US Army Corps of Engineers ®
Walla Walla District

SWEETWATER CREEK ECOSYSTEM RESTORATION

Feasibility Report with Integrated Environmental Assessment

Appendix B

Habitat Evaluation Modeling

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SWEETWATER CREEK ECOSYSTEM RESTORATION FEASIBILITY REPORT WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

APPENDIX B, HABITAT EVALUATION MODELING

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1.0 PROJECT BACKGROUND

Presently, the Walla Walla District is undertaking a Tribal Partnership Program Section 203 ecosystem restoration study on Sweetwater and Lapwai Creeks, Lapwai, Idaho, in cooperation with the project Sponsor, the Nez Perce Tribe.

The Lapwai Creek watershed provides critical habitat for Snake River steelhead, listed under the Endangered Species Act (ESA), as well as other culturally significant fish species highly valued by the Nez Perce Tribe. Sweetwater Creek, in particular, has tremendous cultural significance for the Nez Perce Tribe as an important fishery, and for the spiritual and physical healing powers ascribed to its waters.

The ecological function and quality of the Lapwai Creek watershed is impacted by a period of changed climatologic conditions, changes in runoff characteristics, lack of floodplain connectivity, reduced quantity and quality of riparian habitat, and barriers to historic salmonid spawning and rearing habitat. These conditions have negative impacts on species listed under the ESA. Opportunities exist to restore riparian quality and function and improve instream habitat complexity and quality (pool frequency and physical and hydraulic features).

Two Planning Objectives were developed to address the degraded habitat condition and cultural interests discussed above.

- Improve degraded aquatic habitat to include, quality, quantity and function in the Lapwai/Sweetwater watershed over the period of analysis
- Improve degraded riparian habitat to include, quality, quantity and function in the Lapwai/Sweetwater watershed over the period of analysis

The purpose of this study is to restore riparian and instream ecosystem function on Sweetwater and lower Lapwai Creeks for ESA-listed and culturally significant steelhead (*Oncorhynchus mykiss*) and Coho salmon (*O. kisutch*). Benefits may be realized by providing complex and suitable instream habitat, restoring culturally significant native riparian plant communities, and establishing sustainable river and floodplain morphology and function.

1.1 Study Area

The Lapwai Creek watershed (Figure 1) encompasses 171,000 acres [ac (~267 square miles)]. It is located in Northern Idaho and lies almost entirely on the Nez Perce Reservation. The Lapwai Creek is a tributary to the lower Clearwater River, and is part of the Snake and Columbia River drainages and flows in a northwesterly direction from its headwaters in the Craig Mountains. Portions of the headwaters are located in Lewis County, although the majority of the watershed is contained within Nez Perce County (Figure 2). Lapwai Creek is a fourth order stream that flows in a northwesterly direction for 31 miles, until it reaches its confluence with the Clearwater River. The scope of this study is limited to Lapwai Creek from the mouth of the Clearwater River to the confluence with Sweetwater Creek (approximately 6 miles), and Sweetwater Creek from the mouth to the Lewiston Orchards Irrigation District Diversion Dam (approximately 8 miles).

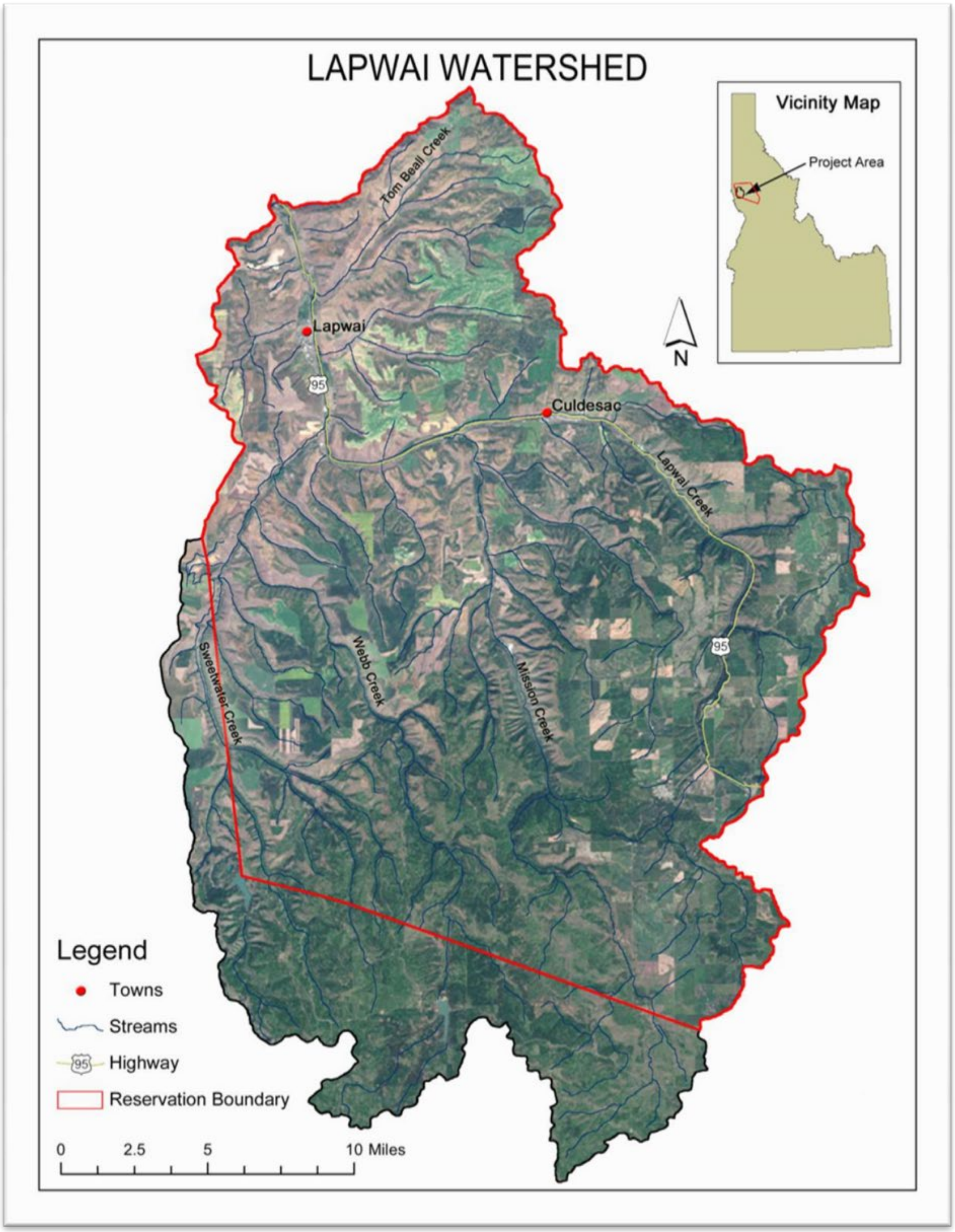

Figure 1. Lapwai Creek watershed

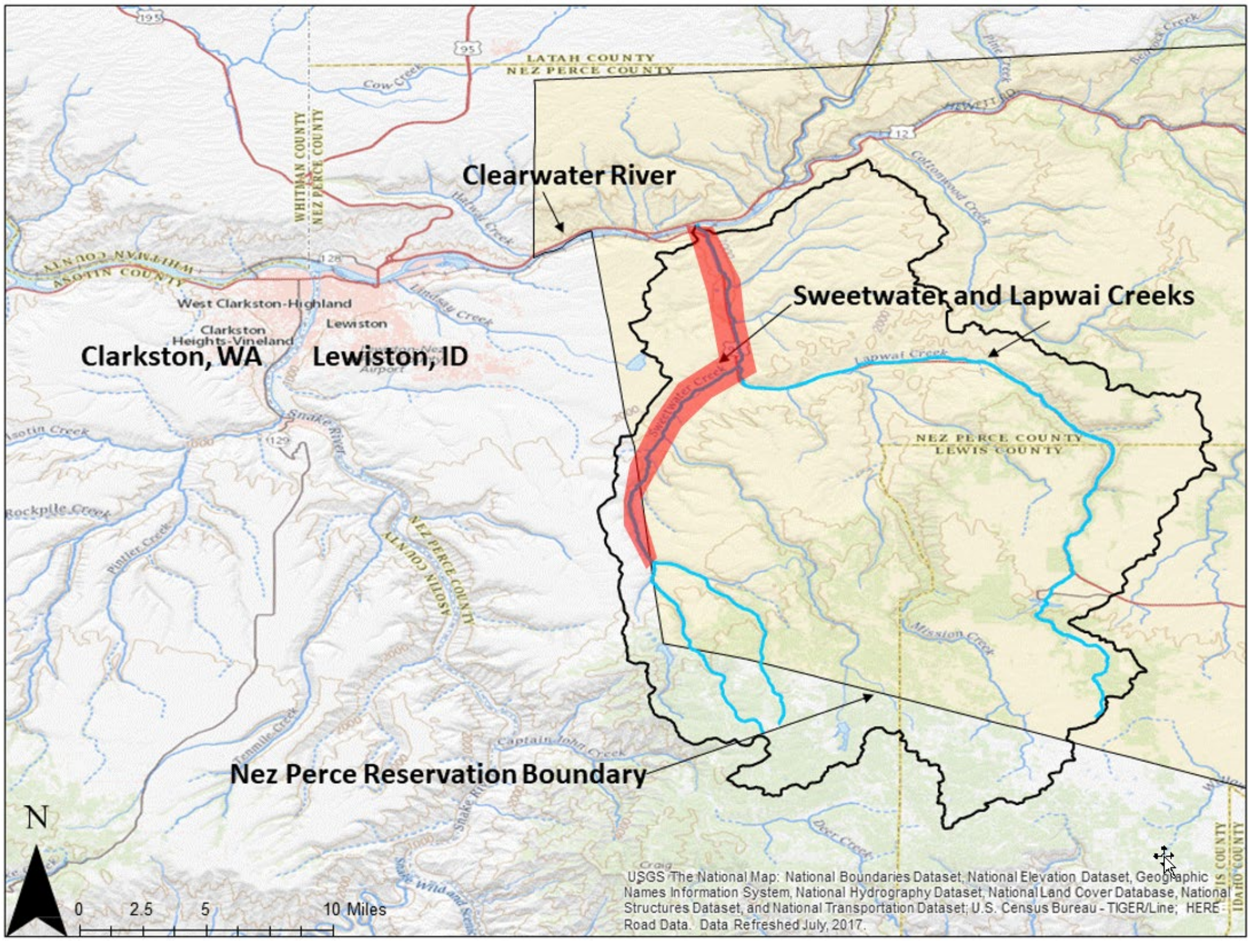

Figure 2. Watershed map showing the approximate study area (red polygon)

1.2 Historic and Present Habitat Characteristics

1.2.1 Forested Riparian and Wetlands

Prior to the settlement of the Lapwai Creek watershed, the floodplain riparian was characterized by seasonally inundated black cottonwood (*Populus trichocarpa*) gallery forest flanked by conifers up to approximately 972 feet wide on Lapwai Creek and 560 feet on Sweetwater Creek, based on recent aerial imagery. Reference cottonwood gallery forested wetlands include multiple canopy layers with a variety of willow (*Salix spp.*) and herbaceous species. Early settlement of the riparian area largely stripped the land of trees and shrubs in the Lapwai Creek watershed (Figure 3).

Figure 3. Early settlement on Lapwai Creek at Culdesac, Idaho, upstream of the confluence with Sweetwater Creek

Floodplain connectivity allowed for sediment and nutrient transport and deposition, shifting islands, forming point bars, and renewing genetic diversity among plant species. The forested floodplain would filter spring runoff and provide cool summer groundwater inputs and shade.

Presently, channel migration and floodplain function is possible in very few areas. The natural processes are largely nonfunctioning due to push-up berms and levees causing channel incision and the upstream Lewiston Orchards Irrigation Diversion (LOID) dam starving Sweetwater Creek of substrate movement and deposition.

Presently, the forested riparian area (floodplain) is limited to an average width of under 80 feet with some exceptions along Sweetwater Creek based on recent aerial imagery. There is little evidence of side channels and ephemeral pools on Sweetwater Creek and several areas of channel complexity on Lapwai Creek.

Specific factors adversely affecting natural ecosystem function within the project area include:

- Loss of habitat complexity due to floodplain manipulation, irrigation diversion, and push-up berms and levees.
- Loss or degradation of wetland and off-channel habitats due to stream incision and loss of floodplain connectivity.
- Irrigation diversions create fish passage barriers and alter sediment and substrate transport.
- Increased invasive plant species in the riparian has reduced habitat value and the diversity of culturally significant species.

1.2.2 Instream Habitat

Prior to anthropomorphic changes to the floodplain and hydrograph (see RDG 2015), channel complexity was likely high and dynamic with point bars, side channels, backwaters, and braided channels throughout the study area (Figure 3). Large woody debris provided by the riparian would contribute to pool formation and complex cover. Based on aerial imagery, fish spawning habitat would have been greater quality and quantity throughout the reach.

Presently, a narrow, vegetated riparian corridor with berms constricts the stream from accessing the floodplain and reduced large woody debris (LWD) recruitment. Consequently, there is little potential for natural processes to form pools and channel meanders. Additionally, the LOID diversion affects sediment transport, limiting spawning gravel recruitment. The riffle-run-pool structure of the stream is at risk of being non-functional with long stretches of uniform rifle or run habitat.

Sweetwater and Lapwai Creeks presently support spawning and rearing rainbow trout and steelhead, largely due to optimal thermal conditions around 60 degrees Fahrenheit (15 degrees Celsius). Chinook salmon (*O. tshawytscha*) have potential to spawn and rear in the system. Juvenile spring chinook have been observed in an area of Lapwai Creek between its mouth and Sweetwater Creek where springs provide summer refugia (WSU 2001). Coho salmon are also of interest to the Nez Perce and may spawn and rear in Sweetwater Creek.

Given a year-round optimal water temperature, quality and quantity of spawning and rearing are limiting factors and can be attributed to the following.

1) A lack of instream habitat complexity, both hydraulic (unbalanced riffle-run-pool sequence, homogenous depth and velocity, little off-channel habitat) and structural (boulders, large wood).
2) A lack of sediment transport and deposition.

Riffle-run-pool sequencing and coarse physical structure is needed to provide a wider variety of flow, depth, and depositional areas. Depth and velocity variation will provide for adult migrant resting and juvenile rearing habitat and will lead to differential deposition of spawning gravels, fines and organic matter that will promote a wide variety of aquatic biota.

1.3 Habitat Function and Value to Wildlife

A variety of wildlife relies on forested wetland habitats across the western United States. Water sources and humidity are required to produce lush vegetation and insects required for migratory and upland bird species brood rearing. For example, greater sage grouse require wetland habitats for brood rearing in later summer months. While sage grouse rely on the soft leaves of sage brush year-round, wetland areas provide lush forbs for adults, and insects for growing juveniles.

The importance of forested riparian and wetland ecosystems is evident in scientific literature.

- *Importance to the Landscape* (Sparks 1992; Krueper 1993; Malanson 1993; Naiman et al. 1993; Dynesius and Nilsson 1994; Ward et al. 1999; Lytle and Merritt 200):
- *Importance to bat species for food, water, and roosting* (Hayes and Adam 1996; Swystun et al. 2007): Insectivorous bats rely on appropriate environmental conditions to provide for insect food sources. The humidity and water sources associated with forested riparian and wetland areas is important for insect production. Bats also seek cavity roosting and nesting in forested riparian areas that provide protection from predators.
- *Importance to small mammals* (Anderson and Ohmart 1977; Pendleton 1984; Golightly Jr. 1997; Melquist 1997): Small mammals, largely mesocarnivores in urban settings, rely on the greenways that river corridors provide for food, shelter and migration. Studies have found as many as 11 rodent species that rely on wetland vegetation and would support mesocarnviores as a food source.
- *Importance to amphibians* (Hecnar and M'Closkey 1998; Houlahan and Findlay 2003): Species richness is positively correlated with wetland area, forest cover, and the amount of wetlands on adjacent lands and negatively correlated with road density and nitrogen levels. While water is necessary for amphibian reproduction, forested areas may provide non-breeding food sources and shelter.
- *Importance to insects* (Batzer and Wissinger 1996): Insect productivity is highest in forested wetland areas due to energy and nutrient transport and availability.
- *Importance to waterfowl for food and nesting* (Dugger and Fredrickson 1992; Boavida 1999): Wetlands provide essential nesting and foraging habitat for migratory waterfowl. Spring and summer insect forage for molting, nesting, and brood rearing are critical. Wood ducks spend their entire lifecycle in forested

wetlands, relying on mature hardwoods (e.g. cottonwood) to provide cavities for nesting.

- *Importance to upland and migratory song birds for food, nesting, brood rearing, and resting* (MacArthur 1964; Austin 1970; Carothers et al. 1974; Johnson et al. 1977; Stamp 1978; Sedgewick and Knopf 1986; Sedgewick and Knopf 1990; Croonquist and Brooks 1993; Krueper 1993; Freemark et al. 1995; Skagen et al. 1998; Saab 1999; Faulkner 2004): Many studies have evaluated various aspects of forested riparian use by migratory song birds in the southwest United States for foraging, migrating, nesting, and brood-rearing. The best predictors of high bird species richness were natural and heterogeneous landscapes, large cottonwood patches, close proximity to other cottonwood patches, and microhabitats with relatively open canopies.

Riparian ecosystems are among the rarest and most sensitive habitat types in the western United States, and are critical for up to 80% of terrestrial vertebrate species, and is especially important in the arid west (Krueper 1993).

In portions of southeastern Oregon and southeastern Wyoming, more than 75% of terrestrial wildlife species are dependent upon riparian areas for at least a portion of their life cycle (Chaney et al. 1990 *as cited in* Krueper 1993).

Riparian areas slow flood flows, filter out sediments, reduce erosion, buffer soil chemistry, enhance biodiversity, protect hydrologic systems from temperature extremes and evaporative loss, and slowly release retained water which extends quality and quantity of water for a variety of consumptive and non-consumptive uses (Carothers 1977, Hubbard 1977, Sands and Howe 1977, Chaney et al. 1990; *as cited in* Krueper 1993).

1.4 Importance and Processes of Riparian Cottonwood Forest

Riparian cottonwood forests represent the most extensive and ecologically important deciduous forest ecosystems in arid parts of the western United States (Lytle and Merritt 2004). Often, the cotton-willow forests support a more diverse understory assemblage than do other understories that contain a mix of perennials and annuals, and of exotic and native species (Campbell and Dick-Peddie 1964; Rucks 1984; Szaro 1989; Wolden 1993; *as cited in* Stromberg 1993).

Both mixed deciduous (e.g. Boise River corridor) and homogenous cottonwood stands support a variety of bird species and population densities, but homogenous cottonwood stands promote the highest among the two (MacArthur 1964; Austin 1970; Carothers et al. 1974). This has been shown in the southeast and southwest U.S. and can be reasonably assumed to correlate to the northwest U.S. as well.

Sedwick and Knopf (1986) suggest that a lack of cottonwood regeneration affects the abundance of cavity nesting birds in Colorado along the Platte River. The yellow-billed cuckoo is a riparian obligate; the range of the species in the west has been severely restricted to remaining isolated riparian forest fragments (Dettling and Howell 2011). Therefore, conservation of contiguous patches of cottonwood forest adjacent to palustrine wetlands is also desirable for many individual bird species and for maintenance of species richness (Saab 1999).

Cottonwoods are key components of river bottomland ecosystems, influencing floodplain processes such as nutrient cycling, light and water availability, rates of alluviation and river meandering, canopy structure, and habitat heterogeneity (Johnson 1992, 2000; Boggs and Weaver 1994; Busch and Smith 1995; Ellis et al. 1998; *as cited in* Lytle and Merritt 2004). Cottonwood and willow are pioneer species with features that allow for colonization of disturbed areas, such as copious seed production at a young age and seed adaptations for long-distance wind and water dispersal. These features allow cottonwood ecosystems to rebound rapidly from unnatural perturbations where appropriate hydrology persists (Stromberg 1993).

Cottonwood forest development is closely coupled with hydrologic and fluvial processes which shape fish habitat and are responsible for the creation of new sites for cottonwood seedling establishment and spawning gravel deposition, for providing hydrologic conditions necessary for seedling survival, and for the process of floodplain evolution that accompanies cottonwood stand development. Cottonwood seed viability may be as high as 99% in newly released seeds (Fenner et al. 1984; Cooper et al. 1999; Sher et al. 2000 *as cited in* Lytle and Merritt 2004), but drops off rapidly following dispersal and rarely persists for more than a few weeks (Lytle and Merritt 2004).

Flooding is the primary disturbance in cottonwood ecosystems and germination and establishment of tress coincides with flood events. Sediment is often deposited during the receding limb of the hydrograph, resulting in bare, moist sites that are optimal for cottonwood seed germination. If conditions are suitable in subsequent years, these moist mineral deposits may serve as sites for seedling establishment and sites of eventual stand formation (Lytle and Merritt 2004).

Therefore, as an ecosystem, establishment, growth, stand development, and the rebirth of cottonwood are linked to environmental stochasticity. Natural disturbance influences mortality and regeneration, thus encouraging species and genetic diversity.

2.0 FACSTREAM STREAM FUNCTIONAL CAPACITY MODEL

There are reaches within Sweetwater Creek with great restoration potential including floodplain connectivity. Habitat quality that may be realized from restoration would not only provide the proper physical features of stream and riparian habitat for a variety of fish and wildlife species, but could also greatly improve stream processes within and downstream of restored reaches. Evaluating stream functional capacity is important for projects that may impair or improve stream function. Therefore, the Functional Assessment of Colorado Streams (FACStream) model was selected to evaluate Project restoration benefits.

Based on the scarcity and importance to fish and wildlife of forested riparian and instream habitats within the western U.S., and the potential for this Project to benefit the entire ecosystem within a given reach, alternative or combination thereof, the FACStream model is an excellent fit.

Simpler models, such as the Habitat Evaluation Procedures suitability indices could provide relative estimates of existing and future with-project conditions. However, the importance of instream and riparian habitat is paramount to the myriad fish and wildlife species including ESA-listed species, as well as at the landscape level. Therefore, evaluating habitat functions and values holistically with a model like FACStream more appropriately assesses the existing and future conditions, and is applicable to the species discussed in Section 1. Model applicability to these species will be further discussed in Section 2.3.

2.1 Model Use Approval

It is desirable to use existing models approved for National use by the Cops Ecosystem Planning Community of Practice (Eco-PCX). However, new and Corps approved models that have been modified may be pending review and approval by the Corps Eco-PCX. One exception is for CAP projects. Models utilized for CAP projects may be approved at the Division level through the Agency Technical Review process as described in the Director of Civil Works' Policy Memorandum #1, dated 19 January, 2011.

The FACStream model has only been approved for single use on several other studies, most recently the Southern Platte Valley CAP 1135 in Denver, CO, 2018. While this Project is being executed on the General Investigation timeline, the Northwestern Division provided guidance that model approval would be obtained at the Division level, as appropriate for this CAP-level study.

A model use request for approval and justification memorandum was provided to Jeff Greenwald of Northwestern Division Environmental team, May 31, 2019. Use approval was received June 12, 2019 (Annex A).

2.2 Model Considerations

FACStream is a reach-scale functional assessment tool that rates functional condition according to the degree of impairment of ten ecological forcing factors (State Variables) that each describe a foundational driver of stream health. The scores for these variables are combined as a weighted average to give an overall reach condition score. The functional capacity index (FCI), an index of the degree of aquatic functioning of the reach on a percent scale, is calculated directly from the condition score.

Stream “functions” are processes that drive the physicochemical makeup of a stream and are objective in the sense that they are not tied to plant or animal species or community requirements, rather the opposite is true. Optimizing habitat for a singular species or habitat feature or function may result in diminished suitability for others. Therefore, FACStream is a value-neutral assessment of functioning, meaning it is designed to assess stream functioning, but not the value of the functions performed (Johnson et al. 2015); therefore, evaluating stream, riparian, and watershed-level components holistically.

FACStream incorporates all aspects of stream function to include riparian and floodplain integrity and connectivity, which encompasses habitat benefits to the myriad wildlife that utilize the Lapwai Creek watershed, and is, therefore, representative of habitat quality and function at the ecosystem level.

A FACStream assessment can incorporate data from any level of effort, be it a remote sensing survey or reconnaissance (EPA Level 1), routine field assessment (EPA Level 2), or intensive field assessment [(EPA Level 3) Johnson et al. 2015]. The reconnaissance level of effort would be used for the Project and is based on professional judgment using the best available information to include web-based tools, aerial imagery, gray- or peer-reviewed literature, and ground-truthed with a site visit. Reconnaissance-level analysis is perfectly applicable to ecosystem restoration as performed under Civil Works, particularly the Continuing Authorities Program and Tribal Partnership Program, primarily to achieve efficiency with an acceptable level of rigor.

Finally, FACStream produces a numerical index output between 0 and 1 that may be directly multiplied by habitat acres to create habitat units (HU). The resulting HUs would then be compared among alternatives to evaluate benefits in the form of lift from the existing condition, and would be compatible with a cost-effective/incremental cost analysis to determine the most efficient restoration alternatives.

Key model applicability points are as follows:

- The model is acceptable for use as-is, without adjustments to variable scoring.
- It is a weight-of-evidence approach suited for varied levels of qualitative and quantitative analysis and can be justified with professional judgment.
- It is a value-neutral ecosystem model assessing the function of riparian and aquatic variables applicable to all local fish and wildlife species.
- It is the formalization of an investigative process that seeks to uncover agents impairing the ability of a stream to function in a manner characteristic of its type.
- It provides scientific context to evaluator observations and site information.
- In FACStream, the quality of evidence, analytical uncertainties and data gaps are made explicit and transparent.
- It considers the severity and extent of stressors to gauge the departure of each State Variable from Reference Standard condition.
- It is a tool to aid mitigation planning, design and reporting, and increase the effectiveness of compensatory mitigation.
- It was developed to assess the function of streams in Colorado landforms similar to the Columbia Plateau.

2.2.1 Description of Input and Output Data

Input data are robust and somewhat complex, requiring educated professional judgment. Model population was based largely on site visit observations and data collected in June, 2019, supporting professional judgment.

The model breaks habitat into 10 functional State Variables with multiple sub-variables (Table 1).

Each State Variable is populated with a letter grade based on the scholastic scale score (Table 2). Letter grades were selected for the existing and future-with project conditions based on data collected and professional judgment of each variable’s functional integrity. Letter grades are rolled up to provide an overall index value for each of the 10 factors based on Equation 1.

The FACStream FCI may be directly multiplied by habitat acres to HUs. The resulting HUs are compatible with a cost effective/incremental cost analysis to identify the best array of alternatives.

Table 1. FACStream State Variables and brief descriptions evaluated against a reference reach

Variables*	Description
V-hyd: Flow Regime	
Total Stream Volume	Considers the total annual volume of water delivered to the reach from its contributing watershed.
Peak Flow	Considers the magnitude and duration of peak flows, or the "high end" of the hydrograph.
Base Flow	Considers the magnitude, and duration of base flows, or the "low end" of the hydrograph.
Flow Variability	Considers the temporal pattern of flows including the characteristic timing of peaks, base flows, and rate of change.
V-sed: Sediment Regime	
Land Erosion	Considers the amount of sediment produced in the watershed via land erosion including both surface erosion and mass erosion.
Channel Erosion	Considers the rate of sediment produced by channel erosion in the contributing watershed.
Sediment Transport	Considers the transport of sediment to and through the reach.
V-chem: Water Quality	
Temperature Regime	Considers temperature as a critical biotic habitat factor.
Organic Nutrient Inputs	Considers organic nutrient supply as foundational to trophic structure.
Inorganic Nutrients/Toxins	Encompasses all of the other physicochemical properties of a reach that are not accounted for in prior variables.
V-con: Floodplain Connectivity	
Saturation Frequency	Considers the access of water to the floodplain and riparian area from the stream channel(s).
Floodplain Width	Assesses the degree to which the lateral extent of the floodplain is decreased from stressors.
Saturation Duration	Considers the amount of time the floodplain is saturated during the vegetation growing season.
V-veg: Riparian Vegetation	
Woody Veg Structure	Considers the physical structure of the woody vegetation layers in the riparian area.
Herbaceous Veg Structure	Considers the physical structure of the herbaceous vegetation layers in the riparian area.
Species Diversity	Considers plant species diversity across all layers.
V-deb: Debris	
Large Woody Debris Supply	Considers the LWD supply to the reach.
Detritus Supply	Considers the detritus supply to the reach.
V-morph: Stream Morphology	
Stream Evolution	Considers gross impacts to stream morphology from stressors.
Stream Planform	Considers gross changes to stream branching, sinuosity patterns, etc.
Stream Dimension	Considers gross changes to stream cross-section, width/depth ratio, etc.
Stream Profile	Considers gross change to stream slope or gradient.
V-stab: Stability/Resilience	
Channel Dynamic Equilibrium	Considers stream deposition, scour and migration as measures of stability.

Table 1 Continued

Variables	Description
Channel Resilience	Considers stream response to disturbance as a measure of stability.
V-str: Physical Structure	
Hydraulic Structure	Considers changes to characteristic distribution of depth and velocity.
Coarse Features (flow, LWD, etc.)	Considers coarse physical structure including bed and bank form.
Fine Features (deposition of detritus, etc.)	Considers fine scale physical structure within the stream channel.
V-bio: Biotic Structure	
Stream Biotic Structure	Considers all taxonomic and trophic groups present.

*Watershed-scale hydrology variables are highlighted blue, reach-scale floodplain variables are highlighted green, and reach-scale physical stream characteristics are highlighted burgundy.

Table 2. Scholastic grade scale for assigning letter grades to model variables

Grade	FCI Score	Level of Impairment
A++	100	None (pristine)
A+	98	Negligible
A	95	
A-	92	
B+	88	Mild
B	85	
B-	82	
C+	78	Significant
C	75	
C-	72	
D+	68	Severe
D	65	
D-	62	
F+	58	Profound
F	55	
F-	52	

Equation 1: $$FCI = \left(\frac{condition\ score}{50}\right) - 1$$

2.2.2 Availability of Input Data

Given the large study area, Lapwai and Sweetwater Creeks were broken into 11 reaches, 4 on Lapwai Creek and 7 on Sweetwater Creek (Figure 4). A team of Corps and Nez Perce employees collected data across all initial reaches of Sweetwater and Lapwai Creeks for all categories except V-Hyd (flow) and V-Chem (water quality) as these data were available from existing sources.

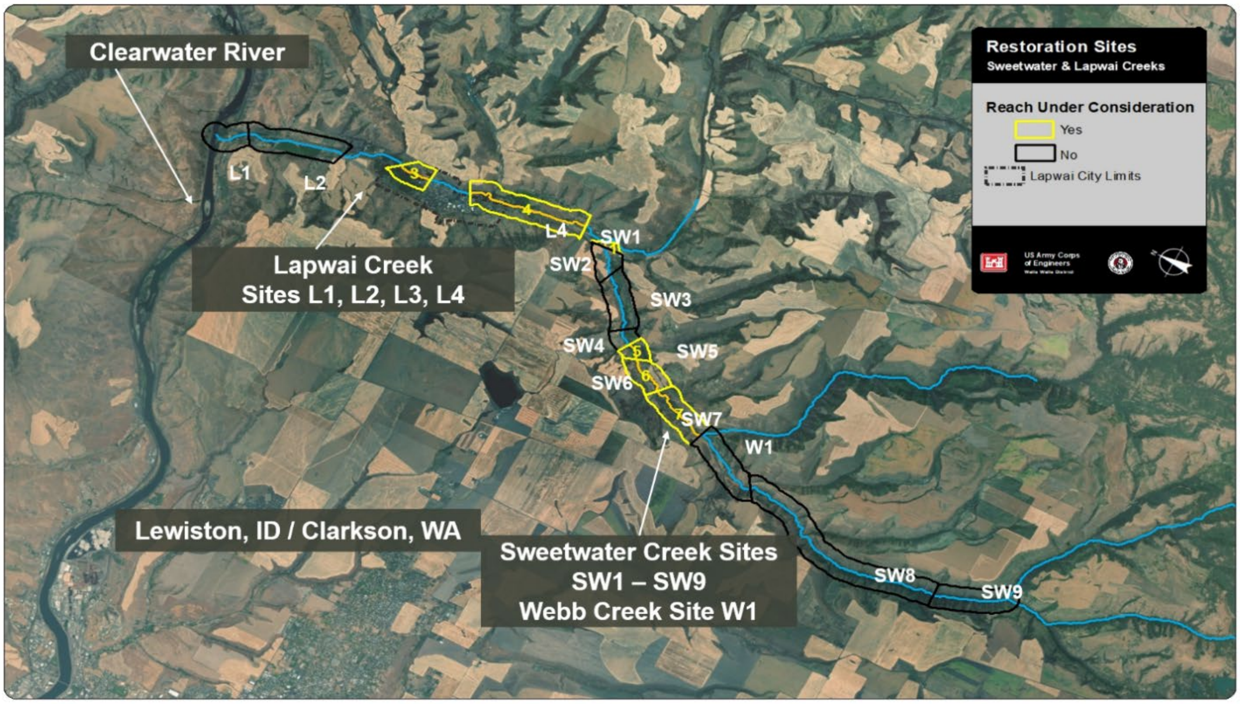

Figure 4. Reaches within the Lapwai Creek Watershed study area. Final study reaches include SW1, SW5, SW6 and SW7

Data collected by the Nez Perce Tribe, reports by the Bureau of Reclamation and professional judgment were used to inform these ratings. Three data points were collected within each reach (typically top, middle, and bottom of the reach, depending upon reach length) and the media letter grade for each sub-variable was used to create a single representative reach FCI value.

The FACStream model guidance (Johnson et al. 2015) explains how to score a site for each model sub-variable. This guidance was used in the field to ensure that all personnel understood the conditions for which each letter grade corresponds. Therefore, letter grade assignments for the existing condition models are expected to be representative of the actual conditions on the ground.

2.2.3 Model Limitations

The FACStream model poses no apparent limitations in relevance and ability to capture holistic present and future site conditions, but there are several clear limitations that affect the representation of project-level benefits and quality control.

1) The FACStream model overall sensitivity to minor changes in letter grade are lost among the myriad variables and calculation weighting. While changing the letter grade of subvariables within an overarching category (e.g. V-stab, V-str, etc.) can

change the overall category letter grade, minor changes in one or two categories (i.e. moving from a B to B+) do not necessarily change the overall model FCI. This is perfectly acceptable in the context of biological condition and relevance, but plays a more significant role in the cost effective/incremental cost analysis modeling to identify best-buy and cost-effective plans.

We did not find this to be problematic for this study due to the relatively large reaches and ability to magnify minor benefits across the area via HU calculations. However, this model may not be suitable for smaller projects where extensive earthwork or floodplain connection are not possible. In other words, a project must significantly improve several categories, or provide minor improvement across most categories for benefits to be measurable to a degree that will easily separate alternatives in the CE/ICA model.

2) Watershed-level hydrology variables are difficult to improve with a localized project. While a project may improve all other categories significantly, the project may never pencil out as the team envisions because the lower scores for the watershed-level variables may not allow the model FCI to reflect the significance identified in other categories. Therefore, the lead biologist may need to explain in greater detail each of the categorical and subvariable improvements to further justify significant benefits not apparent in the FCI value. Providing the model spreadsheets for Agency Technical Review (ATR) is critical.

3) The FACStream model is incredibly robust, which makes it a solid choice for ecosystem restoration projects. Conversely, such a robust model entails at minimum seven spreadsheets to capture assumptions and scores for a given alternative and time series. For this project there are over 100 spreadsheets including assumptions and calculations that ATR reviewers will need to review. This effort fits a General Investigation well, but may be too much for smaller CAP studies.

2.2.4 Model Assumptions

FACStream is based on the assumption that natural systems perform optimally until disturbed by humans. For this reason, we compare the model outcome to a reference reach to measure the departure or level of impairment.

At the individual variable level, assumptions may be based on professional judgment for the level 1 rapid assessment or based on data collection and analysis methods for the level 3 intensive assessment. For the purposes of Sweetwater Creek restoration, the team worked across the board regarding data collection and characterization of existing conditions. Future conditions were based solely on professional judgment and expertise in how the project may mature.

Any applicable assumptions for the hydrology variables (Flow Regime, Sediment Regime, Floodplain Connectivity) and geomorphology variables (Stream Morphology, Stability/Resilience). Model spreadsheets include assumptions for each subvariable as they are scored. General assumptions made by the biologist are provided below.

- *Hydrology Variables:* One assumption worth noting here is the LOID diversion is assumed to be removed by year 20 (or thereabout). Therefore, higher base flow and improved sediment transport are two standard improvements captured for these variables across all reaches and alternatives.
- *Water Quality Variables:* Ratings were based on input from the Tribe referencing data. It was assumed that data being referenced were accurate and future water quality improvements resulting from each alternative and time series are reasonable.
- *Floodplain Connectivity Variables:* Floodplain width/percentage intact was estimated using professional judgment on present land use, presence of push-up berms, and topography. Saturation frequency and duration were estimated using hydrology model data and professional judgment to interpret said data. It was assumed that educated professional judgment and scoring of variables was reasonable, as well as future conditions resulting from each alternative and time series.
- *Riparian Vegetation Variables:* Given the existing condition was observed in the field, future conditions were forecasted on professional judgment and review of scientific literature (Murray and Harrington 1983, Woods et al. 1996; Moore 2016). Riparian benefits were also based on the professional judgment of measures implemented and their magnitude per reach and alternative. The relative benefit captured in the FACStream model was based on the potential proportion of riparian benefit per alternative. The use of professional judgment for vegetation variable scoring is assumed to be appropriate for the level of effort and detail necessary for this study.
- *Debris Variables:* Similar to riparian variables, the magnitude of debris input benefits was based on professional judgment and experience with tree species maturity like black cottonwood. To remain simple and logical in assigning benefits, large wood transport and inputs coming in from outside reaches was not factored into this variable. It was assumed that professional judgment of debris contribution and associated benefits accurately informed the maturation and scores of these variables.
- *Stream Physical Structure Variables:* Changes to hydraulic, coarse and fine physical structure are directly estimable with known results. Estimation of proportional improvements throughout each reach from the various boulder, LWD, pools, side channels and backwaters informed professional judgment for

capturing the benefits in the model. It was assumed that the benefits forecasted are reasonable for these variables.

- *Biotic Structure Variable:* Biotic structure baseline score was based on data and professional judgment of the Tribe, the Corps biologist, and field macroinvertebrate data collection. While the full array of aquatic species present was not readily available, the presence of invasive fishes was assumed to be minimal based on observations by the Tribe. Additionally, the cold water in Sweetwater Creek would preclude most warmwater invasive species like largemouth bass from thriving in the creek. Therefore, the macroinvertebrate data was the driver for this variable. The Ephemeropter, Plecoptera, Tricoptera (EPT) taxa were present at every reach, but abundance was somewhat low, as was overall diversity. It was assumed that this variable would improve (based on increased species diversity and abundance) over time with additional debris inputs and variation in physical structure and sediment deposition, etc. This was assumed to be a reasonable and accurate approach to scoring this variable for this project.

2.3 Model Applicability to Sweetwater Creek Fish and Wildlife Species

The FACStream model applicability to evaluating fish and wildlife habitat value is presented below.

2.3.1 Fishes

Table 3 provides the specifics of how the model applies to salmonids, specifically. While a complete account of the fishes in Sweetwater Creek is not presented, it can be assumed that all other species native to Sweetwater Creek would benefit from this project as natural cohabitants of cold, headwater streams.

Table 3. FACStream State Variables and how they apply to salmonid habitat

Variables*	Application to Salmonid Habitat
V-hyd: Flow Regime	
Total Stream Volume	Migration, spawning and rearing.
Peak Flow	Migration, spawning and rearing.
Base Flow	Migration, spawning and rearing.
Flow Variability	Migration, spawning and rearing.
V-sed: Sediment Regime	
Land Erosion	Spawning and rearing substrates.
Channel Erosion	Spawning and rearing substrates.
Sediment Transport	Spawning and rearing substrates.
V-chem: Water Quality	
Temperature Regime	All salmonid life-history requirements.
Organic Nutrient Inputs	Food sources for rearing salmonids.
Inorganic Nutrients/Toxins	Food sources for rearing salmonids.

Table 3 Continued

Variables*	Application to Salmonid Habitat
V-con: Floodplain Connectivity	
Saturation Frequency	Organic energy inputs and off-channel rearing habitat availability.
Floodplain Width	Organic energy inputs and off-channel rearing habitat availability.
Saturation Duration	Length of time off-channel rearing habitat is available as fish outmigrate.
V-veg: Riparian Vegetation	
Woody Veg Structure	Riparian wildlife food and cover, detritus inputs, bank stability and cover.
V-veg: Riparian Vegetation	
Herbaceous Veg Structure	Riparian wildlife food and cover, detritus inputs, bank stability and cover.
Species Diversity	Riparian wildlife food and cover, detritus inputs, bank stability and cover, plants of cultural significance.
V-deb: Debris	
Large Woody Debris Supply	Food, rearing habitat, riffle-run-pool sequencing, resting.
Detritus Supply	Food sources for rearing salmonids.
V-morph: Stream Morphology	
Stream Evolution	
Stream Planform	Sinuosity, riffle-run-pool sequencing for migration, spawning, rearing, and resting.
Stream Dimension	W/D ratio, riffle-run-pool sequencing for migration, spawning, rearing, and resting.
Stream Profile	Riffle-run-pool sequencing for migration, spawning, rearing, and resting.
V-stab: Stability/Resilience	
Channel Dynamic Equilibrium	
Channel Resilience	
V-str: Physical Structure	
Hydraulic Structure	Migration (depth distribution and channel shape) and rearing
Coarse Features (flow, LWD, etc.)	Spawning, rearing, and resting for steelhead.
Fine Features (deposition of detritus, etc.)	Spawning, rearing, and resting for steelhead.
V-bio: Biotic Structure	
Stream Biotic Structure	Food sources for and predation on rearing salmonids.

* Watershed-scale hydrology variables are highlighted blue, reach-scale floodplain variables are highlighted green, and reach-scale physical stream characteristics are highlighted burgundy.

2.3.2 Insects

Variables V-hyd, V-sed, V-chem inform the difference between *Diptera* and EPT taxa presence, for example. Higher flows, colder water, the various depositional opportunities suggest that EPT taxa will remain dominant in Sweetwater Creek. Water temperature will remain cold and faster flow and cobbles will remain common features that preclude slower water species. With the assumed removal of the

V-con, V-veg, and V-deb variables inform the potential abundance of insects as these variables measure food source supply. Diversity is also captured here by V-con (floodplain connectivity). Floodplain connectivity leads to wetland presence and function. Midges (*Diptera spp.*) are the dominant insect in wetland environments.

Insect productivity is very high in forested wetland and riparian areas because aqueous nutrients from floodwaters and forest leaf litter enrich forested floodplains (*as cited in* Batzer and Wissinger 1996).

V-morph and V-str represent sinuosity, riffle-run-pool sequencing, and the types of structures and depositional opportunities present in the reach. A balanced riffle-run-pool sequence and greater diversity of the physical and hydraulic structure of a reach increases the potential for inspect species diversity via varied substrates, velocity, and depths.

2.3.3 Amphibians

Variables V-hyd, V-sed, V-chem include parameters like temperature, dissolved oxygen, and chemical contaminants, which are critical to amphibians. Amphibians are especially susceptible to contaminant uptake through their moist skin. Changes in dissolved oxygen and temperature can reduce reproduction success, food source availability, and overall organism survival.

V-con, V-veg, and V-deb are important for amphibians in forested riparian wetlands where shade moderates temperature and contributes a more humid environment. This affects the overall environmental suitability for amphibians. While water is necessary for amphibian reproduction, forested areas may provide non-breeding food sources and shelter (Houlahan and Findlay 2003).

The Idaho Department of Fish and Game (IDFG) has identified 8 native amphibian species within Nez Perce County. Woodhouse's toad (*Anaxyrus woodhousii*) and the Idaho giant salamander (*Dicamptodon aterrimus*) are listed as Species of Greatest Conservation Need (SGCN).

2.3.4 Bats

Variables V-hyd, V-sed and V-chem are critical for providing adequate food sources for bats. Appropriate riparian wetland hydrology provides water sources for drinking and greater insect productivity compared to drier habitats. Water-born midges (flies) tend to dominate wetland habitats (Batzer and Wissinger 1996) serving as a significant food source for bats.

V-con, V-veg, and V-deb are important for bat roosting. In semi-arid regions on the prairies of North America, tree cavities in riparian forests, particularly black cottonwood, often provide the primary source of natural roosts for cavity roosting bats (Swaytsun et al. 2007). Cavities provide protection from predators and inclement weather and has been argued that the availability of suitable roost sites is the most important limiting resource for bat populations (Humphrey 1975; Kunz 1982 *as cited in* Swystun et al. 2007).

The IDFG has identified 10 bat species that may occupy the study area. Townsend's big-eared bat (*Corynorhinus townsendii*) and the fringed Myotis bat (*Myotis thysanodes*) are listed as a SGCN.

2.3.5 Mammals

Variables V-hyd, V-sed and V-chem are important to small mammal use of riparian wetlands. Studies have trapped up to 11 small mammal species suggesting that mouse and shrew use of wetland habitats in South Dakota were stratified by soil moisture content and correlated positively or negatively with percent herbaceous cover (Pendleton 1984). This correlates directly with floodplain connectivity and saturation duration and frequency.

Use of wetlands for foraging is likely by mink, raccoon (*Procyon lotor*), and other small mammals in the rodent family as these species are feeding generalists that will seek crustaceans, insects, other small mammals, and vegetation, and utilize terrestrial habitats, whereas species like otters are piscivorous and utilize riverine habitats largely (Melquist 1997).

V-con, V-veg, and V-deb are critical to mustelids such as river otters (*Lontra canadensis*) and mink (*Vison vison*). Mink occupy a home range on average between 1.5 and 3.5 miles (2.2 – 5.5 kilometers) long, while river otters occupy home ranges from 5-92 miles (8 – 148 kilometers) in length in montane river corridor habitats. This is dependent on food abundance and habitat suitability, which relies on quality riparian habitats. Habitat connectivity is significantly important for small mammals (mesocarnivores) but may be less important for small rodents not requiring extensive home ranges.

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These variables are important to small mammal use of riparian wetlands. Studies have trapped up to 11 small mammal species suggesting that mouse and shrew use of wetland habitats in South Dakota were stratified by soil moisture content and correlated positively or negatively with percent herbaceous cover (Pendleton 1984). This correlates directly with floodplain connectivity and saturation duration and frequency.

Mouse, shrew, and vole species forage on a variety of vegetation types to include tree bark, herbaceous vegetation, and tree fruit or mast. Trees are important to mustelids as large woody debris can be used as cover and forage habitat (Melquist 1997). Mustelids may also seek shelter in tree cavities.

Coyotes may seek shelter in large, hollow logs of fallen black cottonwood. They are also food generalists that will seek vegetation, fruit, and mast when necessary, as well as small mammals. Vegetation that supports rodents would do well to support coyotes as well.

The red fox (*Vulpes vulpes*) may share a similar use of riparian wetland habitats, barring competition with coyote in the study area.

White-tailed deer (*Odocoileus virginianus*) and mule deer (*Odocoileus hemionus*) seek riparian and wetland habitats for shelter, water, browse and travel corridors. These habitats often offer summer refugia in the form of shade and cool bedding areas during summer. Thicker riparian habitat and wetlands may serve as preferred fawning areas. Diverse vegetation offers a variety of food sources and nutrition, serving an additional benefit during fawning periods.

The IDFG has identified 40 mammal species (excluding bats) that may occupy the study area. Merriam's shrew (*Sorex merriami*) and the fisher (*Pekania pennanti*) are listed as a SGCN.

2.3.6 Migratory and Upland Birds

Variables V-hyd, V-sed, V-chem

V-con, V-veg, and V-deb are critical to migratory bird species. Because riparian habitats in arid lands have unique features among forests (i.e., long, narrow shapes with large amounts of edge), adjacent landscape patterns might be particularly important to avian community structure (Saab 1999). Modeling results reported by Saab (1999) suggest that cottonwood stand area, proximity to other cottonwood stands, and natural adjacent landscape are among the main predictors of high species richness.

Migrating birds depend on suitable stopover sites, often riparian and other wetland habitats. Long-distance en-route migrants may base their selection of stopover sites on factors extrinsic to rather than intrinsic to the sites, including meteorological conditions, physiological condition, and landscape-level attributes of the available stopover sites such as patch size and shape, degree of isolation or contagion and connectivity, patch orientation, and interception probabilities (Hutto 1985a; Gutzwiller and Anderson 1992 *as cited in* Skagen et al. 1998). Patch size is a key feature of breeding habitat for western yellow-billed cuckoo populations, with larger, wider areas of habitat strongly preferred (Wiles and Kalasz 2017).

Finally, agriculture and residential development adjacent to natural habitat can encourage nest parasites (Saab 1999).

These variables also play a major role in migratory bird nesting, food and cover sources. Breeding bird populations are significantly higher among habitats with perennial compared to ephemeral water sources (MacArthur 1964). In the western U.S., insectivorous landbirds migrating in spring prefer riparian habitats for refueling (Johnson et al. 1977; Stevens et al. 1977; Emmerich & Vohs 1982; *as cited in* Skagen et al. 1998). Therefore, insectivorous migratory birds may experience greater food availability with intact water supply and hydrology.

Twedt and Portwood (1997) suggest that three-dimensional vegetation structure may be more important than specific plant species. Western clematis (*Clematis ligusticifolia*), shrub densities, willow density, and canopy are all indicators of quality habitat. Diversity of bird species has been correlated with diversity of foliage height in riparian habitats of the southwestern United States such as desert riparian, mesquite shrub, sycamore-cottonwood, and mixed deciduous habitats (Austin 1970, MacArthur 1964, Carothers et al. 1974).

Homogenous cottonwood plots with permanent water sources (e.g. streamside stands) have shown the greatest migratory bird species diversity and the greatest population densities of nesting birds relative to other habitat types (MacArthur 1964).

Yellow-billed cuckoo are riparian forest obligates, making forested riparian and wetland habitats critical to their persistence; however, there is some debate over their preferred vegetation structure. Buffington et al. (1997) suggest they prefer mid- and late-successional stands over early-successional, while Hughes (1999) directly and completely contradicts this, stating that yellow-billed cuckoo prefer early-successional stands. One point of consistency is that in the western U.S., yellow-billed cuckoo nesting is strongly associated with large [usually exceeding 98 ac (40 hectares) in size], wide [over 328 feet (100 meters)] patches of low to mid-elevation riparian habitat dominated by cottonwoods, willows, and a mix of other species (Wiles and Kalasz 2017).

The IDFG has identified 187 bird species to include 26 raptors and 7 upland bird species that may occupy the study area, 18 of which are identified as SGCN (Table 4).

Table 4. Bird Species of Greatest Conservation Need in Nez Perce County

Common Name	Latin Name
American Avocet	Recurvirostra americana
American Three-Toed Woodpecker	Picoides dorsalis
Bald Eagle	Haliaeetus leucocephalus
Black-crowned Night-Heron	Nycticorax nycticorax
Brewer's Sparrow	Spizella breweri
Ferruginous Hawk	Buteo regalis
Flammulated Owl	Psiloscops flammeolus
Grasshopper Sparrow	Ammodramus savannarum
Lesser Goldfinch	Spinus psaltria
Lewis's Woodpecker	Melanerpes lewis
Merlin	Falco columbarius
Mountain Quail	Oreortyx pictus
Peregrine Falcon	Falco peregrinus
Pygmy Nuthatch	Sitta pygmaea
Short-eared Owl	Asio flammeus
Swainson's Hawk	Buteo swainsoni
White-headed Woodpecker	Picoides albolarvatus
White-winged Crossbill	Loxia leucoptera

2.3.7 Waterfowl

V-hyd, V-con, V-veg, and V-deb are critical for waterfowl. Distance between resting and feeding areas and patch size and quality are important for migrants and can be captured by floodplain connectivity and saturation duration and frequency, as well as base flow. The surrounding landscape can affect the suitability of wetland habitats for nesting and brood rearing.

Distance between resting and feeding areas and patch size and quality are important for migrants. The surrounding landscape can affect the suitability of wetland habitats for nesting and brood rearing. Waterfowl (non-piscivorous) rely largely on vegetation over winter, but like upland and migratory birds, insect forage becomes an important diet component during spring and summer for molting, egg production, and brood rearing. Live forest and shallow, emergent wetland vegetation are important diet components for wood ducks (Dugger and Fredrickson 1992).

Wood ducks occur in the study area and provide the best representation of waterfowl relying on forested wetlands. They spend 100% of their lives within a forested wetland complex (Dugger and Fredrickson 1992), which can be comprised of various types of forest stands and associated water features. The proximity of wetland features to one another may be important for survival.

Vegetation structure and complexity are critical for wood duck nesting and roosting. Mature forests provide the largest proportion of trees with cavities suitable for nesting. A mix of tree, shrub, and herbaceous species is preferred. It is assumed that the Idaho native cottonwood gallery forest vegetation and species structure would be suitable for wood duck as they naturally occur in the area.

The IDFG has identified 93 waterfowl species that may occupy the study area, 21 of which are identified as SGCN (Table 5).

Table 5. Waterfowl SGCN within the study area

Common Name	Latin Name
American White Pelican	Pelecanus erythrorhynchos
Black Tern	Chlidonias niger
Black-necked Stilt	Himantopus mexicanus
California Gull	Larus californicus
Caspian Tern	Hydroprogne caspia
Cattle Egret	Bubulcus ibis
Clark's Grebe	Aechmophorus clarkii
Common Loon	Gavia immer
Forster's Tern	Sterna forsteri
Franklin's Gull	Leucophaeus pipixcan
Great Egret	Ardea alba
Harlequin Duck	Histrionicus histrionicus
Hooded Merganser	Lophodytes cucullatus
Lesser Scaup	Aythya affinis
Northern Pintail	Anas acuta
Red-necked Grebe	Podiceps grisegena
Sandhill Crane	Grus canadensis
Trumpeter Swan	Cygnus buccinator
Upland Sandpiper	Bartramia longicauda
Western Grebe	Aechmophorus occidentalis
White-faced Ibis	Plegadis chihi

3.0 ALTERNATIVES DEVELOPMENT

Given the large study area, Lapwai and Sweetwater Creeks were broken into 11 reaches, 4 on Lapwai Creek and 7 on Sweetwater Creek. Through the Planning process, we eliminated all reaches on Lapwai and Sweetwater reaches 2 and 4 due to constraints. Sweetwater reach 3 was eliminated due to a separate restoration effort occurring in that reach during the Feasibility Phase of this study.

Seven measures were carried forward as presented in Table 6. Detailed measure descriptions are available in Section 3.4.1.1 of the main report. Measures were combined into standalone "site plans" within each reach [Table 7 (See Appendix D for complete site plan descriptions)]. Overall, 17 alternatives were developed from standalone measures or measure combinations and evaluated individually with the FACStream model. Existing condition and alternative benefits assumptions are presented below.

Table 6. Measures carried forward for analysis

Measure ID	Measure Name	Measure Techniques
A	Riparian	• Riparian Preservation (exclusion fencing) • Riparian Planting (revegetation)
B	Channel Realignment	• Channel Alignment (site specific)
C	Channel Enhancement	• Construct/Enhance Lateral Pools • Construct backwater alcoves • Channel Grading • Connect to overbank side channels
D	In-stream structures	• In-Stream Structures (boulders and wood) • Bank attached (wood)
F	Floodplain	• Floodplain Enhancement • Floodplain Grading / Reconnection
G	Streambank Enhancement & Grading	• Bench Layback, bank grading for insert floodplain transitions • Streambank Grading
H	Levee / Berm Modifications	• Levee/Berm Setbacks and Notching • Berm flow routing

Table 7. "Site Plans" of standalone or combined measures in each reach.

				MEASURES						
				A	B	C	D	F	G	H
SITE	Site Plan ID	Measures	Excludes	Riparian	Channel Realignment	Channel Enhancement	In-Stream Structures	Floodplain	Banks	Levee & Berm
SW1 (RM 0.04 to 0.45)	SW 1.1	A, B, C, D, F, G, H	None	✓	✓	✓	✓	✓	✓	✓
	SW 1.2	A, C, D, F, G, H*	B	✓	✗	✓	✓	✓	✓	✓
	SW 1.3	A, C*, D, F, G, H	B	✓	✗	✓	✓	✓	✓	✓
	SW 1.4	A, D, G	B, C, F, H	✓	✗	✗	✓	✗	✓	✗
SW5 (RM 2.02 to 2.46)	SW 5.1	A, B, C, D, F, G	H	✓	✓	✓	✓	✓	✓	✗
	SW 5.2	A, C, D, F, G	B, H	✓	✗	✓	✓	✓	✓	✗
	SW 5.3	A, D, F, G	B, C, H	✓	✗	✗	✓	✓	✓	✗
	SW 5.4	A, C, D	B, F, H, G	✓	✗	✓	✓	✗	✗	✗
SW6 (RM 2.57 to RM 2.91)	SW 6.1	A, C, D, F, G, H	B	✓	✗	✓	✓	✓	✓	✓
	SW 6.2	A, C, D, F, G	B, H	✓	✗	✓	✓	✓	✓	✗
	SW 6.3	A, D, F	B, C, G, H	✓	✗	✗	✓	✓	✗	✗
	SW 6.4	A, C, D, F	B, G, H	✓	✗	✓	✓	✓	✗	✗
SW7 (RM 2.91 to RM 3.42)	SW 7.1	A, B, C, D, F, G	H	✓	✓	✓	✓	✓	✓	✗
	SW 7.2	A, B, C, D, F, G	H	✓	✓	✓	✓	✓	✓	✗
	SW 7.3	A, C, D, F, G	B, H	✓	✗	✓	✓	✓	✓	✗
	SW 7.4	A, C, D, F	B, G, H	✓	✗	✓	✓	✓	✗	✗
	SW 7.5	A, F	B, C, D, G, H	✓	✗	✗	✗	✓	✗	✗

3.1 Reach and Site Plan Assumptions

Below are assumptions of the existing condition of each reach and estimates of the improvements that may be realized by the implementation of the Site Plans as detailed in Table 7.

3.1.1 Reach 1

Existing Condition – Reach 1 is the smallest reach and lies at the bottom of Sweetwater Creek. Constraints include homes and the Highway 95 bridge at the downstream end. Floodplain connection presently occurs at flood stage, but circumvents the downstream-most house before spilling back in. The stream is deeply incised near the bridge, making floodplain connection on the river-right agriculture lands difficult. The riparian corridor is thick, but narrow (Figure 5).

Figure 5. Representative photo of Reach 1 looking upstream at a location upstream of the home and highway bridge

Site Plan 1.1 – This site plan includes the addition of large wood on the outer bends, boulders, bank shaping, floodplain connectivity and development of 2.38 ac (the most of any alternative in any reach), bank grading, flow-steering berms, and channel realignment for the downstream portion of the reach. The addition of wood and boulders would break uniform velocity patterns and create depositional areas, eddies, and lateral pools over time. This Site Plan will greatly increase habitat diversity, spawning, rearing, and migration for salmon and steelhead, and terrestrial wildlife food, shelter, and migration corridors. Results would increase aquatic habitat suitability approximately 90 percent and riparian suitability 75 percent.

Site Plan 1.2 – This alternative includes much of Site Plan 1.1 with less floodplain connectivity, developing 1.85 ac of inset floodplain. Other connectivity would occur from push-up berm notching and overbank flow management. Bank work and placement of log jams would include a large riparian planting effort. Overall physical structure is complex with lateral pools and potential for backwaters and eddies with boulder placement. Benefits are expected to track closely to Site Plan 1.1. Results would increase aquatic habitat suitability approximately 85 percent and riparian suitability 65 percent.

Site Plan 1.3 – The addition of a few lateral pools, log jams and boulder area will marginally improve habitat complexity. Bank reshaping will improve riparian conditions approximately 25 percent with planting. This Site Plan includes no floodplain development and limited to no connectivity and would likely improve aquatic habitat suitability by 40 percent. Many of the model variable scores will reflect the FWOP condition.

Site Plan 1.4 – This is a minimal project placing boulders. Minimal rearing improvement, but boulders would improve deposition, depth and flow variety, providing a potential 30 percent aquatic habitat benefit. No additional floodplain connectivity or enhancement and assuming no meaningful riparian restoration. Many of the model variable scores will reflect the FWOP condition.

3.1.2 Reach 5

Existing Condition – Reach 5 presents prime opportunity for floodplain connectivity and riparian restoration. The downstream end of the reach experiences side channel and floodplain activity at flood stage and could be enhanced to provide regular activation. Additionally, there is greater potential for riparian restoration and enhancement. The present corridor is narrow with agriculture influence. The stream channel is in similar condition to other reaches with incised banks and homogenous features (Figure 6).

Figure 6. Representative photo of Reach 5

Site Plan 5.1 – This Site Plan includes a complete channel realignment creating sinuosity, the development of backwaters and lateral pools, development of 1.8 ac of floodplain with regularly connected spring rearing habitat and nutrient inputs, boulder placement and log jams, and full riparian restoration from the channel realignment work. This alternative would create complex spawning, migrating and rearing habitat for salmon and steelhead. This Site Plan will greatly increase habitat diversity, spawning, rearing, and migration for salmon and steelhead, and terrestrial wildlife food, shelter, and migration corridors. Results would increase aquatic habitat suitability approximately 95 percent and riparian suitability 80 percent.

Site Plan 5.2 – Similar to 5.1 without complete channel realignment and riparian restoration, slightly less than that of Site Plan 5.1 estimated. Floodplain development and connectivity totaling 1.17 ac, side channels, backwaters, boulders and log jams are included. Results would increase aquatic habitat suitability approximately 70 percent and riparian suitability 60 percent.

Site Plan 5.3 – Reconnects side channels and backwaters and places boulders for varied flow conditions and depositional areas. Inset floodplain would provide connectivity approximately 20 percent. Assumed floodplain connectivity return interval is less than 5 years for the connected areas. Assumed 30 percent improvement in riparian and 40 percent aquatic habitat suitability.

Site Plan 5.4 – Similar to Site Plan 5.3 but reconnects side channels which are more beneficial to rearing than just backwaters and lateral pools. Boulder placement. Assumed 30 percent improvement in aquatic habitat suitability and 25 percent riparian habitat suitability where backwaters are created.

3.1.3 Reach 6

Figure 7. Representative photo of Reach 6 looking downstream at the freshly cleared power line right-of-way

Existing Condition – Reach 6 is another short reach constrained by bridges, private land and a power line right-of-way. The riparian area is in better condition on the upstream end than downstream where it is very narrow and groomed by the power company (Figure 7). Restoration concepts were developed and evaluated for Reach 6 but were not carried forward for evaluation due to an elevated risk of flooding.

Site Plan 6.1 – Bank grading with significant re-sloping and riparian restoration increasing riparian width up to 200 percent that will allow full tree, shrub and herbaceous restoration. Log jams along re-sloped banks would provide fish rearing and macroinvertebrate food source benefits. A few lateral pools and backwaters would be formed to encourage depositional areas. Boulder placement would provide eddies and areas of deposition for rearing and spawning gravel, as would lateral pools. Floodplain work would add approximately 1.83

ac of regularly connected rearing habitat and nutrient inputs in spring. Results would increase aquatic habitat suitability approximately 90 percent and riparian suitability 75 percent.

Site Plan 6.2 – Very similar to Site Plan 6.1 with less bank work and no floodplain connection. The same lateral pools and backwaters would be created. There would be about 0.5 ac of floodplain enhancement and bank work that would require riparian restoration improving. This alternative will score similar to Site Plan 6.1. Results would increase aquatic habitat suitability approximately 75 percent and riparian suitability 50 percent.

Site Plan 6.3 – This is a minimal project placing boulders and activating one backwater. Minimal rearing improvement, but boulders would improve deposition, depth and flow variety. No additional floodplain connectivity or enhancement. Assuming no meaningful riparian restoration. Assumed 25 percent improvement in riparian and 30 percent aquatic habitat suitability. Many of the model variable scores will reflect the FWOP condition.

Site Plan 6.4 –Similar to Site Plan 6.2 with the lateral pools, alcoves, boulder placement. The lateral pools and alcoves provide rearing and resting benefit, while boulders would improve deposition, depth and flow diversity. No additional floodplain connectivity or enhancement. Many of the model variable scores will reflect the FWOP condition. This Site Plan would score lower than Site Plan 6.2 but higher than Site Plan 6.3 due to the salmon and steelhead rearing and resting benefits. Assumed 40 percent aquatic habitat suitability improvement.

3.1.4 Reach 7

Existing Condition – Similar to Reach 5, there is much greater floodplain and side channel activation opportunity in this reach. A large alfalfa field on river left provides opportunity for floodplain connectivity and expanded riparian restoration. The present riparian area is better than the other sites, but instream habitat is similarly homogenous (Figure 8). Some constraints relative to residences and the downstream bridge are present but are manageable relative to floodplain connectivity and potential channel realignment. The riparian area in the upper end of Reach 7 is of reasonable quality, which is one of the reasons extreme upper reach 7 was used as the reference reach for FACStream modeling (Figure 9).

Site Plan 7.1 – This Site Plan provides maximum benefit with extensive channel realignment, the development 1.48 ac of floodplain, log jams, boulders, and extensive bank work for the channel realignment which would require complete riparian restoration, essentially doubling the riparian area and increasing its benefit and function. Lateral pools would be formed with log jams and eddies and pockets formed with boulders. Floodplain development, overland flow and side channels would provide significantly improved connectivity, bringing the return interval down to approximately 1.5 to 2 years with saturation duration of more than 14 days per year as an assumption. Results would increase aquatic habitat suitability approximately 90 percent and riparian suitability 70 percent.

Figure 8. Representative photo of reach 7 restoration area

Figure 9. Representative photo of reach 7 reference condition

Site Plan 7.2 – This Site Plan is similar to Site Plan 7.1 with less riparian restoration. Inset floodplain benches and some bank shaping and realignment at a sharp bend in the river would provide significant riparian improvement. Floodplain development of 1.74 ac would include a 1 ac continual area suitable for rearing salmonids. Lateral pools with LWD, boulder placement and floodplain conveyance would be similar to Site Plan 7.1. This Site Plan would track Site Plan 7.1 closely in score, lower on vegetation and debris variables. Results would increase aquatic habitat suitability approximately 85 percent and riparian suitability 75 percent.

Site Plan 7.3 – This alternative contains a couple lateral pools with log jams, 0.25 ac floodplain connectivity, a couple outer bend banks being shaped, lateral pools and overland flow areas on the floodplain similar to Site Plan 7.2, but far less floodplain development and connectivity. Floodplain connectivity variables will improve only slightly while morphology, stability, veg, debris and physical structure are assumed to follow Site Plan 7.2 closely. Results would increase aquatic habitat suitability approximately 70 percent and riparian suitability 50 percent.

Site Plan 7.4 – This is a very minimal Site Plan similar to the others of this rigor with a couple lateral pools, some boulders, and areas of floodplain enhancement that are assumed to provide marginal benefit. This Site Plan will slightly improve physical structure, connectivity, and vegetation variables. Assumed 25 percent improvement in riparian and 30 percent aquatic habitat suitability. Many of the model variable scores will reflect the FWOP condition.

Site Plan 7.5 – Minor floodplain enhancement will slightly improve the connectivity and vegetation variables consistent with Site Plan 7.4. No direct aquatic habitat improvement would occur. Assumed 20 percent improvement in riparian and 20 percent aquatic habitat suitability. Many of the model variable scores will reflect the FWOP condition.

4.0 ANALYSIS AND RESULTS

4.1 FACStream Scoring and Alternatives Analysis

To be clear on assumptions for each model variable and to remain transparent and consistent with the assumed benefits or condition for each site plan, a time-series workbook was set up for each reach site plan. Assumptions and letter grades were documented for each subvariable at maturation years 0, 5, 10, 20 and 50 and based on assumptions of the benefits each site plan would provide relative to the existing condition.

Existing condition and site plan benefits assumptions are presented below for each reach.

As discussed in Section 2.2, letter grades were assigned for each subvariable across site plans and maturation time steps. The FACStream model then provided the subvariable score roll-up (Figure 10) to include the overall FCI value for each site plan. The overall FCI was then multiplied by the maximum Project area within each reach to estimate Habitat Units (HU).

HUs for each site plan and maturation time step were calculated into Average Annual Habitat Units (AAHU) which inform the benefit of a given site plan or alternative relative to the existing and future without-project conditions for Cost-Effectiveness/Incremental Cost Analysis (CE/ICA) modeling.

Sweewater Creek, Sweetwater, Idaho.	River/Stream	Date	6/20/2019
Sweetwater 1	Site/Reach ID	Evaluators	Trumbo, Price, Dobler, & Miller (USACE); House, Hoover, Yearout (NPT)
Sweetwater TPP	Project ID		
	Reach length (feet)	Affiliation	Biologists, hydrologists, geomorp

C	V_{hyd}	B	$V_{hyd}1$: Total Volume
H	Confidence	C-	$V_{hyd}2$: Peak Flows
		C-	$V_{hyd}3$: Base Flows
		B+	$V_{hyd}4$: Flow Variability
C-	V_{sed}	B	$V_{sed}1$: Land Erosion
H	Confidence	D	$V_{hyd}2$: Channel Erosion
		C	$V_{hyd}3$: Transport
B+	V_{chem}	A++	$V_{chem}1$: Temperature Regime
H	Confidence	B	$V_{chem}2$: Organics/Nutrients
		B	$V_{chem}3$: Inorganics/Toxins
D-	V_{con}	C+	$V_{con}1$: Saturation Frequency
H	Confidence	C-	$V_{con}2$: Floodplain Width
		F	$V_{con}3$: Saturation Duration
F	V_{veg}	F	$V_{veg}1$: Woody Veg. Structure
H	Confidence	F	$V_{veg}2$: Herbaceous Veg. Str.
		D	$V_{veg}3$: Species Diversity
C-	V_{deb}	D+	$V_{deb}1$: LWD
H	Confidence	C	$V_{deb}2$: Detritus
C-	V_{morph}	D+	$V_{morph}1$: Stream Evolution
H	Confidence	B-	$V_{morph}2$: Planform
		D+	$V_{morph}3$: Dimension
		C+	$V_{morph}4$: Profile
C-	V_{stab}	D+	$V_{stab}1$: Dynamic Eq.
H	Confidence	C	$V_{stab}2$: Resilience
C	V_{str}	C-	$V_{str}1$: Hydraulic Structure
H	Confidence	C+	$V_{str}2$: Coarse Scale
		C	$V_{str}3$: Fine Scale
B	V_{bio}	B	$V_{bio}1$: Biotic Structure
H	Confidence		
C	Reach Condition Score		

Process Domain

Physographic Region	Wyo Basin
Hydrologic Region	NW
Ecoregion	SL
Strahler Order	4
Valley Confinement	UC
Valley Slope	L
Riparian Reference	Scrub-Shrub

Morphology

Stream Type	Rosgen	SEM
Existing	C	5
Reference	C	1

Biology Functions FCI	0.50
Physicochemical Functions FCI	0.54
Geomorphology Functions FCI	0.38
Hydraulic Functions FCI	0.40
Overall FCI	0.46

Figure 10. Example FACStream model roll-up. Habitat Units were calculated by multiplying the overall FCI by the maximum alternative footprint in each reach

4.2 FACStream Results

The 17 unique site plans yielded 93 FACStream model runs to include existing and future without-project (FWOP) conditions for each reach and 5 maturation time steps (years 0, 5, 10, 20, 50) for each site plan. Annex B provides scoring and assumptions across reaches and time series and Annex C provides the FACStream model roll-up score sheets. All Annexes are available electronically by request. Net AAHUs for standalone site plans ranged from 0 for FWOP (all reaches) to 4.21 for reach 7, alternative 7.1 (Table 8).

Given the limiting factors of spawning and rearing habitat, and a lack of hydraulic and coarse physical habitat complexity, the alternatives with the greatest benefits included floodplain connectivity, side channel and backwater development and activation, and large wood and boulder placement (.1 and .2 Site Plans among reaches; Table 8). Additionally, off-channel rearing benefits realized from side channel and backwater activation drove the benefits in the less rigorous alternatives (.3, .4 and .5 among reaches; Table 8).

Table 8. AAHU calculations for each standalone measure and alternative across the time series modeled

		Year 0		Year 5		Year 10		Year 20		Year 50			
Reach/Alternative	**Area (ac)**	**FCI**	**Gross AAHU**	**FCI**	**Gross AAHU**	**FCI**	**Gross AAHU**	**FCI**	**Gross AAHU**	**FCI**	**Gross AAHU**	**Total Gross AAHU**	**Net AAHU**
1 Existing/FWOP**	9.88	0.46	0	0.46	0.45	0.46	0.45	0.46	0.91	0.46	2.73	4.54	0
1.1	9.88	0.60	0	0.66	0.62	0.72	0.68	0.82	1.52	0.82	4.86	7.69	3.14
1.2	9.88	0.58	0	0.64	0.60	0.72	0.67	0.80	1.50	0.80	4.74	7.52	2.97
1.3	9.88	0.48	0	0.50	0.48	0.52	0.50	0.60	1.11	0.60	3.56	5.65	1.11
1.4	9.88	0.46	0	0.46	0.45	0.46	0.45	0.50	0.95	0.50	2.96	4.82	0.28
5 Existing/FWOP**	10.67	0.42	0	0.42	0.45	0.42	0.45	0.42	0.90	0.42	2.69	4.48	0
5.1	10.67	0.56	0	0.66	0.65	0.74	0.75	0.82	1.66	0.82	5.25	8.31	3.83
5.2	10.67	0.52	0	0.60	0.60	0.66	0.67	0.74	1.49	0.74	4.74	7.50	3.02
5.3	10.67	0.50	0	0.54	0.55	0.56	0.59	0.62	1.26	0.64	4.03	6.43	1.95
5.4	10.67	0.50	0	0.54	0.55	0.56	0.59	0.64	1.28	0.64	4.10	6.52	2.04
7 Existing/FWOP**	14.23	0.50	0	0.50	0.71	0.50	0.71	0.50	1.42	0.50	4.27	7.12	0
7.1	14.23	0.58	0	0.68	0.90	0.74	1.01	0.84	2.25	0.84	7.17	11.33	4.21
7.2	14.23	0.58	0	0.66	0.88	0.68	0.95	0.76	2.05	0.76	6.49	10.37	3.26
7.3	14.23	0.54	0	0.62	0.83	0.64	0.90	0.72	1.94	0.70	6.06	9.73	2.62
7.4	14.23	0.52	0	0.54	0.75	0.54	0.77	0.60	1.62	0.60	5.12	8.27	1.15
7.5	14.23	0.52	0	0.52	0.74	0.52	0.74	0.58	1.57	0.58	4.95	8.00	0.88

*Reference reach FCI increases by year 50 due to the assumptions that additional base flow will be realized from removal of the LOID, and no negative change in the present land use or riparian condition will occur.
**The future without project (FWOP) does not show a change in FCI or AAHU from existing.

4.3 Economic Analysis and Plan Selection

Because we developed seven combinable measures within and among four river reaches, IWR-Plan software was unable to converge a finite number of alternatives on its own. Additionally, the PDT carried a wealth of restoration experience and knowledge, which was used to develop the array of our site plans to address the limiting factors for salmon and steelhead.

The IWR-Plan Watershed Tool was developed to analyze plans within and among different areas relative to net AAHUs. For simplicity, we developed our site plans to be additive among reaches. Therefore, the AAHUs among site plans were easily combined into alternatives. Note that Reach 6 plans were carried forward to economics analysis before flood risk concerns became clear. This reach was subsequently removed from further consideration.

The CE/ICA model identified 7 Best Buy Alternatives (Table 9). The minor Site Plan 5.4 (Alternative 2 in Table 9), as well as No Action, provided standalone Best Buy Alternatives. Alternative 5.4 includes backwaters and side channel activation for juvenile salmonid off-channel rearing, providing a high benefit per unit cost. The same can be said of the next Best Buy Alternative 5.4-7.3 that would offer the same measures and benefits but in two reaches.

While the smaller alternatives do provide minor benefits, the PDT (including the Sponsor) wanted to seize the unique opportunity to provide high quality restoration on Sweetwater Creek, capitalizing on its already optimal water temperature for salmonids. Therefore, the team looked to select a plan inclusive of more aggressive measures in reaches 5 and 7 to capitalize on floodplain connectivity potential.

Based on FACStream and CE/ICA modeling results, the team identified Alternative 1.2-5.1-7.1 as the NER Plan and Recommended Plan (shown as Alternative 7 in Table 9), providing 11.01 AAHU greater than the No Action Alternative and existing condition. This Alternative incorporates restoration measures resulting optimal instream and riparian conditions in reaches 5 and 7, and near optimal conditions in reach 1, supporting the myriad wildlife and ESA-listed salmonids occupying the Sweetwater Creek ecosystem. Completing work in these three Reaches reduces the amount and distance of less suitable habitat fishes will have to migrate through to reach headwater spawning grounds, and also provides suitable spawning grounds lower in the stream system.

Alternative 7 captures all measures and has the highest amount of riparian and floodplain habitat compared to all other alternatives besides Alternative 8. This is deemed worth the incremental cost per output of $89,700 at an incremental output increase of 0.9 net AAHUs due to the stated protection and restoration of riparian habitat along spawning and rearing streams as an identified objective in salmon recovery (2007, Salmon Recovery Board).

Activating the floodplain at the upstream end of reach 1 with Site Plan 1.1 (Alternative 1.1-5.1-7.1, shown as 8 in Table 9) would have provided optimal conditions in all three reaches, but buying up to include Site Plan 1.1 provided only a minor benefit (additional 0.17 AAHU) over the Recommended Plan.

Table 9. "Best Buy" Alternatives and Associated Costs and HU Benefits Identified by Cost Effectiveness/Incremental Cost Analysis

Alternative	Site Plans	Output (Net AAHUs)	AAC ($1,000)	Total Project Cost ($1,000)	Average Cost ($1,000/AAHU)	Incremental Cost ($1,000)	Incremental Output (AAHUs)	Incremental Cost/ Incremental Output ($1,000/AAHU)
1	No Action	0.00	$0.0	$0.0	$0.00	$0.00	0.0	$0.00
2	5.4	2.04	$34.7	$908.7	$17.0	$34.7	2.04	$17.0
3	5.4, 7.3	4.66	$125.1	$3,311.7	$26.8	$90.4	2.6	$34.5
4	5.4, 7.2	5.30	$150.3	$3,954.0	$28.4	$25.2	0.6	$39.4
5	1.2, 5.4, 7.2	8.27	$268.8	$7,167.4	$32.5	$118.5	3.0	$39.9
6	1.2, 5.1, 7.2	10.06	$368.5	$9,893.3	$36.6	$99.7	1.8	$55.7
7	1.2, 5.1, 7.1	11.01	$453.7	$12,300.1	$41.2	$85.2	0.9	$89.7
8	1.1, 5.1, 7.1	11.18	$530.6	$14,468.6	$47.5	$76.9	0.2	$452.4

*FY23 OCT 2022 Price Level and 2.5 Percent Federal Discount Rate

Figure 11 provides a comparison of the incremental AAHU costs among Alternatives. Extensive earthwork for bank reshaping and floodplain development posed a significant cost driver among alternatives.

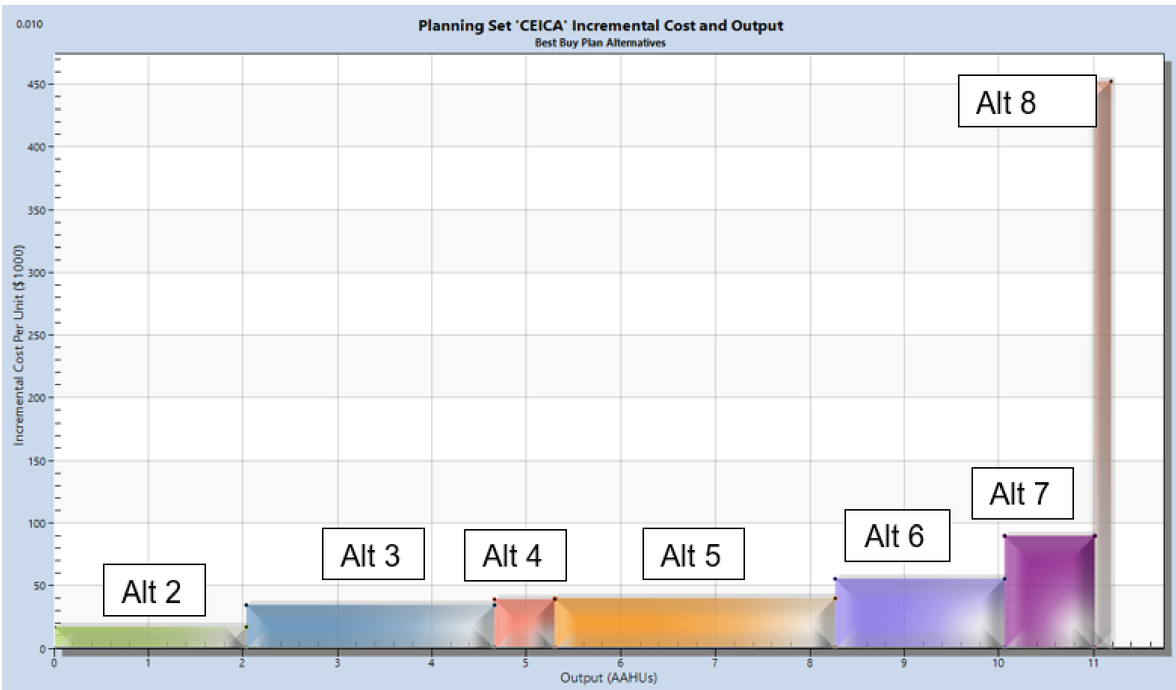

Figure 11. Cost Effectiveness/Incremental Cost Analysis Results Showing the Seven "Best Buy" Alternatives

5.0 RECOMMENDED PLAN

The Recommended Plan includes Site Plans 1.2, 5.1 and 7.1. These plans include boulder placement, log jams, bank reshaping and riparian restoration, floodplain development and reactivation, side channel development and reactivation, backwaters, lateral pools, and restoring sinuosity to reaches 5 and 7. These features will significantly transform the habitat within Sweetwater Creek.

Below are the future without-project condition assumptions, followed by the benefits assumed to be captured in the with-project condition from measures that would be implemented with the Recommended Plan.

5.1 Without-Project Condition Assumptions

The future without-project condition (FWOP), also known as the “No Action Plan,” is the most likely condition expected to occur in the future in the absence of the proposed action or action plans. In this case, the No Action Plan means that no ecosystem restoration activities would be undertaken in the future, beyond those already being implemented or those that have been authorized through other means.

Looking at a 50-year horizon, the overall future without-project condition of the Sweetwater Creek watershed is expected to decline marginally from the existing condition. Land use practices to include livestock grazing and crop production along the creek corridor is expected to continue in relatively stable intensity. Flood risk management or response action including push-up berms are expected to continue and may further degrade floodplain condition and connectivity with the creek. Climate change may worsen system flashiness. More frequent high flow coupled with flood risk management efforts would contribute to further channel incision and sediment and bedload transport out of the reach as depositional areas are few under the existing condition.

Based on professional judgement, the following are assumptions of how each group of FACStream model variables would respond to conditions over time.

- *Hydrology:* Hydrology variables of the watershed are expected to remain similar to the existing condition. The total volume and base flow would improve once the LOID diversion is removed, but peak flow and flow variability may continue to depart from normal patterns as the stream continues to incise.

- *Sediment Transport*: Sediment transport would improve with the removal of the LOID diversion, but deposition and other erosion issues would continue to decline with continued land use practices. The potential more frequent flood events increase with climate change and warming atmospheric temperature and would carry an associated increase in streamside berms and other channel modification to mitigate risk.

- *Water Quality (Temperature, Nutrients, and Toxins)*: Water quality is expected to remain good to marginal with the cold water inputs to Sweetwater Creek. Organic and inorganic material is also expected to remain relatively stable as land ownership and use practices are expected to be representative of the present condition.

- *Floodplain Function*: Floodplain activation and function will likely continue to decline over time as Sweetwater Creek will likely continue to incise where possible with more frequent flooding and bank and channel modifications to mitigate the risk.

- *Riparian Vegetation Structure and Diversity:* The composition of the riparian community would remain similar to existing conditions. Little to no cottonwood regeneration was seen during site visits. As mature trees die, they likely would not be replaced with native vegetation. There are few areas with suitable shrub understory to fill gaps. The risk of invasive species and monoculture takeover would increase.

- *Debris Accumulation:* Detritus and LWD accumulation is expected to remain similar to existing conditions. If a number of trees died or dropped limbs during a stochastic event, short-term accumulation increases are possible. However, the narrow riparian zone and severed floodplain are unlikely to increase debris contributions over time.

- *Stream Morphology and Stability:* Stream morphology and stability are at risk and expected to continue to decline slightly over time. Stream profile is somewhat stable as the streambed appears to be cut to a relatively hard condition. Stream dimension is expected to decline as the channel is constrained all around. The width/depth ratio is over-wide and will likely continue to widen. Dynamic equilibrium, referring to scour and deposition patterns, will continue to degrade as deposition and sediment transport are lacking. Water and bedload moves quickly through the confined channel. Resiliency in the form of stream adjustment to perturbation is greatly diminished and is expected to remain stable or decline as increased flood risk mitigation actions may be taken that would further confine the channel.

- *Stream Physical Structure:* Physical structure is expected to remain stable or decline. Presently, much of Sweetwater Creek exhibits homogenous flow patters with unnatural riffle-run-pool sequencing. Boulders, large wood, and varied gravel and sediment characteristics are lacking and are not expected to improve over time. The lack of pools, eddies and backwaters impact the streams ability to develop finer features like differential deposition of organic material and sediment.

- *Biotic Diversity:* Biotic diversity is at risk but is expected to remain relatively stable over time. A few species of EPT macroinvertebrate taxa dominate the benthic community. This points to relatively good water quality, but is also expected to correlate to the cold water and lack of hydraulic and depositional variety of the habitat.

5.2 With-Project Condition Assumptions

It was assumed that immediate improvement would be realized for aquatic habitat complexity with the placement of boulders and large wood, and reconnection to side channels, floodplain, and lateral pool development. The Nez Perce Tribe has witnessed adult salmonids utilizing resting and spawning habitat within one month of completing similar restoration measures at other sites on Sweetwater Creek.

Incremental increases in riparian and aquatic habitat would occur over time as most plant species (e.g. coyote willow, red osier dogwood, etc.) would mature between 5 and 10 years (Woods et al. 1996; Moore 2016). Full Project benefits would not be measurable until the riparian restoration reaches maturity between Year 20 and Year

50. Black cottonwood may provide near maximum benefit within 25 years based on timber production estimates in plantations (Murray and Harrington 1983), but full maturity, and thus maximum benefit is expected to occur within 60 years (Roe 1958; Nesom 2002).

- *Hydrology*: Hydrology variables of the watershed are expected to remain similar to the existing condition. The total volume and base flow would improve once the LOID diversion is removed. Floodplain development and connectivity would improve peak flow and flow variability from existing to a near natural condition within restored reaches, but not on the watershed scale.

- *Sediment Transport*: Sediment transport would improve with the removal of the LOID diversion, and restored instream flow and habitat complexity would retain sediment and substrate of various particle sizes like a natural reach should. Pools and boulder eddys would encourage deposition of fines and sand and small gravel, and point bars would encourage spawning gravels to settle out.

- *Water Quality (Temperature, Nutrients, and Toxins)*: Water quality is expected to remain good with the cold-water inputs to Sweetwater Creek and the restored riparian area and floodplain connections. Organic and inorganic material is also expected to remain relatively stable as land ownership and use practices outside of the restoration areas are expected to be representative of the present condition.

- *Floodplain Function*: Floodplain activation and function will increase with development and activation from bank reshaping. Approximately 5.1 ac of floodplain would be developed and enhanced. This will create opportunities for wetlands to form and benefit terrestrial wildlife and amphibians, as well as retain and slow some flood flows, provide groundwater recharge and water quality improvements. Organic energy inputs would be provided as flood water recede and pull debris back into the strema.

- *Riparian Vegetation Structure and Diversity:* The composition of the restored riparian community would appear similar to historic riparian conditions. Planting native riparian species would establish a diverse and stable, riparian area that would contribute to all forms of wildlife and fishes. An approximate 75% improvement in riparian across the sites is assumed and would contribute shade, organic matter and large wood to the stream over time. The large wood contribution would assist Sweetwater Creek in maintaining a variety of flow features, macroinvertebrate food sources and fish refugia. Native food sources and improved riparian corridor would provide forage, nesting and sheltering cover and migration safety for mammals and birds.

- *Debris Accumulation:* Detritus and LWD accumulation is expected to improve markedly with the increased floodplain function and riparian restoration. As trees mature and drop branches, flood flows can collect that large wood, transporting it into the stream, contributing to food sources and maintaining pools and flow variability.

- *Stream Morphology and Stability:* Stream morphology and stability are expected to increase immediately with earthwork to restore meanders and proper width/depth ratio. Dynamic equilibrium, referring to scour and deposition patterns, are expected to stabilize within the restored reaches with improved depositional areas and sediment transport regime. Resiliency in the form of stream adjustment to perturbation is expected to stabilize within restored reaches.

- *Stream Physical Structure:* Physical structure would improve immediately by establishing more natural riffle-run-pool sequencing. Boulders, large wood, and varied gravel and sediment characteristics would be placed immediately and would maintain over time as the riparian matures and sediment transport and deposition return to a more natural process. The immediate improvement in coarse in-stream habitat complexity would allow the stream to begin developing finer features like differential deposition of organic material and sediment, which would also be maintained over time.

- *Biotic Diversity:* Biotic diversity already includes desirable species of EPT macroinvertebrate taxa. The improvement in deposition, debris, and flow and depth variety will encourage more diverse macroinvertebrate and native fish communities.

Anticipated Project Maturity

- Year 1: Immediate improvement in floodplain connectivity, riparian species diversity to include native species, large woody debris. Significant improvement in stream morphology and physical structure due to placement of boulders and LWD, and channel shaping and sinuosity improvement. Riparian vegetation structure, detritus inputs, water quality, biotic features and stream resilience and stability would not change or would decline as a result of earthwork.

- Year 5: No changes are anticipated in watershed-scale hydrology or sediment transport variables yet. Stream morphology, stability and resilience would improve from the project “wearing in” and stabilizing. The same logic can be applied to physical structure, which would be near optimal condition. Woody vegetation cover is decreased by more than 20%, or multiple structural characteristics relative to the reference condition because riparian restoration has not yet matured. Assuming riparian species like willow and redosier dogwood and mesic species like Woods's rose would provide benefits, as well as herbaceous grasses and forbs providing optimal herbaceous cover and contributing organic material. Willow and dogwood would be over 6-feet high by now and nearing their maximum potential. Black cottonwood would still be small, not providing much deciduous canopy cover or detritus. Riparian benefits are expected to increase through Year 20, after which the growth rate of these parameters is expected to decrease, particularly for the shrub species.

- Year 10: No change ares anticipated in watershed-scale hydrology or sediment transport variables yet. Woody vegetation cover is decreased by more than 10% from the reference reach. Riparian restoration is nearing optimal condition as plants like red osier dogwood and coyote willow are fully mature providing nesting, foraging, and resting habitat for birds and small mammals, contributing in-stream organic matter and fully developed complex root structures and overwater cover for fishes. Minor improvements from Year 5 in stream stability and resilience, while morphology is remaining at nearly optimal condition. Biotic structure would improve at Year 10 to capture additional macroinvertebrate and possibly native fish species occupying restored in-stream habitat.

- Year 20: Approximately Year 20 is when the LOID Diversion is expected to be removed and base flow returned to Sweetwater Creek. Immediate improvements to high-functioning watershed hydrology and sediment transport variables would be realized, albeit not related to the Recommended Plan. However, these improvements would be capitalized upon by the Recommended Plan. Floodplain connectivity would reach optimal condition for saturation frequency and duration and remain near optimal for other functions. Riparian vegetation would be near optimal for all functions assuming mature trees at approximately 40-feet tall. Active invasive species management will have subsided and invasive species may be establishing somewhat. Debris inputs would be near optimal as the riparian matures. Morphology, stability and resilience, and biotic structure are all stable at near optimal condition.

- Year 50: Watershed hydrology and sediment transport variables expected to remain stable and highly functional. Floodplain connectivity remains stable and near optimal. A slight decline is anticipated in riparian herbaceous plant structure and native species diversity as invasive species are expected to be creeping back in. Woody debris inputs are at optimal condition with mature cottonwood and detritus inputs remain optimal. Morphology, stability and resilience, and biotic structure are all stable at near optimal condition. Coarse physical structure is anticipated to decline slightly as high flow events may shift and change some features over time.

6.0 CONCLUSIONS

Model results suggest that implementation of Alternative 1.2-5.1-7.1 would restore aquatic and terrestrial habitat quality, quantity and ecological function for juvenile and adult ESA-listed Snake River Basin steelhead, culturally important coho salmon, and the myriad other native flora and fauna within the Sweetwater Creek watershed. Aquatic and terrestrial habitat condition would be optimal in Reaches 5 and 7, and near optimal in Reach 1.

Plan implementation would result in increased aquatic habitat complexity, sediment deposition and transport, and physical and hydraulic structure. Floodplain enhancement, development and connectivity would be substantially increased, as would juvenile salmonid rearing and adult salmonid resting, spawning and migration habitat.

While Alternative 1.1-5.1-7.1 would provide optimal habitat in all three reaches, it would only provide a minor 0.17 AAHU greater benefit than the Recommended Plan. The cost to obtain the additional benefits does not appear to be a responsible use of funds. Use of the AAHUs calculated from the FACStream model to populate the CE/ICA model suggests that Alternative 7 is a “best buy,” plan capable of producing a satisfactory outcome for aquatic and riparian species. Therefore, Alternative 1.2-5.1-7.1 is the Recommended Plan.

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Annex A

FACStream Single Use Model Approval for the Sweetwater Creek Tribal Partnership Program 203 Restoration

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NORTHWESTERN DIVISION
PO BOX 2870
PORTLAND, OR 97208-2870

CENWD-PDD

MEMORANDUM FOR Walla Walla District, Environmental Compliance Section Chief

SUBJECT: Sweetwater Creek Section 203 Ecosystem Restoration Study, Tribal Partnership Program, Habitat Modeling Process Concurrence

1. References:

a. U.S. Army Corps of Engineers, Implementation Guidance for Section 1031(a) of the Water Resources Reform and Development Act of 2014 (WRRDA 2014), and for Section 1121 of the Water Resources Development Act of 2016 (WRDA 2016), Tribal Partnership Program. February 16, 2018.

b. U.S. Army Corps of Engineers, Walla Walla District Memorandum, June, 2019. Habitat Model Use Justification and Approval Request for the Sweetwater Creek Restoration Project under the Tribal Partnership Program, Walla Walla District, Walla Walla, Washington.

c. Johnson, B., M. Beardsley, J. Doran, and D. Sutherland. 2016. Functional Assessment of Colorado Streams, Version 1.0. EcoMetrics. Sponsored by the U.S. Environmental Protection Agency.

d. U.S. Army Corps of Engineers, Director of Civil Works Policy Memorandum #1, January 19, 2011. Continuing Authority Program Planning Process Improvements.

2. Section 203 of WRDA 2000, as amended (33 U.S.C. 2269), authorizes the Secretary to carry out the Tribal Partnership Program, consisting of water-related planning activities, and activities related to the study, design and construction of water resources development projects, that substantially benefit federally-recognized Indian Tribes and that are located primarily within Indian country, or in proximity to Alaska Native Villages. The MSC Commander may approve reports and recommended plans, where the Federal design and construction costs do not exceed $10,000,000, as discussed in the Implementation Guidance (see reference 1.a.). If the Federal design and construction costs are anticipated to exceed $10,000,000, SMART planning process and milestones are required, including vertical team review, and resulting in a Chief's Report in order to request Congressional authorization. The Northwestern Division (NWD) Commander retains decision document approval authority for the Sweetwater Creek Section 203 Ecosystem Restoration study, because it is anticipated that the total Federal project costs for design and construction will be well below the $10,000,000 threshold. Because NWD has delegated approval authority for the decision document, similar to a Continuing Authorities Program (CAP) study, NWD is assuming approval responsibilities for use of ecological models. NWD has coordinated with the National Ecosystem Planning Center of Expertise (ECO-PCX) on approval of use of ecological models for the Sweetwater Creek Section 203 Ecosystem Restoration study, and the ECO-PCX concurs with the proposed approach.

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3. The Sweetwater Creek Section 203 Ecosystem Restoration study area is located in northern Idaho and lies almost entirely on the Nez Perce Reservation. The purpose of the study is ecosystem restoration, and an ecological model is needed to assess environmental benefits of alternatives. Walla Walla District (NWW) has requested approval (see reference 1.b.) from NWD for use of the Functional Assessment of Colorado Streams (FACStream) model to use as part of the Habitat Evaluation Procedure (HEP) process.

4. As discussed in references 1.b. and 1.c., FACStream is a reach-scale functional assessment tool for assessing streams that rates functional condition according to the degree of impairment of ten ecological variables. Variable ratings are based on best-available evidence of the degree of departure from an unimpacted reference standard condition. FACStream is a forensic, weight-of-evidence method, meaning that variable scores must be commensurate with documented evidence. Evidence may be gathered by any investigative means from simple observations to rigorous long-term monitoring of complex parameters, depending on project circumstances. A FACStream assessment can incorporate data from any level of effort, be it a remote sensing survey or reconnaissance, routine field assessment, or intensive field assessment. In the case of the Sweetwater Creek Section 203 Ecosystem Restoration study, the project team proposes to apply reconnaissance level methods to incorporate data into the modeling effort. The reconnaissance level of effort will consist of environmental analysis and professional judgment using various existing data sources, including web-based tools, aerial imagery, and literature, and a site visit to ground-truth the data.

5. The proposed FACStream model was developed by Colorado State University for use as an assessment tool for Colorado streams and is not currently certified in USACE for use regionally or nationally. While FACStream was developed for use on Colorado streams there are similarities between the ecological and physiographic regions in Colorado and NWW. Upon review of Colorado's physiographic regions, the northwest Wyoming Basins region is very similar to the Columbia Plateau encompassing the lower Snake River and its tributaries in southeast Washington and the neighboring area of western Idaho. More specifically, Colorado's Shrublands, Grasslands, and Coniferous Forest ecoregions are similar to the Columbia Plateau (WA, OR, ID), Blue Mountains (WA, OR), Canadian Rockies (WA), and Northern Rockies (ID) ecoregions within the Walla Walla District. These similarities and their relevance to broader landform consideration in the model suggests that the FACStream model is appropriate for use on the Sweetwater Creek study. In addition, the model objectively estimates stream functional capacity and stream-specific characteristics such as bank-full width, basic flow regime, geologic setting, and valley form and therefore may also be viewed as having broad application and not specific to Colorado landforms.

6. FACStream will be used in the overall Habitat Evaluation Procedure (HEP) framework. FACStream produces a numerical score between 0 and 1, which will then be multiplied by the area of effect to produce an overall habitat unit output. The resulting habitat unit output will be compatible with a cost-effective – incremental cost analysis.

7. NWD has reviewed the request and its intended use of the model and approves it for use on the Sweetwater Creek Section 203 Ecosystem Restoration Study (in accordance with reference 1.d.).

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8. The point of contact for this action is Mr. Jeff Greenwald at 503.808.3863.

JIM K. FREDERICKS
Chief, Planning,
Environmental Resources,
Fish Policy and Support Division

CF:
National Ecosystem Planning Center of Expertise (Nate Richards)