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Re: Summary of: a) likely impacts of construction and maintenance of pipeline for the proposed Oregon LNG Terminal and Oregon Pipeline Project (Project) on watersheds and aquatic resources;[1] and b) adequacy and veracity of the discussion and assessment of these impacts in the Project's Biological Assessment (BA), Joint Permit Application (JPA), and supplements thereto.

The following comments are based on review of the JPA, BA, supplements thereto, and salient scientific literature and information, regarding the projects' likely impacts on aquatic and watershed resources. In developing these comments, I also drew upon my education and more than 30 years of experience. A copy of my curriculum vitae is attached to the comments.

These comments describe some of the numerous significant ways that the JPA and BA distorted and incorrectly assessed the severe long-term impacts of pipeline construction and operation on watershed and aquatic resources. These comments are not an exhaustive description and discussion of the many shortcomings in the JPA and BA with respect to the pipeline's direct, indirect, and cumulative impacts on aquatic and watershed resources, due to the number of significant flaws in the JPA and BA and time and space constraints. Therefore, these comments describe only some of the more significant flaws in the assessment of these impacts in the BA and JPA.

Table 1 summarizes the duration and types of impacts from the pipeline and which impacts were improperly assessed in the JPA and BA. The reasons for the differences in impact and duration between those in Table 1 and the inadequate assessments in the JPA and BA are explained in the following sections

1 In these comments, "aquatic resources" is used to denote biotic and abiotic in-channel elements and processes, including fish and macroinvertebrate populations, habitats for these populations, water quality, large woody debris, channel morphology, substrate, and streamflow, as well as the riparian processes and elements that strongly influence the condition of these aquatic resources. In these comments, "watershed resources" is used to denote processes and elements at the watershed scale that influence aquatic resources. These processes and elements include vegetation, soils, wetlands, erosion, sediment routing, surface runoff, and, groundwater-surface water interactions.

Table 1. Summary of the pipeline's likely impacts on affected watershed and resources, and duration of the impact. A "+" denotes that the element is a "Pathway Indicator" used in NMFS' framework for assessing impacts on ESA-listed salmonids. An "*" denotes that impact and/or duration of impact is substantively different than incorrectly assessed in JPA and BA.

Element/ process affected	Impact	Negatively affected resources	Activity contributing to effect	Duration
Water temperature[+]	Degrade already widely degraded conditions	Salmonid survival and production, water quality, compliance with water quality standards	Permanent loss of vegetative shading at corridors for Pipeline stream crossings construction and operation, permanent loss of base flows from pipeline, and stream width increases due to sedimentation from pipeline construction and operation.	Permanent*
Turbidity and suspended sediment[+]	Degrade already widely degraded conditions	Salmonid survival and production, water quality, compliance with water quality standards	Soil, vegetation, bank, and runoff impacts of pipeline construction and operation, limited effectiveness of BMPs	Long-term*
Substrate[+]	Degrade already widely degraded conditions	Salmonid survival and production; loss of macroinvertebrates	Soil, vegetation, bank, and runoff impacts of pipeline construction and operation, limited effectiveness of BMPs	Long-term*
Large Woody Debris (LWD)[+]	Degrade already widely degraded conditions*	Salmonid survival and production.	Permanent degradation of riparian areas in pipeline corridors at stream crossings	Permanent*
Pool frequency[+]	Degrade already widely degraded conditions*	Salmonid survival and production.	Combined impact of LWD loss from permanent degradation of riparian areas in pipeline stream crossing corridors and increased sediment delivery from pipeline construction and operation	Permanent*
Pool quality[+]	Degrade already widely degraded conditions*	Salmonid survival and production.	Combined impact of LWD loss from permanent degradation of riparian areas in pipeline stream crossing corridors and increased	Permanent*

			sediment delivery from pipeline construction and operation	
Off-channel habitat+	Degrade already widely degraded conditions*	Salmonid survival and production.	Combined impact of permanent LWD loss from permanent degradation of riparian areas in pipeline stream crossing corridors and increased sediment delivery from pipeline construction and operation	Permanent*
Refugia+	Degrade already widely degraded conditions*	Salmonid survival and production.	Combined impact of LWD loss from permanent degradation of riparian areas, truncation of channel migration at pipeline stream crossing corridors, water temperature increases, and increased sediment delivery from pipeline construction and operation	Permanent*
Width/depth ratio+	Degrade already widely degraded conditions*	Salmonid survival and production, water temperature, water quality, water quality standards.	Combined impact of permanent degradation of riparian areas in pipeline stream crossing corridors and persistent elevated sediment delivery from pipeline construction and operation	Long-term*
Streambank condition+	Degrade already widely degraded conditions	Salmonid survival and production.	Permanent degradation of riparian areas in pipeline stream crossing corridors from pipeline construction and operation	Permanent*
Floodplain connectivity+	Degrade already widely degraded conditions*	Salmonid survival and production, water temperatures and water quality standards.	Combined impact of truncation of channel migration in pipeline stream crossing corridors and impermeable pipeline in floodplains.	Permanent*
Peak flows/base flows+	Degrade already widely degraded conditions*	Salmonid survival and production, water temperatures and water quality standards.	Combined impact of deforestation in pipeline corridors, wetland damage, long-term soil compaction, impermeable pipeline in watersheds, riparian areas, wetlands, and floodplains.	Permanent*

Increase in drainage network	Degrade already widely degraded conditions*	Salmonid survival and production, water temperatures and water quality standards.	Combined impact of roads, soil compaction and impermeable pipeline in riparian and wetland pipeline corridors.	Permanent*
Watershed disturbance levels+	Degrade already widely degraded conditions	Salmonid populations, watershed processes	Soil and vegetation impacts of pipeline construction and operation, particularly the permanent adverse impacts in riparian areas.	Permanent*
Riparian reserves+	Degrade already widely degraded conditions	Salmonid populations	Permanent degradation of vegetation and soils in pipeline corridors in areas at 185 stream crossings	Permanent*
Wetland hydrology and functionality+	Degrade already widely degraded conditions*	Salmonid populations, water quantity and water quality	Soil compaction and impermeable pipeline in wetlands crossed by pipeline	Permanent*

General pervasive problems in the JPA and BA

There are several types of repeated defects in the JPA and BA that result in severe underestimation of the magnitude and persistence of pipeline impacts on watershed and aquatic resources. These recurrent defects include the following.

1. The JPA and BA baselessly assume that best management practices (BMPs) consistently reduce impacts to negligible levels. While it is known that BMPs cannot eliminate—or in some cases, even reduce—the numerous and enduring impacts caused by pipeline construction and operation, especially near streams in steeper terrain (Kattelmann, 1996; Espinosa et al., 1997; Beschta et al, 2004; GLEC, 2008), the JPA and BA fail to properly examine the limits of the effectiveness of mitigation measures and BMPs based on available scientific information and literature, including applicable case studies.

Instead of assessing impacts resulting from the pipeline combined with the limited effectiveness of mitigation and BMP effectiveness, the JPA and BA arbitrarily assume that impacts will be eliminated or significantly reduced by BMPs and mitigation, in the complete absence of a hard look the limited efficacy of mitigation measures. This recurrent defect precludes reasonable disclosure of the project's impacts and ignores the best available scientific information.

This type of defect occurs throughout the JPA and BA in their assessment of pipeline impacts on aquatic and watershed resources. For example, the JPA notes (p. 6-35) that construction mats will be used under heavy equipment operating in soft and saturated wetland and riparian soils, but fails to assess the degree, extent and persistence of the inevitable compaction that will still occur in these soils and its consequent impacts. The mats will not obviate soil compaction. Severe compaction in saturated soils is inevitable because they are highly susceptible to compaction and heavy equipment will exert considerable pressure on these soils, even with mats. The failure of the JPA and BA to assess this impact is a severe shortcoming because compaction in riparian areas and wetlands has long-lasting adverse impacts on infiltration rates, water holding capacity, runoff processes, and other affected wetland and riparian area functions, including the ability to absorb, store, and slowly release water, which, in turn, have direct, indirect, and cumulative impacts on wetland functions, including erosion, sediment delivery, water quality, peak flows, low flows and water quality. These defects in the JPA and BA are significant because soil compaction is extremely persistent, requiring more than 50 years for recovery, particularly in the types of soils commonly found in wetlands and riparian areas (USFS and USBLM, 1997a; Beschta et al., 2004). For these combined reasons, the JPA and BA fail to reasonably assess the effects of these soil impacts on wetland functions that affect watershed processes, including runoff, peak flows, low flows, and water quality in streams that ultimately affect the survival and production of salmonids.

In their assessment of the impacts of pipeline construction and operation near streams, the BA (e.g., pp. 3-103 to 3-104, 3-117, 3-129, 3-130) repeatedly and incorrectly assume that BMPs will effectively render runoff and sediment delivery impacts to streams negligible or transient. This is in direct conflict with available scientific information, which indicates that such BMPs do not eliminate such impacts from vegetation removal and significant soil damage that occurs in close proximity to streams, on steep slopes flanking streams, and/or in areas with high levels of precipitation and runoff, especially in the Pacific Northwest (Kattelmann, 1996; Espinosa et al., 1997; Beschta et al, 2004; GLEC, 2008). However, the JPA and BA completely ignore such well-documented information on the limits of BMPs. In so doing, the JPA and BA fail to reasonably assess the pipeline's impacts related to sediment and runoff.

Similarly, the BA (pp. 3-95, 3-115, 3-129) incorrectly asserts that post-construction revegetation attempts via seeding on very heavily disturbed soils on the pipeline corridor will be effective and significantly reduce the sediment-related impacts from pipeline construction on aquatic systems. This assertion is in direct conflict with numerous studies documenting that post-disturbance seeding is highly ineffective at reducing erosion and sediment delivery from disturbed soils where vegetation has been removed (e.g., Kattelmann, 1996; Beschta et al. 2004; Keeley, 2004; Keeley et al., 2006; Wagenbrenner et al., 2006; Robichaud et al, 2006; Stella et al., 2010).[2]

Similarly the JPA and BA repeatedly and baselessly assert that measures for project activities near streams will "minimize" their impacts on water temperature, runoff, and sediment delivery (JPA, p. 6-35; BA pp, 3-103, 3-115, 3-128 to 3-130). These assessments are made without any hard look at the effectiveness of the cited measures, based on available scientific information. These assertions are also made without any clear definition as to what is deemed to be a "minimized" impact. There is abundant scientific information that such measures do not eliminate the significant and numerous project impacts in close proximity to streams on runoff and sediment delivery (Kattelmann, 1996; Espinosa et al., 1997; Beschta et al, 2004; GLEC, 2008), which the JPA and BA completely fail to factor into their analysis. In so doing, the BA and JPA fail to adequately assess the impacts of

[2] While most of the cited literature above involves the ineffectiveness of seeding in postfire environments, it applies to other type of disturbance involving loss of soil cover. Notably, fire does not cause the severe soil damage that pipeline construction will cause. This severe soil damage from pipeline construction will likely further impede seeding effectiveness, because severe soil damage impedes post-disturbance revegetation (Beschta et al., 2004).

stormwater runoff, vegetation removal, and elevated erosion from pipeline construction and operation with the cited measures in place, based on thorough analysis of available scientific information on the limits of the effectiveness of proposed measures. It is not valid to merely cite measures together with an unsupported assessment that they will effectively "minimize" impacts to a wholly undefined degree.

These severe flaws in the JPA and BA must be rectified by reasonably evaluating the efficacy of proffered mitigation measures based on available scientific information, together with the physical setting of the Project's impacts, and using this to reasonably determine the direct, indirect, and cumulative impacts on aquatic and watershed resources in a clear fashion.

2. In a related vein, in many of the discussions of the project's impacts, the JPA and BA repeatedly merely list mitigation measures and plans aimed at addressing impacts, instead of analyzing and disclosing the impacts on aquatic and watershed resources with the listed measures and plans in place. This does not constitute a reasonable assessment of the magnitude, extent, intensity, and persistence of impacts to aquatic and watershed resources that still accrue. Examples of defects of this ilk occur with great regularity throughout the document. But a few examples of this common flaw include discussions of the impacts from wetland damage and destruction, permanent riparian area damage, revegetation measures, noxious weed spread, "frac outs" from HDD, and water quality impacts, and the lack of a hard look at the effectiveness of listed mitigation measures.

3. The JPA and BA fail to reasonably evaluate and disclose the likelihood and significance of negative collateral impacts from proposed mitigation measures. For instance, the JPA and BA improperly assume that adding the some unmerchantable LWD cut down for pipeline construction to streams in an attempt to mitigate the impacts of clearing riparian areas for pipeline construction (JPA, p. 6-27, BA, p. 130), will, without fail, render the permanent reduction of LWD recruitment caused by the pipeline construction and operation as "minor" (e.g., BA, p. 131). While this assumption is not tenable, as discussed in greater detail in later in these comments, the BA and JPA fail to properly factor into their assessment that available information indicates that such wood additions are often not only ineffective of mitigating in-stream wood loss, but that these wood additions also interfere with a variety of important stream processes and degrade aquatic habitat attributes (Kauffman et al., 1997; Buffington et al., 2002; Beschta et al., 2004).

As another example of the failure of the BA to examine collateral damage, the BA notes that seeding for revegetation will occur on areas cleared of vegetation for the pipeline as an erosion control measure (BA, pp. 3-95, 3-115, 3-129), but utterly fails to reasonably make known that seed mixes used for revegetation often contain noxious weed seeds, such as cheatgrass, resulting in the spread of noxious invasive weeds (Karr et al., 2004; Keeley et al., 2006). The BA also fails to properly factor into its assessment of project impacts that post-disturbance seeding stunts the re-growth of native vegetation, including native trees (Keeley, 2004; Keeley et al., 2006) while completely failing to reduce post-impact erosion and sediment delivery (Kattelmann, 1996; Beschta et al. 2004; Keeley, 2004; Keeley et al., 2006; Wagenbrenner et al., 2006; Robichaud et al, 2006; Stella et al., 2010). Due to the adverse impacts of post-disturbance seeding on the regeneration of native species, seeding can prolong post-disturbance accelerated erosion and sediment delivery, thereby increasing the duration and magnitude of related aquatic impacts (Kattelmann, 1996; Beschta et al., 2004). Although the BA fails to properly assess it, available information indicates that seeding has negligible benefits, but significant and enduring ecological costs.

For these combined reasons, the BA fails to properly assess the negative impacts of BMPs and mitigation measures. In so doing, the BA did not reasonably determine the direct, indirect, and cumulative impacts of pipeline construction and operation on watershed and aquatic resources.

4. The JPA and BA fail to reasonably assess the severity of pipeline construction and operation impacts on salmonids within the context of the existing condition of affected salmonid habitats and ongoing impacts. For instance, the JPA and BA incorrectly assert that water temperature increases caused by pipeline will have "…biological insignificant" effects on salmonids (e.g., BA, p. 3-128). However, in many of the affected streams, water temperatures are already severely elevated and are major limiting factor for the survival and production of affected salmonids (IMST, 2002; Stout et al., 2012; JPA, 4-26). Under these conditions, *any* increase in water temperature is extremely significant, although the BA and JPA consistently ignore this critical context. The JPA (p. 4-26) concedes that high water temperatures are already a primary limiting factor for salmonid spawning and incubation. However, both the JPA and BA fail to properly assess that the degradation of this limiting factor by persistent water temperature increases caused by the numerous impacts of the pipeline will further reduce the survival, production, and abundance of affected salmonids.

Most of the watersheds and streams affected by the pipeline are already pervasively degraded (USFS et al., 1993; IMST, 2002). However, the JPA and BA completely fail to assess how pipeline impacts will combine with the on-going impacts of degraded watersheds to affect streams that are already degraded with respect to water temperatures, riparian conditions, sediment loads, channel form, pools, and large wood (USFS et al., 1993; IMST, 2002; Stout et al., 2012), all of which would be degraded still more in a persistent fashion by the pipeline.

For instance, the JPA (p. 4-26) acknowledges that high sediment loads are also a limiting factor for salmonid spawning and incubation. There is no question that pipeline construction and operation will greatly elevate sediment loads still further in an enduring fashion, as discussed in greater detail later in these comments. However, both the JPA and BA fail to properly assess that the degradation of this limiting factor caused by the numerous impacts of the pipeline on sediment loads will further reduce the survival, production, and abundance of affected salmonids.

5. The JPA and BA fail to assess the pipeline's cumulative effects on aquatic resources in several ways. Instead, it primarily provides piecemeal analysis of individual impacts. For instance, as discussed in greater detail later in these comments, pipeline construction and operation will elevate water temperatures via several mechanisms including those that are not examined at all: channel widening due to elevated sediment delivery and the loss of stream flows due to the combined impacts of riparian and wetland soil damage and the impermeable pipeline in riparian and wetland soils. However, the JPA and BA only assess, albeit in a cursory manner, the impacts of riparian vegetation removal on water temperatures and thereby fail to examine the cumulative impacts of pipeline construction and maintenance on water temperatures.

6. The JPA and BA fail, in many ways, to properly assess the direct, indirect, and cumulative impacts from pipeline construction and operation on small non-perennial or perennial headwater streams crossed by the pipeline and their cumulative effects on downstream fish habitats. For

instance, the BA only lists the non-perennial streams crossed by the pipeline (BA, App. 6E), but provides no reasonable assessment of the individual and cumulative impact of these stream crossings on downstream conditions. Instead, the BA only provides assessments of the effect of only a relatively few perennial stream crossings by the pipeline (e.g., compare BA Table 3.5-2 with JPA, App. E). This is a severe defect for several reasons.

First, headwater streams, including those that are non-perennial, comprise the overwhelming majority of the channel network, exerting a profound influence on downstream conditions (USFS et al., 1993; Rhodes et al., 1994; USFS and USBLM, 1997b; Montgomery and Buffington, 1998; May and Gresswell, 2003; Allen and Dietrich, 2005; Allen et al., 2007). These streams supply the bulk of runoff and material transfers to downstream river segments, including sediment to downstream reaches with fish habitat (Rhodes et al., 1994; USFS and USBLM, 1997b; Montgomery and Buffington, 1998).

Second, all non-perennial streams will be crossed using the most damaging pipeline stream crossing construction method. The JPA notes (p. 6-36), "Intermittent and ephemeral streams that are dry at the time of crossing will be crossed using conventional upland construction techniques." As discussed in greater detail later in these comments, these techniques will cause severe and during soil damage, accelerated erosion and sediment delivery, increased peakflows, loss of LWD and LWD recruitment, as well as severe direct damage to affected stream channels.

Third, the enduring losses of LWD recruitment caused by the crossings on these streams will cumulatively deplete LWD in downstream reaches with fish habitat (May and Gresswell, 2003), although this is never properly assessed or made known in the BA. Due to this major defect, the BA's assessment of LWD impacts of the pipeline is wholly inadequate. This severe failure of the BA to properly assess linkages between upstream LWD impacts on downstream conditions also fatally flaws the BA's assessment of impacts on pools, channel form, and salmonids due to the importance of LWD to these conditions and the importance of these conditions to salmonid persistence.

Fourth, the persistent increases in sediment delivery to non-perennial headwater streams results in relatively rapid and efficient this of sediment, particularly mobile fine sediment, to downstream reaches (USFS et al., 1993; Rhodes et al., 1994; USFS and USBLM, 1997b). Headwater streams supply the overwhelming majority of water and sediment to downstream habitats (USFS et al., 1993; Rhodes et al., 1994; USFS and USBLM, 1997b). Downstream low-gradient stream reaches are highly susceptible to deposition of sediment transported from upstream reaches (Rhodes et al., 1994; Rosgen, 1994; Montgomery and Buffington, 1998). The sediment delivered from upstream reaches degrades a variety of downstream conditions including turbidity and suspended sediment (Rhodes et al., Reid, 1998; Purser et al., 2009), pool conditions (USFS et al., 1993; Rhodes et al., 1994; McIntosh et al., 2000; Buffington et al., 2002), and substrate (Buffington and Montgomery, 1999; Hassan and Church, 2000; Cover et al., 2008). The degradation of these attributes of fish habitat by sediment delivered from upstream channels contributes to reductions in the survival and production of salmonids (Bjornn and Reiser, 1991; USFS et al., 1993; Rhodes et al., 1994; USFS and USBLM, 1997b, IMST, 2002; Stout et al., 2012). The BA's assessment of pipeline impacts on salmonids is severely deficient because the BA failed to assess the cumulative effects of the majority of stream crossings and of all crossings of ***all streams*** on downstream fish habitats at the scale of watersheds with fish habitat.

Fifth, many common types of headwater channels, including those that are non-perennial, are extremely sensitive to disturbance, including increases in sediment delivery and runoff (Rosgen, 1994), both of which will be elevated by pipeline crossings in enduring fashion, as discussed in greater detail later in these comments. Even relatively small increases in peakflows in headwater streams trigger significant increases in channel erosion and downstream sediment transport (Dunne et al., 2001). Headwater streams are also quite sensitive to upslope impacts, due to the steeper slopes associated with these streams (USFS et al., 1993; USFS and USBLM, 1997b). Many common types of headwater streams also have very poor prospects for post-disturbance recovery (Rosgen, 1994; Rhodes et al., 1994). However, the BA does not reasonably factor these innate characteristics headwater streams, including those that are non-perennial, in any reasonable way into the assessment of pipeline impacts.

Sixth, a highly significant fraction of the pipeline's 185 stream crossings (JPA, p. 8-3), are on streams that are non-perennial (BA, App. 6E). By only focusing on a relatively few crossings near perennial reaches with critical habitat for ESA listed, the BA completely fails to assess the direct, indirect, and cumulative effect of pipeline crossings of perennial and non-perennial streams upstream of critical habitats and habitats for other native salmonids on those downstream habitats. However, the BA failed to properly assess the effect of a significant fraction of the total stream crossings on downstream fish habitats at the scale of watersheds with fish habitat. In so doing, he BA also did not properly evaluate the effect of **all crossings** of ***all streams*** on downstream fish habitats at the scale of watersheds with fish habitat. Due to the numerous impacts of all crossings and their downstream cumulative effects on critical habitat attributes, the BA's assessment of salmonid impacts from the pipeline is bereft of a sound cumulative effects analysis.

Seventh, water temperature impacts to headwater streams influence downstream water temperatures (Allen and Dietrich, 2005; Allen et al., 2007). For these reasons, the repeated assumptions in the JPA and BA that impacts to non-perennial or small perennial streams have negligible effect on downstream fish habitats and populations is in direct conflict with available scientific information.

The JPA and BA do not reasonably assess the magnitude and persistence of sediment-related impacts from pipeline construction and operation that will affect water quality and fish habitat.

The JPA and BA failed in many ways to properly assess how the pipeline construction and operation will persistently and significantly elevate sediment delivery to affected streams in numerous and additive ways. There is a considerable body of information indicating that ground-disturbing activities that occur within several hundred feet upslope of streams and water bodies have numerous negative and enduring sediment-related impacts on those water bodies and streams (e.g., USFS et al., 1993; Rhodes et al., 1994; Kattelmann, 1996; USFS and USBLM, 1997a; b; IMST, 2002; Beschta et al., 2004).

Contrary to the baseless and incorrect assertions in the BA (p. 3-132), pipeline stream crossings will cause major long-term increases in sediment delivery. The crossings will involve periodic vegetation removal that will be maintained over a 30 foot wide corridor over the pipeline in close proximity to streams on a continuing basis (JPA, p. 8-2). The crossings will also involve significant soil disturbance and compaction, including that on the associated work spaces, in close proximity to streams. All of these impacts significantly elevate erosion and sediment delivery to streams, as legions of studies have demonstrated (e.g., USFS et al., 1993; Rhodes et al., 1994; Kattelmann, 1996; USFS and USBLM, 1997a; b; IMST, 2002; Beschta et al., 2004).

Pipeline clearing and severe soil disturbance from excavation and heavy machinery will have impacts akin to road construction. Roads undergo elevated erosion for decades, even after obliteration (USFS, 1993; USFS and USBLM, 1997b; Rhodes et al., 1994; Beschta et al., 2004). The soil compaction from pipeline construction activities is likely to persist for at least 50-80 years (USFS and USBLM, 1997a) and even longer in soils with high clay content (Beschta et al., 2004). Soil compaction contributes to elevated surface erosion (Kattelmann, 1996; USFS and USBLM, 1997a) by radically degrading surface and subsurface hydrology in several ways (e.g., Booth et al., 2002; Beschta et al., 2013). Compaction significantly reduces the ability of soils to absorb, store, and slowly release water, resulting in higher levels of surface runoff (Booth et al., 2002; Beschta et al., 2013). Increases in surface runoff increase erosion and sediment delivery. However, the BA and JPA completely ignore the long-lasting impact of soil damage on erosion and sediment delivery to streams.

The JPA and BA also fail to reasonably factor in that at and near stream crossings, efforts to the prevent delivery of eroded sediment are usually not completely effective, as is the case with road crossings (Kattelmann, 1996; GLEC, 2008). Instead, the JPA and BA incorrectly assume that BMPs will consistently be effective at reducing sediment delivery from pipeline corridors in riparian areas and stream crossings to minimal and transient levels, in direct conflict with available scientific information. Instead of properly assessing the magnitude and duration of these pipeline impacts within the context of available sound scientific literature, the JPA (p. 3-104) relies on Anderson et al. (1996), the senior author of which was employed by a Canadian gas pipeline company Reid and Anderson, 1999; http://www.alliancepipeline.com), and, thus not particularly credible and certainly not without conflict of interest.

The area over the pipeline will periodically be subject to vegetation removal, including trees and shrubs over 15 feet high (JPA, p. 8-2), on a continuing basis, which will have sediment-related impacts akin to those from logging, which are highly significant and persistent. Significantly elevated erosion in logged areas typically persists for at least five years (Rhodes et al., 1994). This will increase the magnitude and persistence of elevated sediment-delivery from pipeline operation on a continuing basis.

This periodic removal of ecologically important vegetation for pipeline construction and operation will also accelerate bank erosion and reduce bank stability at stream crossings, because trees and deep-rooted vegetation are critically important to bank stability (USFS et al., 1993; Rhodes et al., 1994). Decreased bank stability contributes to both stream sedimentation and channel widening. The persistent loss of bank stability associated with pipeline construction and maintenance at water bodies will persistently elevate sediment delivery, although this is never assessed in the BA and JPA.

The BA and JPA fail to properly evaluate that the pipeline will also elevate runoff and streamflow in all affected channels via several mechanisms, including the elevation of surface runoff by enduring soil compaction (Booth et al., 2002; Beschta et al., 2013). The increase in runoff and streamflow will inexorably elevate channel erosion (Rhodes et al., 1994; Dunne et al., 2001; Booth et al., 2002), especially in tandem with the removal of streamside vegetation (USFS et al., 1993; Rhodes et al., 1994; Beschta et al., 2013). This elevated channel erosion will deliver increased sediment loads downstream where it will degrade a variety of habitat attributes vital to the production and survival of salmonids, including pools, substrate, water quality, and channel widths. Even relatively minor changes in peakflow magnitude and frequency can have major effects on salmonids by triggering significant changes in channel erosion and sediment transport (Dunne et al., 2001).

Notably, many headwater streams are extremely sensitive to elevated runoff and channel erosion and have poor prospects for recovery after being degraded (Rosgen, 1994). Although the pipeline will cross a large number of perennial headwater streams, severely elevating runoff, sediment delivery, and channel erosion, the BA and JPA are bereft of any sound analysis of these cumulative impacts on downstream fish habitats and water quality. This failure is one of the most severe in the JPA and BA with respect to sediment impacts on fish habitats, because all stream crossings upstream of fish habitats will cause enduring increases in sediment delivery that will *cumulatively elevate* sediment delivery to downstream habitats. The lower gradient downstream fish habitats are highly susceptible to the deposition of sediment delivered from upstream reaches (Rosgen, 1994; Montgomery and Buffington, 1998). However, the BA and JPA do not assess this cumulative effect from **all stream crossings** at the scale of affected watersheds.

For instance, there is high number of stream crossings in the watershed of the highly degraded Nehalem River which provides critical habitat for ESA-listed coho. However, the BA and JPA provide no cumulative assessment of the combined effect of these crossings on coho habitat in the river. This is a fatal flaw.

The pipeline will also elevate sediment delivery to streams via the increased use of unpaved roads associated with the construction and operation of the pipeline. Studies have consistently documented that elevated use of unpaved roads vastly elevates sediment delivery from roads to streams (Reid et al., 1981; Foltz, 1996; Reid, 1998; Gucinski et al., 2001; Beschta et al., 2004; GLEC, 2008) particularly near and at stream crossings, where it is impossible to eliminate the delivery of sediment from road runoff (Kattelmann, 1996; Gucinski et al., 2001; Beschta et al., 2004; GLEC, 2008). Therefore, this pipeline impact will also elevate sediment delivery to streams. The elevated use of unpaved roads is a certainty. However, the JPA and BA utterly fail to address this obvious source of elevated sediment delivery to streams or make known the length and location of roads subject to elevated traffic from pipeline construction and operation.

Although there is the considerable potential for “frac-out” with HDD crossings, resulting in high levels of sediment delivery caused by the associated release of drilling mud to streams, the JPA and BA fail to reasonably assess the likely level of sediment delivery based on a reasonable estimate of the likely frequency of frac-out events. These are severe defects, because frac-outs from HDD crossings are relatively common (Reid et al. 2002). The BA and JPA fail to reasonably assess that relatively frequent frac-outs will result in severe increases in sediment delivery, turbidity, and substrate in affected streams. Frac-outs release drilling mud, primarily bentonite (BA, p. 2-53), which is a clay that would greatly increase turbidity. Frac-outs not only release drilling mud, but also disrupt unconsolidated channel substrate, which will also generate downstream sediment delivery and turbidity in addition to that from drilling mud. Once clays released from frac-outs intrude into substrate, they persistently degrade substrate, because particles have a low level of detachability, although this is wholly ignored in the BA. Both the BA and JPA also fail to reasonably factor in to their assessments, that almost nothing can be done to abate the sediment-delivery impacts of frac-outs once the sediment from these events has been introduced into the riverine system. Due to the these foregoing defects in the JPA and BA related to HDD impacts on sediment-delivery and related instream impacts, the JPA and BA fail to properly evaluate the pipeline's impacts on water quality, stream conditions, and salmonid survival and production.

The soil spoils from pipeline construction will also add to accelerated sediment delivery from pipeline construction. Spoils from excavated crossings can be stockpiled as close as 25 feet from perennial streams and as close as 10 feet from non-perennial streams (JPA, 6-37). Available scientific information indicates that even with BMPs this will result in significant delivery of sediment to streams from spoils, especially on steeper slopes (USFS et al., 1993; Rhodes et al., 1994; USFS and USBLM, 1997).

The clearing of pipeline corridors will cause long-term loss of LWD and its recruitment to headwater streams, including those that are non-perennial, which will also contribute to elevated sediment delivery to downstream fish habitats. This is because LWD in headwater streams stores significant amounts of sediment in these headwater streams (Rhodes et al., 1994; May and Gresswell, 2003). As in-channel LWD is lost in headwater streams without replacement due to the loss of recruitment, stored sediment will be flushed downstream and storage of additional sediment in headwater streams will no longer occur. This loss of sediment storage will contribute to the downstream degradation of several vital salmonid habitat attributes affected by sediment delivery.

The JPA and BA also completely fail to note that the enduring increases in sediment delivery caused by the pipeline in affected watersheds is in direct conflict with what is needed to restore decimated salmonid populations in coastal lowland streams in Oregon. The IMST (2002) examined restoration needs for these salmonids in these streams and clearly and repeatedly stated the need to reduce sediment delivery and sediment-related damage to salmonid habitats in order to restore salmonid populations. Stout et al (2012) examined the status of ESA-listed coho and threats to their persistence. Stout et al. (2012) concluded that elevated sediment delivery and the resulting sediment-related impacts on coho habitat were a major threat to coho and a major factor for their decline. The BA and JPA ignore these critically important contexts and findings with respect to assessing the significance of sediment-related impacts from the pipeline.

For these combined reasons, the JPA and BA fail to properly address the obvious: pipeline construction and operation will significantly and persistently elevate sediment delivery in all streams affected by pipeline crossings. These sediment-related impacts will propagate downstream in an additive fashion to degrade a number vital salmonid habitat attributes and water quality.

Substrate

The elevated sediment delivery will affect a host of aquatic conditions in ways that contribute to reduced water quality and salmonid survival and production. It is well-documented by both field and laboratory studies that elevated sediment delivery degrades substrate conditions by elevating fine sediment levels (Rhodes et al., 1994; Buffington and Montgomery, 1999; Hassan and Church, 2000; Cover et al., 2008). Increased levels of fine sediment in substrate reduce salmonid survival and production in many ways (Bjornn and Reiser, 1991; USFS et al., 1993; Rhodes et al., 1994; USFS and USBLM, 1997b; Suttle et al., 2004; Cover et al., 2008). Although it is completely ignored in the BA and JPA, Suttle et al. (2004) demonstrated that any increment of added fine sediment reduces steelhead production—there is no level increased fine sediment that is insignificant. However, the survival and production of all salmonids drop sharply with increased levels of fine sediment in substrate (Bjornn and Reiser, 1991; Rhodes et al., 1994; USFS and USBLM, 1997b; Suttle et al., 2004; Cover et al., 2008). Therefore, the pipeline's effects on substrate will persistently reduce the survival and production of all salmonids that spawn and rear downstream of pipeline crossings.

The pipeline's impacts on substrate are likely to persistent due to a) the persistence of elevated sediment delivery from pipeline impacts; and, b) existing cumulative sediment loads and substrate conditions. Notably, many of the affected streams have acute and long-standing sediment-related problems (McIntosh et al., 2000; IMST, 2002; Stout et al., 2012), indicating that additional sediment delivery from the pipeline will not have transient impacts. This is because streams with significantly degraded conditions caused by highly elevated sediment loads reflect that the affected streams are already unable to transport existing sediment loads. Hence, the degradation from additional sediment is not transient, because under such conditions, additional sediment delivery adds to existing degradation in a persistent fashion—additional sediment is *not rapidly transported* out the system, but instead deposited in pools, substrate, channels, and bank margins. High levels of fine sediment in substrate and in pools are diagnostic of streams that are already overloaded with sediment and not able to readily transport existing or additional sediment loads (Rhodes et al., 1994; Buffington and Montgomery, 1999; Hassan and Church, 2000; Cover et al., 2008).

Notably, even the highly inadequate stream condition information in the BA provides several examples of streams that will be severely affected by sediment generated by pipeline construction and operation--they have substrate conditions that are highly degraded, diagnostic of existing sediment loads that far exceed stream transport capacity. Cedar Creek has 65% fine sediment in its substrate (BA, p. 3-110), which is diagnostic of severely degraded substrate caused by existing sediment loads that are obviously far greater than sediment transport capacity. The Cedar Creek crossing will be crossed via flume method (BA, p. 190) which will severely damage and compact riparian soils, remove all riparian vegetation along the work corridor and associated work spaces, severely damage banks, persistently reduce bank stability and severely alter the riparian hydrology, all of which will cause enduring and major increases in sediment delivery. Due to the existing condition of Cedar Creek, this will cause additional degradation of already severely degraded substrate conditions that harm salmonid survival and production.

Similarly, Rock Creek, which would have a crossing constructed via the flume method, has severely elevated levels of fine sediment, with fine sediment comprising 55-60% of substrate (BA, 3-97). This level of fine sediment is diagnostic of existing sediment loads that already far exceed stream transport capacity. This crossing will greatly elevate sediment delivery still further in Rock Creek by severely damaging and compacting riparian soils, removing all riparian vegetation along the pipeline corridor and associated work spaces, severely damaging banks, reducing bank stability and severely degrading the creek's the riparian hydrology. Further, at least two tributaries of Rock Creek would be crossed by trenching (JPA, App. E), which also vastly elevates sediment delivery due to long-lasting impacts on soils, banks, vegetation, and hydrology. This sediment delivery will be transported downstream where it will exacerbate the existing highly-degraded condition of substrate in Rock Creek.

Bear Creek also has severely degraded substrate conditions with fine sediment comprising about 50% of substrate (BA. p. 3-98), which is diagnostic of existing elevated sediment loads that are far in excess of the sediment transport capacity of the creek. The mainstem of Bear Creek will be crossed by the pipeline using the trenching method, as will four other tributaries to the creek (JPA, App E), which is already highly degraded by existing sediment loads. These crossings will vastly elevate sediment loads in an enduring manner due to long-lasting adverse impact on soil, vegetation, and hydrology in riparian areas affected by the crossings. These impacts will add to the already severe degradation of substrate conditions in Bear Creek.

The BA offers no credible site-specific assessment of the effect of highly elevated sediment delivery from pipeline construction and maintenance that factors in site-specific substrate conditions in affected streams. The BA provides the same "cookie-cutter" assessment of sediment-related impacts on streams with exceedingly high levels of fine sediments in substrate, such as Bear Creek, Rock Creek, and Cedar Creek, as it does for streams with far lower levels of fine sediment in substrate (BA, Table 3.5-3, BA, pp. 3-96 to 3-101). As previously discussed, the duration and magnitude of adverse effects on substrate from increases in sediment delivery are likely to vary considerably in response to existing sediment loads and substrate conditions. Therefore, the BA has clearly failed to assess substrate impacts based on site-specific information consistent with available scientific information.

The BA's contention (p. 3-104) that the cleaning of redds by spawning salmonids might limit the persistent sediment impacts of the pipeline on salmonid survival is wholly without merit. Studies have repeatedly demonstrated that heavy sedimentation of redds, including major intrusion by fine sediments, is quite rapid and severe in stream systems with high levels of fine sediment and/or sediment loads (Rhodes and Purser, 1998; Purser et al., 2009). Under such conditions, the effect of redd cleaning by spawning salmon is transient (Rhodes and Purser, 1998; Purser et al., 2009). By ignoring this information, the BA fails to reasonably assess sediment-related impacts from the pipeline on salmonids.

Pools

Increases in sediment delivery also contribute to adverse changes in quality, quantity, and volume of pools, as numerous scientific studies have repeatedly confirmed (e.g., Lisle and Hilton, 1992; USFS et al., 1993; Rhodes et al., 1994; McIntosh et al., 2000; Buffington et al., 2002; Cover et al., 2008). USFS et al. (1993) and McIntosh et al., (2000) noted the elevated sediment delivery is a primary cause of the documented loss of large pools in streams in western Oregon. Stream with major losses in the number of deep pools include both the Lewis and Clark and Clatskanie rivers

(USFS et al., 1993). Two perennial tributaries of the Clatskanie River[3] will be crossed via trenching (BA, App E) which will greatly and persistently increase sediment delivery to this river due to the intense soil damage and compaction of riparian soils, removal of all riparian vegetation along the work corridor and associated work spaces, severe bank damage, long-term loss of bank stability, and severe alteration of riparian hydrology caused by this crossing method and pipeline maintenance. This will add to the existing severe degradation of pools documented in the Clatskanie River.

Eight tributaries of the already highly degraded Lewis and Clark River will be crossed by the pipeline via methods (JPA, App. E) that involve trenching including in saturated soils (JPA, p. 6-36) that are extremely susceptible to long-lasting soil compaction. This crossing will severely damage and compact riparian soils, remove all riparian vegetation along the pipeline work corridor and associated work spaces, severely damage banks, persistently reduce bank stability and severely alter the riparian hydrology of the tributary, all of which will cause enduring and major increases in sediment delivery that will be transported downstream. Due to the existing condition of this river, the crossing-caused acceleration of sediment delivery will exacerbate already degraded pool conditions, although the BA is completely remiss in failing to assess this obvious consequence of the pipeline.

This degradation of already degraded pool conditions will harm salmonid survival production. Salmonids require large pools at several lifestages for their survival and production (USFS et al., 1993; Rhodes et al. 1994; USFS and USBLM, 1997a; McIntosh et al., 2000; IMST, 2002). USFS et al. (1993) noted that the pervasive loss of large pools has likely contributed to the documented loss in the range and abundance of salmonid species in western Oregon. Pool loss in coastal cutthroat trout habitats reduces the abundance of these trout (Johnson et al., 1999). The survival and production of most salmonids in natal habitats decreases with decreasing pool quality and quantity of large pools. Therefore, the persistent adverse impact of the pipeline on pool conditions via sediment impacts will adversely affect all salmonid populations downstream of the pipeline in an enduring manner, although both the BA and JPA to reasonably assess this obvious consequence of pipeline impacts.

Channel width and water temperature

Elevated sediment delivery also contributes to reductions in channel depth and increases in channel width (Rhodes et al., 1994) that increase water temperatures (Rhodes et al., 1994; Bartholow, 2000), even in the absence of the removal of stream shade. As will be discussed in greater detail later in these comments, these adverse impacts on channel form from the pipeline's sediment impact will cause additional warming of affected to streams caused by pipeline impacts on riparian vegetation. Increased water temperature has numerous significant negative impacts on salmonid survival and production, including at sublethal temperatures (McCullough, 1999). This will significantly and adversely impact salmonids, water quality, and compliance with water quality standards for temperature. Elevated water temperature is one of the most pervasive water quality problems in streams affected by the pipeline and major problem for salmonids, especially those that spawn and rear lower in rivers (IMST, 2002).

[3] The BA's App. E does not provide names for these tributaries.

Turbidity and suspended sediment

It is extremely well-documented that increases in sediment delivery elevate suspended sediment and turbidity (Rhodes et al., 1994; Reid, 1998). These impacts affect both water quality, compliance with water quality standards, salmonids, and downstream beneficial uses of water, including for drinking water and irrigation. Increases in suspended sediment increase drinking water treatment costs, although both the JPA and the BA entirely fail to assess these impacts of the pipeline on this beneficial use.

Notably, the BA's (pp. 3-103 to 3-107) discussion of the effect of suspended sediment levels on salmonid survival and production is baseless, misleading, and in conflict with a large body of scientific information. Contrary to the BA's discussion, there is robust information that demonstrates that vital salmonid functions are significantly impaired by increases in suspended sediment, particularly at concentrations greater than 100 mg/L (Rhodes et al., 1994; Purser et al., 1999). Reid (1998) noted that available data has shown that salmonid feeding is impaired by turbidity in excess of 100 NTU. The BA's (p. 3-105) citing of unnaturally harmfully elevated suspended sediment levels in already severely degraded streams within the action area does nothing to obviate the impact of high levels of suspended sediment; this ploy in the BA is merely a red herring.

The BA's (p. 3-105) assertion that the effect of the pipeline on elevated turbidity and suspended sediment will be pulsed and short-lived is without merit. As previously discussed, the pipeline impacts on sediment delivery, and, hence turbidity and suspended sediment, will be enduring due to the enduring nature of the impacts.

The BA completely fails to factor in that turbidity and suspended sediment conditions in many affected streams are already widely degraded (IMST, 2002). The cited turbidity levels from unnamed salmonid streams in the BA (p. 3-105) indicate that many coastal streams already have suspended sediment concentrations that impair salmonid functions that are vital to salmonid survival and production.

Due to the nature of turbidity and suspended sediment impacts caused by the pipeline, it is unlikely that salmonids will be able to cope with the increases by avoiding them. This is because they will occur in a large number of headwater streams and propagate through the stream system, reducing avoidance options (Reid, 1998). Suspended sediment and turbidity levels in affected streams are already high. Salmonids may not be able to access off-channel refugia during the low flow period (Reid, 1998) when high levels of turbidity and suspended sediment will be generated by pipeline construction.

Summary

Due to existing conditions and the nature of the pipeline's sediment-related impacts, the pipeline will cause enduring adverse impacts on suspended sediment and turbidity, thereby causing long-term adverse impacts on affected salmonid populations, water quality, water quality standards, and downstream beneficial uses.

For these reasons, the sediment-related impacts of the pipeline are likely to degrade substrate, pools, suspended sediment and turbidity, water temperature, and channel form in ways that reduce salmonid survival and production. These impacts will also harm downstream beneficial uses, water quality, and exacerbate and expand existing levels of noncompliance with water quality standards. For these same reasons, the JPA and BA do not reasonably assess the impacts to these aquatic habitat conditions. In so doing, the BA and JPA also fail to credibly determine the persistent and significant adverse impacts of the pipeline on affected salmonid populations, beneficial uses, water quality and compliance with water quality standards.

Pipeline construction and operation will have numerous enduring adverse impacts on water temperature in affected streams.

The pipeline construction and operation will elevate water temperatures by removing vegetation near streams within pipeline corridors and preventing the regrowth of the vegetation. At excavated crossings all vegetation will be cleared from a 100 foot corridor over the pipeline route (BA, 3-95). The JPA (p. 8-2) notes that all shrubs and trees greater than 15 feet in height will be periodically removed from 30 foot width pipeline corridors on a continuing basis. Although the JPA and BA concede this impact, albeit inadequately, both fail to examine the other impacts of the pipeline on water temperature.

It is well-established that elevated sediment delivery, as will be caused by the pipeline, contributes to channel widening, which, in turn, elevates water temperatures (Bartholow, 2000), even in the absence of shade loss. The loss of bank stability caused by vegetation removal near streams at pipeline crossings also contributes to channel widening. This information indicates that the pipeline crossing effects on channel width will add to the water temperature elevation caused by the persistent removal of riparian vegetation for pipeline crossings.

Although it is completely ignored in both the JPA and BA, the impermeable pipeline will also serve to reduce baseflow contributions from groundwater to streams.[4] This will increase water temperature in a two-pronged fashion: 1) reductions in stream flow, alone, increase water temperature, other factors remaining equal (Rhodes et al.; 1994; IMST, 2004); 2) reduced levels of groundwater inflows typically increase water temperature in streams, because groundwater typically cools streams equal (Rhodes et al.; 1994; IMST, 2004). These pipeline impacts on water temperature will be permanent.

Notably, the JPA and BA both completely fail to assess temperature impacts due to channel widening via vegetation and sediment-related effects, in concert, with the inexorable and permanent

4 The pipeline is impermeable, thus its burial in soils inexorably reduces groundwater storage capacity in soils. Soils within 400 feet of streams typically supply groundwater to streams during low flows. Assuming that the pipe displaces soils with 50% porosity within 400 feet of streams, the pipeline with an outer diameter of 36 inches will reduce groundwater storage by 2,826 cubic feet at each stream crossing and thereby reduce stream flows during the summer low flow period. With 185 stream crossings (JPA, p. 8-3), the pipeline will reduce groundwater storage at all stream crossings by about 522,810 cubic feet, very significantly reducing groundwater inflows and streamflows throughout the Project area and thereby elevating water temperature via reductions in cool groundwater inflows and resulting decreases in streamflow. At the scale of watersheds crossed by the pipeline, assuming displaced soils have 50% porosity, the impermeable pipeline will permanently reduce available groundwater storage by about 1,613,363 cubic feet, greatly altering baseflow contributions to streams, surface runoff, and water temperatures.

loss of groundwater inflows due to the impermeable pipeline. In so doing, the JPA and BA fail to adequately assess the combined impacts of the pipeline on water temperature.

The BA's (p. 3-130) assertion that "All of the waterbodies that are listed (1972 CWA § 303(d)) as temperature sensitive along the pipeline would be crossed using HDD, thereby avoiding loss of streamside shade in these temperature sensitive waterbodies" is demonstrably incorrect. For instance, the Clatskanie River is listed as water quality limited (WQL) for temperature (http://www.deq.state.or.us/wq/assessment/rpt2012/search.asp, accessed 1/11/5). Two perennial tributaries of the Clatskanie River[5] will be crossed via trenching (BA, App 6E), which will result in long-term shading on these perennial streams. Perennial tributaries are extensions of downstream rivers, are quite temperature-sensitive to the loss of stream shade, and exert a considerable influence on downstream water temperatures (IMST, 2002; IMST, 2004; Allen and Dietrich, 2005; Allen et al., 2007). Therefore, it is quite clear that temperature sensitive reaches of this river system will be crossed by non-HDD methods, contrary to the BA's misleading statement.

Similarly, much of the Nehalem River is WQL for temperature (http://www.deq.state.or.us/wq/assessment/rpt2012/search.asp, accessed 1/11/5). Numerous perennial tributaries to the river, which are extensions of the river, will have shade removed at non-HDD crossings (BA, p. 3-109 and JPA, App. E). Therefore, it is quite clear that temperature sensitive reaches of this river system will be crossed by non-HDD methods, contrary to the BA's misleading statement.

Bear Creek is WQL for temperature (http://www.deq.state.or.us/wq/assessment/rpt2012/search.asp, accessed 1/11/5). There will be two crossings by the pipeline of mainstem of Bear Creek or its perennial tributaries that will be constructed via trenching (JPA, App E), resulting in a complete and long-lasting loss of stream shade. Therefore, it is quite clear that temperature sensitive reaches of this WQL creek will be crossed by non-HDD methods, contrary to the BA's misleading statement.

Wolf Creek is WQL for temperature (http://www.deq.state.or.us/wq/assessment/rpt2012/search.asp, accessed 1/11/5). There will be three non-HDD pipeline stream crossings constructed on this creek's mainstem or its perennial tributaries (BA, App. 6E) that are extensions of stream network. The associated long-term loss of shade on this creek sensitive will elevate water temperatures persistently in the WQL creek, in direct conflict with the BA's misleading assertions.

Due to the duration and nature of pipeline impacts on water temperatures, the pipeline will permanently degrade water temperatures in a significant fashion. As is the case with sediment-related impacts, the BA and JPA completely fail to examine the significance of the pipeline's impacts on water temperatures and salmonids within the context of the total cumulative impacts of existing and ongoing impacts on water temperatures and salmonids. Water temperatures are quite degraded in most of the affected streams. Elevated water temperature is one of the most pervasive problems affecting salmonids within the project area (USFS et al., 1993; IMST, 2002; Stout et al., 2012). Notably, Stout et al. (2012) found that existing water temperature problems throughout the range of ESA listed coastal coho is one of the primary threats to their persistence, although this vital context is completely ignored in the JPA and BA. Climate change is already increasing water

[5] The BA's App. E does not provide names for these tributaries.

temperatures and is likely to increase it further, even in the absence of additional impacts, rendering streams even more inhospitable to salmonids (Stout et al., 2012; Beschta et al., 2013). For these reasons, the assessment of water temperature impacts in the BA and JPA are woefully underestimated, as are the assessment of resulting impacts on affected salmonids.

The pipeline will persistently degrade LWD and the frequency and quality and quantity of pools.

The pipeline will remove riparian trees from the numerous stream crossings. Within a 30 foot wide corridor at these crossings, pipeline maintenance will continually remove trees greater than 15 feet in height (JPA, 8-2), permanently preventing the growth of large trees that provide LWD to streams. A sizable fraction of trees within 200 feet of streams contribute LWD to streams, if trees are allowed to grow to their site-potential height. Based on the foregoing, the pipeline will permanently and completely reduce LWD recruitment to streams over an area of 51 acres in riparian zones at the 185 stream crossings.

The assertion in the JPA and BA that the permanent loss of LWD and LWD recruitment at pipeline crossings will have little effect on LWD levels in affected streams due the in-stream placement of trees that are cut down at crossings is without any merit. If trees were left standing, they would grow larger before being recruited to streams as LWD. It is well-established that larger LWD is more beneficial than smaller LWD. In-stream LWD functionality and longevity increases with LWD size (Rhodes et al., 1994). The placement of relatively small LWD pieces does nothing to compensate for the permanent loss of larger LWD caused by pipeline crossings.

The JPA (p. 6-27) and BA (p. 3-130) note that only *some unmerchantable* trees greater than 12 inches dbh that are cut down for pipeline construction might be added to streams. This indicates that merchantable trees will not be retained and added to streams. This is significant because merchantable trees tend to be considerably larger than unmerchantable trees. Thus, the JPA and BA indicate that only a fraction of wood, and only smaller pieces, removed from pipeline corridors will be added to the stream system. The loss of recruitable LWD at the corridors due to the loss of larger merchantable trees will significantly reduce LWD volumes and stream functionality. It is well established that larger LWD has greater instream longevity, stability, and functionality (USFS et al., 1993; Rhodes et al., 1994; USFS and USBLM, 1997b; Buffington et al., 2002). Therefore, this proposed mitigation measure will not compensate for the LWD robbed from streams by pipeline construction and operation.

The loss of LWD in headwater streams that do not have fish habitat still affects downstream fish habitat. This is because a significant amount of LWD in fish habitats is supplied from headwater tributaries (May and Gresswell, 2003). The enduring losses of LWD recruitment caused by the crossings on these streams will cumulatively deplete LWD in downstream reaches with fish habitat (May and Gresswell, 2003), although this is never properly assessed or made known in the BA.[6]

[6] Notably, the BA (p. 3-113) cites May and Gresswell (2003) but completely fails to factor in one the primary findings: that LWD delivered from small streams is an important component of LWD levels in larger fish-bearing streams and "Forest management that relies primarily on recruitment of wood from riparian buffers along the larger fish-bearing streams may result in much lower levels of wood recruitment than the historic range of conditions" (May and Gresswell, 2003)

Further, LWD in headwater tributaries provides numerous functions important to the maintenance of favorable downstream habitat conditions, including providing large amounts of in-stream sediment storage (Rhodes et al., 1994; May and Gresswell, 2003). Therefore, permanent loss of LWD in headwater streams will also contribute to significant sediment-related degradation of downstream habitats.

This permanent loss of LWD due to the pipeline will cause significant harm to salmonid habitats and populations. Affected streams are already have a severe deficit of LWD due to existing land use, which is a major cause of the documented severe loss of pool volumes in many coastal rivers (USFS et al., 1997; McIntosh et al., 2000), including those affected by the pipeline (USFS et al., 1993). Coastal streams in Oregon are already widely degraded with respect to LWD levels (IMST, 2002) and the associated loss of stream complexity poses a significant threat to salmonids, including ESA listed coastal coho (IMST, 2002; Stout et al., 2012). The loss of LWD and pools has likely contributed significantly to the decline of affected salmonid populations (USFS and USBLM, 1993), although this context is ignored in the JPA and BA.

For these combined reasons, the pipeline will permanently degrade LWD conditions in streams. This will permanently harm affected salmonid populations.

Pool quality and quantity will be degraded by the persistent loss of LWD and increased sediment delivery caused by pipeline construction and operation. It is extremely well established that LWD is critically important to pool quality, volume, and frequency (e.g., USFS et al., 1993; Rhodes et al., 1994; USFS and USBLM, 1997; McIntosh et al., 2000; Buffington et al., 2002). The loss of LWD is major factor in the documented loss of large pools in western Oregon (USFS et al., 1993; McIntosh et al., 2000).

Increased sediment delivery is also a primary mechanism of pool loss and loss of pool volume and quality (Lisle and Hilton, 1992; USFS et al., 1993; Rhodes et al., 1994; USFS and USBLM, 1997; McIntosh et al., 2000; Buffington et al., 2002; Cover et al., 2008). Therefore, the pipeline's combined effect on sediment delivery and LWD will persistently degrade pool conditions in affected streams in an enduring manner.

The pipeline will persistently degrade off-channel habitats and refugia.

Channel migration is a critically important process for the maintenance of off channel habitats, because off-channel habitats are created by channel migration. Pipeline construction and maintenance will truncate channel migration at crossings, because the pipeline maintenance measures do not allow the surface exposure of the pipeline that would occur with channel migration. Further, LWD is an important component of productive off-channel habitat, and as previously discussed, the pipeline will reduce LWD levels.

Off-channel habitats will also be degraded by the pipeline persistent elevation of sediment delivery to streams. This is because off-channel habitats occur at channel margins in zones with relatively low water velocities, which are the most prone to significant sedimentation. The elevated sediment loads will contribute to the loss of off-channel habitats due to accelerated sedimentation.

The pipeline will also contribute to reductions in low flows in streams. This will reduce the volume of habitat in off-channel habitats. Low flow reductions can render such off-channel habitats inaccessible to salmonids via the loss of surface water connectivity between the channel and off-channel habitats.

For these combined reasons, the pipeline will degrade off-channel habitats and thereby reduce salmonid survival and production.

In order to be usable by salmonids, refugia must have water temperature conditions that hospitable to salmonids. As previously discussed, the pipeline will permanently degrade water temperature conditions in many ways including the removal of shade, the permanent reduction in groundwater inflows, and stream channel widening. These impacts will degrade refugia for salmonids.

The pipeline will persistently degrade width/depth ratio, bank conditions, and floodplain connectivity.

As previously discussed, the enduring significant increases in sediment delivery from the pipeline will contribute to increases in width/depth ratio, as available scientific information reliably indicates. Reduced bank stability caused by vegetation removal at pipeline crossings will also contribute to the degradation of width/depth ratio.

Therefore, the pipeline will degrade this indicator. As previously discussed, the degradation of width/depth ratio will contribute to increases in water temperatures, as well.

The removal of deep-rooted vegetation in riparian areas at pipeline crossings will also contribute to reductions in bank stability and increased bank erosion. The loss of deep-rooted vegetation also is likely to impede the development of overhanging banks which provide refugia for several lifestages of salmonids. The exacerbation of peakflows caused by the combined pipeline impacts on wetlands, soil compaction, and loss of soil water storage from the impermeable pipeline will also contribute to elevated bank erosion. In aggregate, these pipeline impacts will degrade bank conditions.

The project will also degrade floodplain connectivity in two primary ways. First, the pipeline will occupy a significant amount of floodplain (JPA, p. 4-34). As previously discussed, the existence of the impermeable pipeline will reduce the hydrologic connectivity between these affected floodplains and streams by reducing groundwater exchanges to and from streams due to the significant reduction in groundwater storage.

Second, the pipeline maintenance and operation will impede normal channel migration in floodplains, which is a key aspect of physical stream floodplain connectivity that is also essential to creation and rejuvenation of off-channel habitats. This will significantly degrade floodplain-stream connectivity.

The pipeline will persistently degrade peak and base flows.

The pipeline will elevate peak flow and contribute to reductions in base flows in several ways. First, the impermeable pipeline will permanently reduce available water storage in affected in riparian areas, wetlands, floodplains, and at the scale of watersheds. Because most surface runoff in the action area is generated from saturated soils, this loss of available water storage will increase the duration, magnitude, and extent of surface runoff in response to storm events. This will, in turn, contribute to increased peak flows.

Second, the pipeline and associated construction activities will also persistently compact soils. Soil compaction reduces both infiltration rates and available soil water storage in a persistent fashion. Both soil impacts contribute to increased surface runoff during storm events. Soil compaction radically alters surface and subsurface hydrology in several fundamental ways, significantly reducing the ability of soils to absorb, store, and slowly release water (Booth et al., 2002; Beschta et al., 2013). These impacts increase surface runoff during storm events, contributing to elevated peakflows.

Third, base flows will also be reduced due to the permanent loss of water storage in soils caused by the displacement of permeable soils by impermeable pipeline. This impact of the loss of water storage in wetlands, riparian areas, and floodplains will contribute to reductions in baseflows.

Fourth, soil compaction caused by pipeline construction activities will also contribute to reduced baseflows in two ways. Compaction reduces the cumulative available water storage in soils at the watershed scale, thereby reducing the total amount of water in soils that are ultimately available to contribute to base flows. The loss of available water storage and decreased infiltration both result in more precipitation being shunted to streams via surface runoff instead of being absorbed, stored, and ultimately released by the soil systems. These impacts also contribute to reductions in low flows because more precipitation is shunted to surface runoff rather to soils where it can ultimately contribute to base flows. Notably, these are long-term impact on peak and base flows because soil compaction persists for many decades.

For these combined reasons, the pipeline will permanently degrade peak and baseflows.

The pipeline will persistently degrade drainage network increase, watershed disturbance, and riparian conditions.

The pipeline crossings will effectively increase the drainage network, thereby degrading this indicator in a permanent fashion. As previously mentioned, pipeline crossings will have impacts akin to roads, including complete permanent removal of deep-rooted vegetation over the pipeline corridor and severe disruption and compaction of soils in close proximity to streams. Due to the resulting effects on infiltration, available water storage, and surface runoff generation these crossings will route accelerated runoff to the streams and thereby expand the drainage network. For these combined reasons, the pipeline will expand the drainage network, elevating peak flows and sediment delivery, degrading this indicator permanently.

The pipeline will permanently degrade riparian conditions via soil damage and disturbance, the impermeable pipelines occupation of riparian soils, and recurring vegetation removal. The same impacts will permanently degrade watershed disturbance levels.

The pipeline will permanently degrade wetland hydrology and related wetland functions.

The JPA (pp. 8-2, 8-3) erroneous assertion that wetlands crossed by the pipeline "…**will retain their wetland hydrology…"** is demonstrably incorrect. As previously discussed, the impermeable pipeline will permanently occupy a significant volume in wetlands soils that would otherwise be available to store water, which is a key hydrologic wetland.

Based on a reasonable value of 50% porosity for wetland soils permanently displaced by the pipeline, the 36 inch diameter pipeline will reduce available subsurface in affected wetlands by about 3,553 cubic feet per 1,000 feet of pipeline in wetlands. This permanent significant loss of water storage will permanently alter wetland hydrology. Thus, the permanent occupation of wetland soils by the impermeable pipeline will permanently degrade wetland hydrology and preclude the retention of natural wetland functionality.

The permanent loss of wetland water storage and resulting degradation of affected wetlands will also exacerbate flooding and the duration, extent, and magnitude of surface runoff in affected watersheds. This is because wetlands and their soils are important for attenuating runoff, generally, and especially during flood events.

Pipeline construction will also persistently compact soils in wetlands, altering wetland hydrology in an enduring fashion. Soil compaction radically alters surface and subsurface hydrology in several fundamental ways that significantly reduce the ability of soils to absorb, store, and slowly release water (Booth et al., 2002; Beschta et al., 2013), which are some of key ecologic features of wetlands. This increases runoff, contributing to elevated peakflows, as well as reducing low flows and the duration of surface inundation in wetlands. Notably, soil compaction persists for more than 50 years. Therefore, the combined impacts of pipeline construction on soil compaction will significantly degrade wetland hydrology for decades.

There is no sound basis for the BA's assumption that removal of barriers to increase in accessible habitat will mitigate for the lost abundance of coho caused by the combined impacts of pipeline construction and maintenance.

The BA (pp. 3-147 to 3-148) asserts without any sound basis that the removal of passage barriers to coho spawning habitat can offset *some* of the expected losses of ESA-listed coho. However, this assumption is unsound for several reasons.

First, it is premised on the unsubstantiated notion that the quantity of spawning habitat is a limiting factor. However, the BA provides absolutely no evidence that coho numbers are limited by the spawning habitat quantity.

Second, the spawning habitat made available by barrier removal would need to be at least amenable to successful spawning. The BA is devoid of any assessment of the condition of this spawning habitat.

Third, the mitigation ignores that in highly degraded systems, such as those affected by the pipeline, density-independent effects are often far more limiting than the amount of accessible habitat (Rhodes et al., 1994; USFS and USBLM, 1997b).

Fourth, the long-lasting manifold impacts of the pipeline are likely to reduce salmonid survival and production in many ways. Increasing habitat quantity in a few places is unlikely to offset the pervasive damage to salmonid habitats caused by the pipeline, although the BA is bereft of such a needed assessment.

Summary and conclusions.

The JPA and BA fundamentally fail to properly assess the extent, duration, and magnitude of sediment-related impacts on affected streams. In so doing, the JPA and BA do not properly evaluate related impacts on pools, substrate, channel widths, water quality, compliance with water quality standards, and beneficial uses in streams draining watersheds affected by the pipeline. These impacts will persistent and adversely affect salmonid populations in an enduring manner, which is not adequately assessed in the BA and JPA.

The pipeline will also degrade water temperatures, LWD levels, channel widths, bank conditions, peak flows, base flows, wetlands, riparian areas, and watershed disturbance in an enduring manner which is not correctly evaluated in the JPA and BA. These impacts will also negatively affect salmonid populations in persistent fashion that is not adequately evaluated in the BA and JPA.

The JPA and BA failed to properly assess these impacts in many ways. One primary way is that BA and JPA include no sound assessment of the very limited effectiveness of proposed mitigation and BMPs aimed at lessening impacts. Another primary problem is that both JPA and BA failed to include a sound assessment of the combined effect of impacts on headwater streams, including those that are non-perennial, on downstream conditions.

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EDUCATION

1989: Doctoral candidacy degree in forest hydrology at the Univ. of Wash. Completed all requirements but dissertation.

1985: M.S. in Hydrology and Hydrogeology at the Univ. of Nev.-Reno. Thesis topic: The influence of seasonal stream runoff patterns on water quality.

1981: B.S. in Hydrology and Water Resources at the Univ. of Ariz.

PROFESSIONAL HISTORY

Sept. 2001 -- present. Principal Hydrologist, Planeto Azul Hydrology. Main duties: Analysis of water and land use effects on streams and aquatic resources, including native salmonids and their habitats; diagnosis of watershed and stream conditions; stream monitoring; development of programmatic and site-specific watershed and stream protection measures; project management. Some recent projects (and clients): Analysis of potential effects of groundwater pumping on streamflow (Conf. Tribes of the Umatilla Indian Reservation, OR); diagnosis of watershed and stream conditions in an urbanized watershed (West Multnomah Soil and Water Conservation District, OR); analysis of data on sediment effects on ESA-listed salmon in the South Fork Stillaguamish River, WA (Snohomish County, WA). See list of clients at the end of the CV.

Aug. 1990 -- Sept. 2001. Consulting hydrologist for non-profit organizations. Past projects (and clients) include: hydrologic characterization of remnant marsh proposed as urban wildlife refuge/greenspace (Multnomah Co. Parks Dept, OR); review of aquatic effects of: quarry expansion (Friends of Forest Park, OR), urban construction (homeowners consortium, W. Linn, OR); forest manipulations on streamflow (Pacific Rivers Council).

Apr. 1989 -- Sept. 2001. Senior Fishery Scientist-Hydrologist, Columbia River Inter-Tribal Fish Commission. Main duties: Administration and implementation of projects monitoring channel change from land use; development of programmatic and site-specific land management plans to ensure protection of watershed integrity, water quality and aquatic resources; development of restoration plans for watersheds degraded by grazing, roads, logging, and mining; design of plans for monitoring watershed and stream erosion, sedimentation, water quality, and habitat conditions; review of land management plans for adequacy of protection of aquatic resources; field evaluation of watershed and channel conditions throughout the Columbia Basin; expert witness testimony; development of technical recommendations for policy staff for protection of natal habitat for anadromous fish; review of state and federal aquatic resource monitoring plans; report and proposal writing; and, participation in various state and federal technical work groups.

Aug. '84 -- Apr. '89. Research assistant, College of Forestry, Univ. of Wash. Main duties: analysis and interpretation of water quality-quantity data; technical report writing; design and maintenance of water chemistry and quantity monitoring network in a coastal forested watershed; training in data acquisition techniques; public presentation of findings.

July -- Oct. 1987 and May -- Oct. 1988. Consulting hydrologist, Tahoe Regional Planning Agency, CA and NV. Main duties: field delineation and mapping of riparian zones, wetlands, and erosion-prone areas.

June -- Sept. 1985 and July 1986. Research assistant, Dept. of Geophysics, Univ of Wash. Main duties: operation of field station for glacier research on Mt. Olympus, Wash.; measurement of snow and glacier melt rates; mapping of supra- and extra- glacial streams contributing to basal sub-glacial flow rates on surging and non-surging glaciers in the Alaska Range, Alaska.

Jan. 1984. Consultant with C.M. Skau, Reno, NV. Main duties: field evaluation of logging roads for erosion potential and sedimentation risk; recommendations for placement of future roads to minimize erosion and sediment delivery to fish-bearing streams in coastal Northern California.

Oct. 1983 -- June 1984. Hydrologic Tech., USGS, Carson City, NV. Main duties: aid in development and calibration of predictive water quality model for the Truckee River; statistical analysis of water quality data; identification and quantification of non-point sources of nutrients to Truckee River, NV.

Aug. 1981 -- Sept. 1983. Research Assistant, Univ. of Nev.-Reno. Main duties: design and installation of instrument network to monitor water chemistry and quantity in a small, forested alpine watershed in the Sierra Nevada; water quality sampling; data interpretation and management; preparation of reports, grant proposals, and publications, computer programming for data reduction and storage; mapping of geology, soils and runoff-producing areas; and, training of field technicians.

Feb. -- May 1981. Water Quality Intern, Pima Assoc. of Gov'ts., Tucson, AZ. Main duties: water quality sampling of agricultural production wells; mapping of groundwater levels; and, coordination of sampling efforts.

PROFESSIONAL SERVICE

May 2009 – present. Peer Reviewer for the scholarly journal, Open Forest Science Journal, for papers related to hydrology and forest and watershed responses to disturbance.

Mar. 2013. Invited Panel Speaker, Public Interest Environmental Law Conference: “Public Land Livestock Grazing and Climate Impacts on Aquatic Systems” and “The High Ecological Costs and Low Benefits of Logging Under the Rubric Of Restoration,” Univ. of OR, Eugene, OR.

Feb. 2010. Invited Guest Lecturer, Lewis and Clark School of Law course on public lands law: “PACFISH and INFISH and Imperiled Salmonids on Public Lands” Portland, OR.

Feb. 2009. Invited Guest Lecturer, Lewis and Clark School of Law course on public lands law: “PACFISH and INFISH and Imperiled Salmonids on Public Lands” Portland, OR.

Feb. 2008. Invited Guest Lecturer, Lewis and Clark School of Law course on public lands law: “PACFISH and INFISH and Imperiled Salmonids on Public Lands” Portland, OR.

Mar. 2007. Invited Panel Speaker, Public Interest Environmental Law Conference: “Fuel Treatments & Thinning: Its Impacts and Low Priority Relative to Other Needed Restoration Measures” and “The Impacts of Livestock Grazing on Water Quality and Trout Habitats,” Univ. of OR, Eugene, OR.

Feb. 2005. Invited Guest Lecturer, Lewis and Clark School of Law course on public lands law: “Postfire Watershed Management on Western Public Lands” Portland, OR.

Mar. 2004. Invited Panel Speaker, Public Interest Environmental Law Conference: "Postfire Watershed Restoration," Univ. of OR, Eugene, OR.

April 2002. Invited Speaker, Restoring Public Lands Conference: Reclaiming the Concept of Forest Restoration, "Watersheds and Fisheries: Restoration Needs for Trout Habitats," Univ. of CO, Boulder, CO

Mar 2002. Invited Panel Speaker, Public Interest Environmental Law Conference: "Soils, Impacts and Effects on Trout Habitat," Univ. of OR, Eugene, OR

Mar. 2001. Invited Panel Speaker, Public Interest Environmental Law Conference: "NFMA and Salmon Habitat Protection," Univ. of OR, Eugene, OR.

May 2000. Invited speaker, 5th National Tribal Conf. on Environmental Management: "Federal Land Management's Effects on Critical Habitat for Endangered Salmon," Lincoln City, OR

July 1998-2000. Peer Reviewer for the scholarly journal, N. Amer. J. Fish, for papers related to the sedimentation of fish habitat in response to erosion from land uses and fire.

Feb. 1998. Invited Speaker, Oregon AFS Annual meeting: "Adaptive management: Is it really adaptive?" Sunriver, OR

May 1996-2000. Guest lecturer, Oregon State Univ. graduate course on riparian and wetland ecology, Corvallis, OR

Apr.-May 1996. Peer-reviewer for Proceedings of Forest-Fish Conference: Land Management Affecting Aquatic Ecosystems, Proc. Forest-Fish Conf., May 1-4, 1996, Calgary, Alberta, Canada. Nat. Resour. Can., Can. For. Serv. Nort. For. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-356.

Apr. 1995. Invited speaker, Pacific Rivers Council Workshop on Watershed Analysis and Salvage Logging, Wenatchee, Wash.

Apr. 1995. Invited speaker, Oregon State Univ. Dept of Fisheries and Wildlife Seminar, Corvallis, OR

Apr. 1995. Invited speaker, American Fisheries Society North Pacific International Chapter, Annual Meeting, Vancouver B.C., Can.

Mar. 1995. Invited speaker, American Fisheries Society Idaho Chapter Annual Meeting, Boise, ID.

Nov. 1994. Invited speaker, President's Council on Sustainable Development Workshop, Yakima, WA.

Sept. 1994. Invited speaker, Oregon Water Resources Research Institute Streambank Restoration Conference: "Biological Methods to Stabilize Streambanks--From Theory to Practice," Portland, OR.

Mar.-April, 1994. Peer-reviewer for Henjum et al., 1994. Interim Protection for Late Successional Forests, Fisheries, and Watersheds: National Forests East of The Cascade Crest, Oregon and Washington. The Wildlife Soc., Bethesda, MD.

Jan. 1993-Sept. 1995. Member, Oregon Department of Environmental Quality's (ODEQ) Technical Advisory Committee for Triennial Review of the State Water Temperature Standard.

Mar. 1993. Invited speaker, Northwest Scientific Association Symposium: "Cumulative Effects of Land Management Practices on Anadromous Salmonids," La Grande, OR.

Aug. 1992 - Sept. 1992. Member, Ad Hoc Consultant Selection Committee for Portland Water Bureau Study of Future Water Supply Needs.

May 1992. Invited Speaker, US Forest Service, Pacific Northwest Region, Regional Workshop on Monitoring Soil and Water Resources, Bend, OR.

May 1992. Invited Speaker, Northern Arizona University, School of Forestry, Graduate Seminar Series, Flagstaff, AZ.

Jan. 1991 - Mar. 1995. Member, Technical Work Group: Upper Grande Ronde River Anadromous Fish Habitat Protection, Restoration and Monitoring Plan.

Aug. 1989 - Feb. 1990. Member, Technical Advisory Committee to ODEQ for development of definitions for level of beneficial use impairment by nonpoint sources.

May 1989 - Jan. 1991.Member, Nonpoint Source Technical Advisory Committee to Idaho Department of Environmental Quality: Coordinated Nonpoint Source Monitoring Program For Idaho.

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1993. A comprehensive approach to restoring habitat conditions needed to protect threatened salmon species in a severely degraded river--The Upper Grande Ronde River Anadromous Fish Habitat Protection, Restoration and Monitoring Plan. USFS Gen. Tech. Rept RM-226, pp. 175-179. (Co-authors: J.W. Anderson, R.L. Beschta, P. Boehne, D. Bryson, R.E. Gill, S. Howes, B. McIntosh, M.D. Purser and J. Zakel).

1993. Dante's Video Guide to Habitat Conditions for Wild Spring Chinook Salmon, Steelhead and Bull Trout in the John Day Basin, Oregon. (Video) Presented at AFS National Meeting, Portland, Or, Aug. 29-31. (Co-authors: R. Taylor and M. Purser).

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1999. Annual Project Report: Watershed Evaluation and Aquatic Habitat Response to Recent Storms. Bonneville Power Administration (BPA), Portland, OR. (Co-author: C. Huntington)

1999. Annual Project Report: Monitoring Fine Sediment in Salmon Habitat in John Day and Grande Ronde Rivers. BPA, Portland, OR (Co-author: M. Purser)

2000. Annual Project Report: Watershed Evaluation and Aquatic Habitat Response to Recent Storms. BPA, Portland, OR. (Co-author: C. Huntington)

2000. Annual Project Report: Monitoring Fine Sediment in Salmon Habitat in John Day and Grande Ronde Rivers. (Co-author: M. J. Greene)

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2001. Imperiled Western Trout and the Importance of Roadless Areas. Western Native Trout Campaign, Center for Biological Diversity, Tucson, Az. (Co-authors: J. Kessler, C. Bradley, and J. Wood)

2002. Tryon Creek Watershed: Overview of Existing Conditions, Data Gaps, and Recommendations for the Protection and Restoration of Aquatic Resources. West Multnomah Soil and Water Conservation District, Portland, OR

2002. An Analysis of Trout and Salmon Status and Conservation Values of Potential Wilderness Candidates in Idaho and Eastern Washington. Western Native Trout Campaign, Center for Biological Diversity, Tucson, AZ. (Co-authors: C. Bradley, J. Kessler, C. Frissell)

2003. Stream and Fish Habitat Conditions in Tryon Creek: Their Likely Causes and Ramifications for Salmonids. Proceedings of Urban Ecology and Conservation Symposium, January 24, 2003, Portland, OR. Portland State University, Environmental Sciences and Resources, Portland, OR

2008. Primary Sources of Fine Sediment in the South Fork Stillaguamish River. Interim progress report for Washington State Salmon Recovery Funding Board, Olympia, WA. Snohomish County Public Works Surface Water Management, Everett, WA. (Co-authors: M. Purser, B. Gaddis, S. Britton, T. Coburn, and M. Rustay)

2009. Primary Sources of Fine Sediment in the South Fork Stillaguamish River. Project completion report for Washington State Salmon Recovery Funding Board, Olympia, WA. Snohomish County Public Works Surface Water Management, Everett, WA. (Co-authors: M. Purser, B. Gaddis,)

Semi-Technical Publications:

1993. Dam the analysis--heal streams instead. The Assoc. of Forest Service Employees for Env. Ethics Inner Voice, **5**(6): 1, 4-5.

1994. Invited Preface to Northwest Science Special Issue--Environmental History of River Basins in Eastern Oregon and Washington. Northwest Sci., **68**.

PROJECT MANAGEMENT

1993-1996. Technical Assistance Contract with NMFS to produce technical guidance for ESA consultations for effects of land management on critical habitat for listed Columbia basin salmon. Main duties: Co-Primary Investigator; primary author of peer-reviewed reports including proposed ESA consultation guidelines for effects on salmon habitat (Rhodes et al., 1994), evaluation and comparison of compatibility of land management plans with protection of critical salmon habitat (Rhodes, 1995), and evaluation of models for estimating land management effects on salmon habitat (Rhodes, 1996); review and synthesis of available scientific literature; budget preparation and tracking; coordination with subcontractors and grantor representatives. Total budget: $230,000.

1998-2000. Watershed Evaluation and Aquatic Habitat Response to Recent Storms. Main duties: Primary Investigator; design and implementation of monitoring methods, coordination of technical staff in 10 watersheds with differing levels of grazing and logging in 3 subbasins in Idaho, Washington, and Oregon; technical training; data analysis; contract administration; proposal development; report preparation; budget development and tracking; coordination with grantor representatives. Total budget: $164,000.

1998-2000. Evaluation of Effects of Grazing on Rate of Salmon Habitat Recovery. Main duties: Primary Investigator; design and implementation of monitoring methods, training of field technician; data analysis and synthesis; proposal development; preparation of progress reports; budget development and tracking; coordination with grantor representatives. Total budget: $73,000.

1998-2001. Monitoring Fine Sediment Levels in Salmon Habitat in Grande Ronde and John Day Rivers. Main duties: Primary Investigator; design and implementation of methods for monitoring fine sediment levels in four rivers; field technician training; data analysis and synthesis; subcontract administration; proposal development; progress and technical report preparation; budget development and tracking; coordination with grantor representatives. Total budget: $128,000.

2001-2002. Western Native Trout Campaign, Aquatic Scientist and Coordinator. Main duties: Oversight and scientific integrity assurance for all work products; coordinate conservation efforts among campaign member organizations and other groups working to protect and restore trout habitats and populations; reporting; and, budget tracking. Total budget: ca. $1,000,000.

HONORS AND AWARDS

1996. Leadership and Excellence. Col. River Inter-Tribal Fish Comm., Portland, OR

1991. Employee of the Year. Col. River Inter-Tribal Fish Comm., Portland, OR

1984. Academic Recruitment Scholarship for Outstanding Graduate Prospect. Univ. of Wash, Seattle, Wash.

1982. Maxey Award -- Outstanding Graduate Student Paper in Hydrology. Univ. of Nev.-Reno.

1980. Winslow and Myron Reuben Scholarship for Outstanding Undergraduate in the Earth Sciences. Univ. of Ariz., Tucson, Az.

ADDITIONAL TRAINING

1993. USFWS Water Temperature Modeling via SNTEMP

1991. USFWS Introduction to IFIM Investigations