994

Forest Service and Bureau of Land Management. 1994b. Standards and Guidelines, Management of Habitat for Late-Successional and Old-Growth Forest Related Species within the Range of the Northern Spotted Owl. USDA Forest Service and USDI Bureau of Land Management. Portland, Oregon. 1994

Forest Service and Bureau of Land Management. 1994c. Final Environmental Impact Statement, Management of Habitat for Late-Successional and Old-Growth Forest Related Species within the Range of the Northern Spotted Owl. USDA Forest Service and USDI Bureau of Land Management. Portland, Oregon. 1994

Forest Service, Bureau of Land Management and US Fish and Wildlife Service 1998. South Cascades Late Successional Reserve Assessment. Forest Service, Umpqua National Forest; Bureau of Land Management, Roseburg District; US Fish and Wildlife Service, Roseburg Field Office. Roseburg, OR. April 1998

Forest Service 2013. A Soil Bioengineering Guide for Streambank and Lakeshore Stabilization. USDA Forest Service, Technology and Development Program, San Dimas, CA. Published online: http://www.fed.us/publications/soil-bio-guide. San Dimas, CA 2013

Forest Service and BLM. 2011. Northwest Forest Plan—the first 15 years (1994–2008): status and trends of Northern Spotted Owl populations and habitats; U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, OR

Forest Service and BLM. 2011a. Northwest Forest Plan–the first 15 years (1994–2008): status and trends of late-successional and old-growth forests, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, OR

Forest Service and BLM. 2012. Northwest Forest Plan - The first 15 years (1994-2008): watershed condition status and trends: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, OR

Fowler, Steve. Personal Communication. Stream temperature concerns from Middle and Big Creek Crossings. April 30, 2013

GeoEngineers. 2009. Addendum to Geologic Hazards Evaluation: Pacific Connector Gas Pipeline. Letter report to Pacific Connector Gas Pipeline, LP. Salt Lake City, UT. January 16, 2009.

GeoEngineers. 2013a. Channel Migration and Scour Analysis: Pacific Connector Gas Pipeline Project, Southern Oregon. GeoEngineers, Salt Lake City, UT. May 29, 2013.

GeoEngineers. 2013b. Geologic Hazards and Mineral Resources Report: Pacific Connector Gas Pipeline, Coos Bay to Malin, Oregon. Salt Lake City, UT. May 29, 2013.

GeoEngineers. 2013c. Stream Crossing Risk Analysis: Pacific Connector Gas Pipeline Project; Coos, Douglas, Jackson and Klamath Counties, Oregon. Salt Lake City, UT. May 29, 2013.

GeoEngineers. 2013d. Resource Report No. 2: Water Use and Quality, Pacific Connector Gas Pipeline Project. Salt Lake City, UT. June 2013.

GeoEngineers. 2013e. Turbidity-Nutrients-Metals Water Quality Impacts Analysis: Pacific Connector Gas Pipeline Project; Coos, Douglas, Jackson and Douglas Counties, Oregon. Salt Lake City, UT. May 29, 2013.

GeoEngineers 2013f. Thermal Impacts Assessment: Pacific Connector Gas Pipeline Project; Coos, Douglas, Jackson and Douglas Counties, Oregon. Salt Lake City, UT. May 29, 2013.

GeoEngineers 2013g. Stream Crossing Hyporheic Analysis, File No. 16724-001-06. Pacific Connector Gas Pipeline Project. Southern Oregon. Salt Lake City, UT. May 29, 2013.

Goodman, Linda, E.W. Shepard, M. Pool, B Weingardt. 2007. FS-Memorandum; BLM Instruction Memorandum No. OR-2007-060 dated 5/22/2007: Compliance with the Aquatic Conservation Strategy. Forest Service, Bureau of Land Management. Portland, OR. May 22, 2007.

Gomi, T., R. Moore, and A. Dhakal. 2006. Headwater Stream Temperature Response to Clearcut Harvesting with Different Riparian Treatments, Coastal British Columbia, Canada. Water Resources Research 42: W08437 [doi:10.1029/2005WR004162].

Grant, Gordon E.; Lewis, Sarah L.; Swanson, Frederick J.; Cissel, John H.; McDonnell, Jeffrey J. 2008. Effects of forest practices on peak flows and consequent channel response: a state-of-science report for western Oregon and Washington. Gen. Tech. Rep. PNW-GTR-760. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 76 p.

Geyer, Nancy A., 2003. Upper Cow Creek Watershed Assessment and Action Plan. Umpqua Basin Watershed Council, November 2003.

Hanek, G. 2011. Resource Report: Review of February 8, 2011, GeoEngineers Inc. Geologic Hazards Evaluation, EFCC Routing Alternatives Report. Letter report prepared for Umpqua National Forest, Roseburg, OR. March 24, 2011.

Hassan, Marwan A., Michael Church, Thomas E. Lisle, Francesco Brardinoni, Lee Benda, and Gordon E. Grant. 2005. Sediment Transport and Channel Morphology of Small, Forested Streams. Journal of the American Water Resources Association, 41(4):853-876.

Keppeler, E. T., P. H. Cafferata, et al. 2007. State forest road 600: a riparian road decommissioning case study in Jackson Demonstration State Forest. Sacramento, CA, State of California, the Resources Agency, California Dept. of Forestry & Fire Protection.

Koler, Thomas E. 2012. Resource Report: Earthflow Terrains Crossed by the PCGP in East Fork Cow Creek—Review of Previous Assessments. Prepared for North State Resources, Inc., Redding, CA. December 11, 2012.

Lanigan, Steven H.; Gordon, Sean N.; Eldred, Peter; Isley, Mark; Wilcox, Steve; Moyer, Chris; Andersen, Heidi. 2012. Northwest Forest Plan—the first 15 years (1994–2008): watershed condition status and trend. Gen. Tech. Rep. PNW-GTR-856. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 155 p.

Legleiter, C. J., Rick L Lawrence, Mark A. Fonstad, W. Andrew Marcus, and Richard Aspinall. 2003. Fluvial Response a Decade after Wildfire in the Northern Yellowstone Ecosystem: A Spatially Explicit Analysis. Geomorphology 54(119-136).

Levesque, Lucie. M. and Monique. G. Dube. 2007. Review of the effects of in-stream pipeline crossing construction on aquatic ecosystems and examination of Canadian methodologies for impact assessment. Environ Monit Assess. 2007 132:395-409, National Hydrology Research Center, Saskatoon, Canada

Lindell, L. 2007. Pipeline at Approx. MP 126.26–127.2 (T 34 S., R. 1 E., Sec.18). Email from Laurie Lindell, District Hydrologist, Bureau of Land Management, Medford District, to Lori Dalton, Williams, and Dan Duce, Edge Environmental. May 17, 2007.

Madej, M. 2000. Erosion and sediment delivery following removal of forest roads. U.S. Geological Survey Western Ecological Research Center.

Malmon, Daniel V., Steven L. Reneau, Danny Katzman, Alexis Lavine, and Jared Lyman. 2007. Suspended Sediment Transport in an Ephemeral Stream following Wildfire. Journal of Geophysical Research 112(FO2006) doi:10.1029/2005JF000459J.

Moeur, M.; Ohmann, J.L; Kennedy, R.E.; Cohen, W.B.; Gregory, M.J.; Yang, Z.; Roberts H.M.; Spies, T.A.; Fiorella, M. 2011. Northwest Forest Plan-the first 15 years (1994-2008): Status and Trends of Sate-Successional and Old-Growth Forests. [General Technical Report PNW-GTR-853.] USDA Forest Service, Pacific Northwest Research Station. Portland, OR. November 2011.

Moore, R.D., D.L. Spittlehouse, and A. Story. 2005. Riparian Microclimate and Stream Temperature Response to Forest Harvesting: A Review. Journal of the American Water Resources Association 41:813-834.

Newcombe, C. P, and J. O. T. Jensen. 1996. Channel Suspended Sediment and Fisheries: A Synthesis for Quantitative Assessment of Risk and Impact. North American Journal of Fisheries Management, 16:693-727. 1996

Newcombe, C. P., and D. D. Macdonald (1991): Effects of Suspended Sediments on Aquatic Ecosystems, North American Journal of Fisheries Management, 11:1, 72-82

North State Resources, Inc. 2009. Pacific Connector Gas Pipeline Project: Technical Memorandum for Water Temperature Effects Assessment. Prepared for Pacific Connector Gas Pipeline by North State Resources, Inc. Redding, California. April 13, 2009.

North State Resources, Inc. 2014 (in preparation). Pacific Connector Gas Pipeline Project: Technical Memorandum for Water Temperature Effects and Restoration Assessment. Prepared for Pacific Connector Gas Pipeline by North State Resources, Inc. Redding, California. August, 2014.

Oregon Department of Environmental Quality, 1998, Guidance for Ecological Risk Assessment - Levels I, II, III, IV: Oregon Department of Environmental Quality Waste Management Cleanup Division (contains updates of November, 1998; December 2001; and March 2000). (Cited in Resource Report 2, GeoEngineers 2013)

Orton, G. P. Kennedy and D. Hutchinson 2007. Biosolids and woodchips as soil organic amendments for promoting soil restoration in decommissioned forest roads. Administrative Study, Umpqua National Forest, Oregon Department of Environmental Quality, Bureau of Land Management. Roseburg Oregon, 2007.

Poole, G. 2001. A comment on “Influence of Streamside Cover and Stream Features on Temperature Trends in Forested Streams in Western Oregon.” In: Issue Paper 3 - Spatial and Temporal Patterns of Stream Temperature (Revised), G. Poole, J. Risely, and M. Hicks. EPA-910-D-01-003. USEPA, Seattle, WA.

Pettigrew, E. L., P. N. Owens and T. R. Giles. 2006. Wildfire Effects on the Quantity and Composition of Suspended and Gravel-Stored Sediments. Water, Air, and Soil Pollution: Focus (2006) 6: 647–656

Reeves, G. L. 1999. Declaration of Gordon Reeves, Ph.D., Civil No. C 99-0067 R, Western District of Washington at Seattle

Reeves, Gordon R., J. E. Williams, K. M. Burnett, and K. Gallo. 2006. The Aquatic Conservation Strategy of the Northwest Forest Plan. Conservation Biology, Volume 20, No. 2, 319-329, Society for Conservation Biology.

Reid, S., and P. G. Anderson. 2002. Evaluation of Isolated Water Course Crossings during Winter Construction along the Alliance Pipeline in Northern Alberta. Environmental Concerns in Rights-of-Way Management: Seventh International Symposium. I.W. Goodridr-Mahoney, D.F. Mutrie and C.A. Guild (editors). Calgary, Alberta, Canada. September 2000.

Reid, S. M., S. Stoklosar, S. Metikosh and J. Evans. 2002. Effectiveness of Isolated Pipeline Crossing Techniques to Mitigate Sediment Impacts on Brook Trout Streams. Water Qual. Res. J. Canada, Vol. 37, No. 2, 473-488. 2002

Reid, S. M., F. Ade and S. Metikosh. 2004. Sediment entrainment during pipeline water construction: predictive models and crossing method comparison. J. Environ. Eng. Sci. 3: 81-88. NRC Canada. January 2004.

Ryan, S. E., M. K. Dixon, K. A. Dwire. 2006. The use of turbidity sensors for monitoring sediment loads following wildfires. Proceedings of the Eighth Federal Interagency Sedimentation Conference. Reno, NV April 2006.

Pacific Connector Gas Pipeline, Resource Report 2. 2013. Water Use and Quality, Pacific Connector Gas Pipeline Project. June 2013. Salt Lake City, UT

Pacific Connector Gas Pipeline Resource Report 3. 2013. Fish Wildlife and Vegetation. Pacific Connector Gas Pipeline Project. June 2013. Salt Lake City, Utah

Pacific Connector Gas Pipeline Resource Report 7. 2013. Soils. Pacific Connector Gas Pipeline Project, June 2013. Salt Lake City, Utah

Pacific Connector Gas Pipeline. 2013. Hydrostatic Test Plan, Pacific Connector Gas Pipeline Project, January 2013. Salt Lake City, UT

Pacific Connector Gas Pipeline. 2013. Wetland Delineation Report (Draft), Pacific Connector Gas Pipeline Project, June 2013. Salt Lake City, UT

Robichaud, Peter R., J. L. Byers, D.G. Neary, 2000. Evaluating the Effectiveness of Postfire Rehabilitation Treatments. [General Technical Report RMRS-GTR-63] USDA Forest Service, Rocky Mountain Research Station. September, 2000.

Shaw, E. A. and J. S. Richardson. 2001. Direct and indirect effects of sediment pulse duration on stream invertebrate assemblages and rainbow trout (Oncorhynchus mykiss) growth and survival. Canadian Journal of Fisheries and Aquatic Sciences 58: 2213-2221. NRC Canada, 2001.

Shasta-Trinity National Forest. 2014. Bagley Fire Case Study. USDA Forest Service, Shasta-Trinity National Forest, Shasta McCloud Management Unit. Redding, CA. April, 2014

Switalski, T. A., J. A. Bissonette, T. H. DeLuca, C. H. Luce, and M. A. Madej. 2004. Benefits and Impacts of Road Removal. Frontiers in Ecology and the Environment 2(1):21-28.

Swanson, F.J. 1981. Fire and Geomorphic Process. In: Proceedings, Fire Regimes and Ecosystems Conference, Dec 11-15, 1978. Honolulu, HI. [General Technical Report WO-26.] USDA Forest Service, Washington DC. 1981. (Cited in Catching Beaver WA)

Tippery, S., K. K. Jones, K. J. Anlauf, C. H. Stein., M. J. Strickland. 2010. The Oregon Plan for Salmon and Watersheds: Effectiveness Monitoring Report for the Western Oregon Stream Restoration Program, 1999-2008. OPSW-ODFW-2010-6, Oregon Department of Fish and Wildlife, Salem, OR. July 2010

Trombulak, S. C. and C. A. Frissell (2000). "Review of Ecological Effects of roads on terrestrial and aquatic communities." Conservation Biology 14(1): 18-30.

Overview of Forest Planning and Project Level Decisionmaking. USDA Office of the General Counsel, Natural Resources Division. June, 2002, Washington DC

US Geological Survey. 2013 Gage Data, Coastal HUC 12. USGS Gage data provided by US Geological Survey.

Wagenbrenner, J. W., L. H. Macdonald and D. Rough. 2006. Effectiveness of three post-fire rehabilitation treatments in the Colorado Front Range. Published in Wiley Interscience (www.interscience.wiley.com). DOI: 10.1002/hyp.6146

Wondzell, S. M., and j. G. King. 2003. Postfire Erosional Processes in the Pacific Northwest and Rocky Mountain Regions. Forest Ecology and Management 178: 75-87.

Zwieniecki, M.A., and M. Newton. 1999. Influence of Streamside Cover and Stream Features on Temperature Trends in Forested Streams of Western Oregon. Western Journal of Applied Forestry 14: 106-113.