



**US Army Corps
of Engineers®**
Walla Walla District

**BARBER POOL SECTION 1135
ECOSYSTEM RESTORATION
ADA COUNTY, IDAHO**

**DRAFT INTEGRATED FEASIBILITY REPORT AND
ENVIRONMENTAL ASSESSMENT**

APPENDIX B, HABITAT MODELING

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ADA COUNTY, IDAHO
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APPENDIX B, HABITAT MODELING

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ACRONYMS AND ABBREVIATIONS

BPCA	Barber Pool Conservation Area
BSU	Boise State University
BOR	Bureau of Reclamation
CAP	Continuing Authorities Resolution
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
ER	Engineering Regulation
ESA	Endangered Species Act
FONSI	Finding of No Significant Impact
FR/EA	Feasibility Report and Environmental Assessment
IDFG	Idaho Department of Fish and Game
NEPA	National Environmental Policy Act
NSF	Non-Federal Sponsor
PL	Public Law
USACE	U.S. Army Corps of Engineers
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
SV	subvariable

SECTION 1 - INTRODUCTION

Presently, an ecosystem restoration study conducted by the U.S. Army Corps of Engineers (USACE) Walla Walla District and Boise State University (BSU), the non-Federal sponsor (NFS), is being studied in an Integrated Feasibility Report and Environmental Assessment (FR/EA) to address the need for ecosystem restoration in the Barber Pool Conservation Area (BPCA), located on the Boise River in Boise, Idaho.

The BPCA is a critical aquatic and riparian habitat that has experienced significant ecological degradation over time due to factors such as altered hydrology due to dams, sedimentation, invasive species, and human activities. The degradation has resulted in the loss of native vegetation, diminished water quality, reduced habitat complexity, and declining populations of native fish and wildlife species.

Restoration is warranted because the BPCA's ecological fabric is unraveling on several interconnected fronts. Decades of disturbance have stripped away native aquatic and riparian habitat, shrinking the living space and resources available to endemic species and disrupting vital watershed functions. Altered flow regimes and unnaturally high sediment loads now foster channel instability, bank erosion, and habitat fragmentation, eroding the river's natural self-maintaining processes. Invasive plants and animals have taken hold across large portions of the BPCA, reshaping community structure, outcompeting native populations, and weakening overall ecosystem resilience. Compounding these stresses, runoff-driven nutrient loading and turbidity continue to degrade water quality, further diminishing the area's capacity to sustain diverse and abundant aquatic life.

Planning objectives represent desired positive changes to the without-project condition. All the planning objectives focus on activity within the study area and within a 50-year period of analysis, from year 2027 to 2077. The planning objectives for this study are as follows:

1. Restore in-channel aquatic habitat diversity within the Boise River Channel.
2. Restore portions of disconnected floodplain within the BPCA.
3. Restore riparian and wetland habitat within the BPCA.

The purpose of the BPCA Restoration Project is to improve the ecological health, function, and resilience of the BPCA ecosystem through actions such as enhancing in-channel aquatic habitat, reconnecting some of the historic floodplain, and rehabilitating riparian and wetland habitats to support biodiversity throughout the Boise River corridor.

Enhancing natural processes and habitat complexity is necessary to sustain the ecological integrity of the BPCA and ensure it continues to provide essential ecosystem services such as wildlife habitat, water quality improvement, floodwater storage, and opportunities for environmental education and passive recreation. These efforts will also

support public engagement and long-term stewardship consistent with the conservation vision for the area.

1.1 STUDY AREA

The study area is the BPCA, a wildlife refuge located along the Boise River, approximately six miles southeast of Boise, Idaho, in Ada County (Figure 1-1).

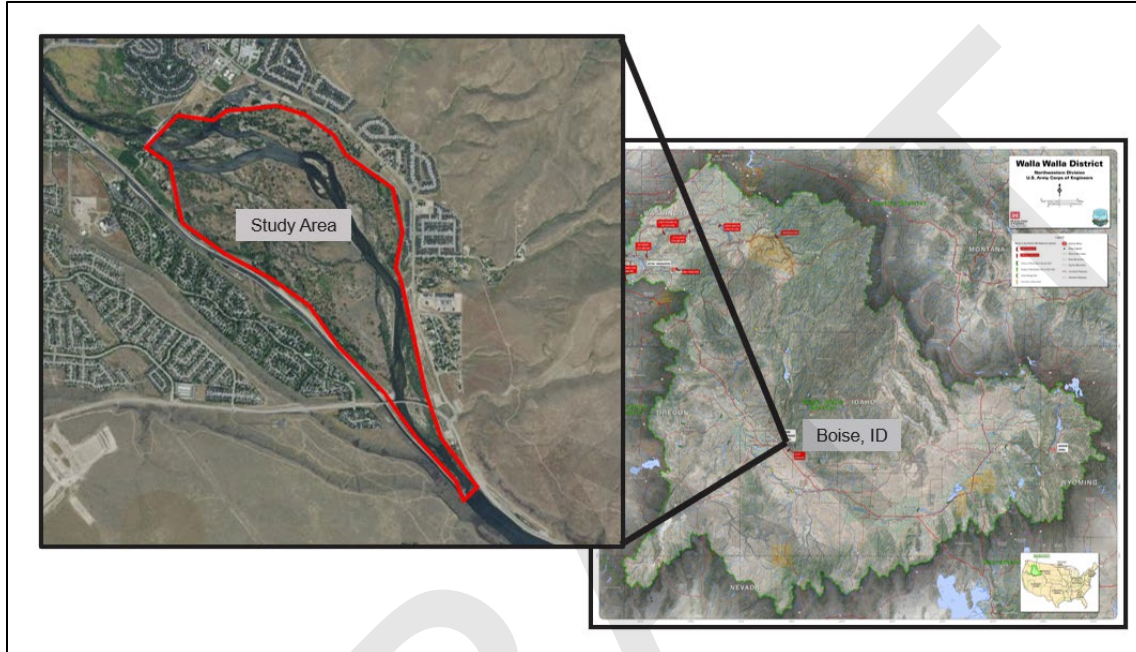


Figure 1-1. Barber Pool Study Area (Red Polygon) near the city of Boise, ID with nested position within the Walla Walla District Boundary shown on the right-hand map

The BPCA is within a two-mile reach between Diversion Dam and Barber Dam, approximately three miles downstream of Lucky Peak Dam.

1.2 INSTREAM HABITAT

The BPCA is an area that is, and has been, profoundly affected by manmade structures on the Boise River. Historic maps and photos show that the configuration of the Boise River through the BPCA has changed dramatically, due in part to the construction of Barber Dam, Boise Diversion Dam, and the diversion works that feed New York and Penitentiary Canals. Prior to construction of Lucky Peak Dam upstream, the water regime on the Boise River was less regulated, and the BPCA was more prone to the effects of a dynamic river system, scouring and deposition. Since the construction of Lucky Peak Dam and the regulation of water flows through Boise, the landform and river channel through the BPCA have stabilized. Some of the consequences of this regulation are the reduced generation of black cottonwood trees in the riparian zones along the Boise River, and lowered groundwater levels related to recharge from the Boise River within the BPCA. Within the BPCA, the channel is primarily single-thread

with a high width-to-depth ratio. Bed composition grades downstream from cobble–gravel in the upper reach to sand in the lower reach, with few pools and generally homogeneous bedforms. In-channel structural elements are largely absent. Banks are composed mainly of gravel and sand and show frequent slump failures. The floodplain includes seasonal side channels scoured into the first-terrace surface, evidenced by active sand deposition; downstream sections of these side channels are subject to backwater inundation, and beaver activity has augmented side-channel development.

Current processes reflect the influence of upstream and local controls. Local bed material is recruited through bank erosion associated with channel widening, and the elevated water surface created by Barber Dam promotes bank slumping as water laps against the banks. Recent deposition within the backwater zone derives from upland runoff and local bank erosion. Functionally, the combined effects of limited coarse sediment supply from upstream dams and backwater conditions from Barber Dam have produced a sand-dominated reach where as much as six feet of sand deposition has created a wide, low-gradient channel with low physical complexity. At the same time, the dam-elevated water table supports a continuous, thriving riparian community in low-lying areas

1.2.1 Historic and Present Habitat Characteristics

Prior to Euro-American settlement, the Boise River functioned under a completely different flow regime than the highly regulated river of today (Figure 1-2). Frequent small-scale floods and occasional large floods associated with this historic hydrologic regime shaped the landscape creating a diverse and ever-evolving river corridor. Historic accounts and maps from the 1800s suggest the Boise River was primarily single threaded with several islands in the area near the cities of Boise and Eagle. The channel in this area was described in 1834 by John Kirk Townsend as “a beautiful stream, about one hundred yards in width, clear as crystal, and, in some parts, probably twenty feet deep.” Early drawings from farther downstream suggest the lower 30-40 miles of the channel became primarily multi-threaded with “many islands” as depicted on David Thompson’s 1818 Map of the River.

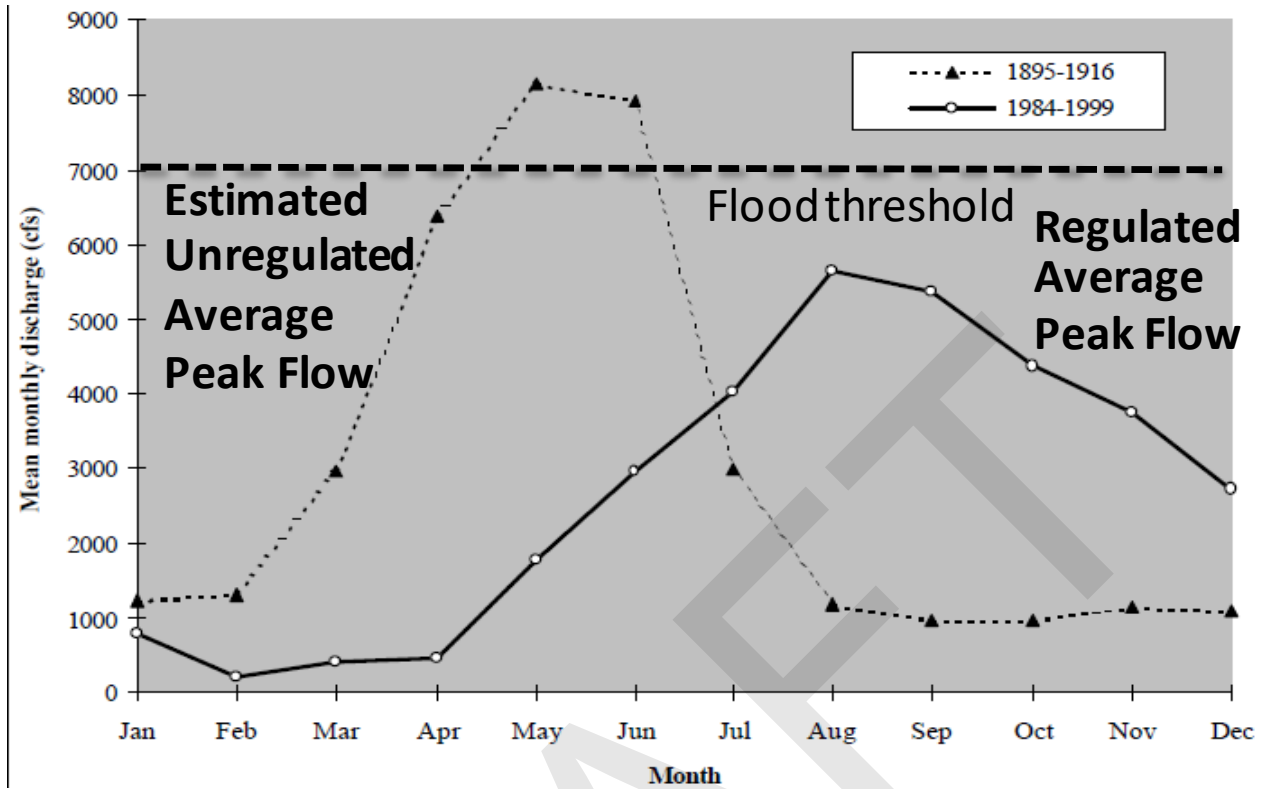


Figure 1-2. Boise River historic versus existing hydrograph

The average historic hydrograph included higher magnitude floods typically occurring during the late spring compared with lower magnitude floods and peaks occurring later in the season. Existing base flows are also generally lower than historic averages (figure adapted from ID DEQ, 2001).

The banks of the Boise River are typically composed of sand and silt overlying coarser gravels and cobbles. The sand and silt represents historic floodplain deposition. The coarser material underlying the flood deposits represents the deposited bedload of the historic channel. Bank erosion and the resultant channel migration of the historic river were aided by the poor cohesion of these alluvial bank materials. Bank stability was principally provided by riparian vegetation and large woody material (LWM). LWM was recruited to the channel from upland and/or up-river debris flows and bank erosion undermining trees in the riparian area.

Recruited LWM is typically deposited on gravel bars, was pinned against the bank, or was retained by stable in-stream obstructions. The historic Boise River had the potential to accumulate substantial volumes of LWM as discussed below. The largest, most substantial pieces (key members) had the potential to rack additional LWM transported through the system forming log jams. These logjams created hard points that obstructed flow, which forced flow convergence and scoured pools.

Evidence of a historical river shaped by LWM and log jams is rooted within the name “Boise”. Early in its settlement history, upon seeing the broad riparian forest of the lower Boise River floodplain, English explorers coined it the “Woody River.” The current name is derived from French fur trappers favoring the popularized French name “Bois”, which

translates to “wood” (Townsend, 1834.). Records also show that the riparian vegetation was dominated by cottonwoods and willows (McCoy and Blew, 2005). These trees require frequent floodplain disturbance in order to expand their area. Studies have shown that cottonwood seed dispersal typically occurs during declining river flows following floodplain inundation events that expose barren and moist microsites in which transported seeds may germinate (Braatne et al. 1996).

1.2.2 Forested Riparian and Wetlands

The land areas contained within the BPCA may be categorized as the north shore, south shore, and the islands. Vegetation on the large peninsula of the south shore is composed of degraded shrub-steppe, with transition areas of palustrine forest and shrub-steppe that becomes pure palustrine forest.

Palustrine scrub-shrub communities also occupy large areas of the south shore. Palustrine emergent wetlands are found primarily in the flooded channels and ponds. Much of the shrub-steppe in the BPCA consists of gray rabbitbrush (*Chrysothamnus nauseosus*) and cheatgrass (*Bromus tectorum*), although there are some shrub-steppe areas that contain little more than cheatgrass. The shrub-steppe is just starting to establish and, with coarse soils on the site, this development will be slow. Some areas of moderately good soils support dense stands of cheatgrass (*B. tectorum*), and rye (*Secale cereale*).

Vegetation of the north shore area is dominated by palustrine forest and palustrine scrub-shrub. The area near the river is dry, with little under story. The deeper channels away from the river exhibit dense cottonwood forest with golden currant and rose. An open, forested meadow with scattered pockets of cottonwood and willow or green ash (*Fraxinus pennsylvanica*), cheatgrass, annual rye (*Secale cereale*), and white-top (*Cardaria draba*) is also found in the area.

The south shore and, to a lesser extent, the islands and the north shore, are classified as perched wetland habitats. The National Wetland Inventory depicts wetlands only on the lower islands and in isolated spots on the mainland areas. The wetland areas away from the river are created by seepage from New York Canal. The palustrine forest and palustrine scrub-shrub areas outside of this influence are at risk and will survive only if fire or some other impact (such as beavers) does not kill the trees or root crowns.

The young cottonwood and willow in the area are regrowth of existing root masses, and little vegetative reproduction appears to be taking place, due to lack of suitable hydrological conditions for seedbeds. The islands may be classified predominantly as dry palustrine forest, with fringes of palustrine scrub-shrub and palustrine emergent of sedge and Kentucky bluegrass (*Poa pratensis*).

Vegetation within the BPCA is shifting due to changes in the hydrological regime. The lowering of the elevation of Barber Dam resulted in less water behind the dam, and

lower groundwater and wetland elevations within the BPCA. Further regulation of the hydrological regime by Lucky Peak Dam limits high water events that help to create suitable seedbeds for black cottonwoods. The consequence is that vegetation traditionally associated with the BPCA, the black cottonwood riparian forest, is changing. Without intervention, some of the upland forested areas will probably convert to a shrub-steppe community over the next 10 to 20 years.

Shrub-steppe communities will most likely develop slowly due to the sandy soils within the BPCA. Competition from noxious weeds will also limit establishment of desirable native species. The current weed control practices will help to establish native species within the BPCA, thus enhancing wildlife habitat

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 mesocarnivores 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 PROCESS OF RIPARIAN COTTONWOODS

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 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 trees 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.

SECTION 2 - FACSTREAM MODELING

Evaluating stream functional capacity is important for projects that may impair or improve stream function. There are reaches within BPCA 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. 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

In USACE feasibility studies it is required to use existing models approved for National use by the Cops Ecosystem Planning Community of Practice (Eco-PCX). The FACStream model is such a model and was approved for regional use within the civil works boundaries of Walla Walla district 11 July 2024. The approval expires 11 July 2031.

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 evaluate 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 like the Columbia Plateau.

2.2.1 Descriptions 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, previous reports, data collected via GIS, and professional judgment.

FACStream breaks habitat into 10 functional State Variables with 28 sub-variables (SV) (Table 2-1).

Table 2-1. FACStream Variables and descriptions.

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 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.

Variables*	Description
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.
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.

Each SV is populated with a number from 50-100 based on the scholastic scale score. 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.

Table 2-2. Scholastic grade scale for assigning letter and number grades to model subvariables.

Grade	FCI Score	Level of Impairment
A++	100	None (pristine)
A+	98	Negligible
A	95	
A-	92	
B+	88	Mild
B	85	

Grade	FCI Score	Level of Impairment
B-	82	
C+	78	
C	75	Significant
C-	72	
D+	68	Severe
D	65	
D-	62	
F+	58	Profound
F	55	
F-	52	

Letter grades are rolled up to provide an overall functional capacity index value for each of the 10 factors based on the equation in Figure 2-1.

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

Figure 2-1. Equation that converts the Subvariables condition score into a functional capacity index score.

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.

2.2.2 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.
 - (a) We did not find this to be problematic for this study due to the large reaches and area 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.

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 several spreadsheets including assumptions and calculations that ATR reviewers will need to review. This effort fits ecosystem restoration projects well.

2.2.3 Model Assumptions

FACStream assumes that natural system perform optimally until disturbed by humans. 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 BPCA 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. Model spreadsheets scores assumptions for each SV are mentioned in Section 4.

2.2.4 Model Applicability to Fish and Wildlife

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

2.2.4.1 Fishes

Table 2-3 provides the specifics of how the model applies to fishes, specifically. While a complete account of the fishes in BCPA is not presented, it can be assumed that all native species would benefit from this project as natural cohabitants of cold, headwater streams.

Table 2-3. Model Applicability

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.
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.	

Barber and the Boise River Diversion dams were the first fish barriers (1908) to salmon migration on the Boise River and effectively blocked all salmon migration (Caldwell and Wells 1974). Historically, the Boise River supported migratory and resident forms of bull trout and redband trout (SBNFWAG 1998). Also represented in the resident native fish community were white sturgeon, mountain whitefish, northern pikeminnow, shorthead sculpin, chiselmouth, several sucker species, and possibly Pacific lamprey (Caldwell and Wells 1974; USFWS 1980). Barber Dam does not create a reservoir and therefore this reach was not included in total length of river inundated for this study. There is virtually no fishery in the 4.6-km section of the Boise River above the Boise River Diversion Dam, as it is nearly entirely silt bottomed and is annually reduced to 2-6 m³/s or less in the winter, providing little habitat for salmonids.

2.2.4.2 Insects

Variables V-hyd, V-sed, V-chem inform the difference between Diptera and EPT taxa presence, for example. Colder water and the various depositional opportunities suggest that EPT taxa will remain dominant. 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 insect species diversity via varied substrates, velocity, and depths.

2.2.4.3 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).

2.2.4.4 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).

2.2.4.5 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.

Use of riparian 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).

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.

2.2.4.6 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).

2.2.4.7 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.

DRAFT

SECTION 3 - ALTERNATIVES DEVELOPMENT

Overall, 5 alternatives were developed from standalone measures or measure combinations and evaluated individually with the FACStream model. Existing condition and alternative benefits assumptions are presented in this section.

3.1 FUTURE WITHOUT PROJECT

This alternative assumes the status quo for the next 50 years at the BPCA. What has been happening is assumed to continue happening, no changes or measures suggested here.

3.2 ALTERNATIVE: WETLAND MOSAIC (WM)

The Wetland Mosaic Alternative (Figure 3-1) focuses on low-lying uplands adjacent to the Boise River within the Barber Pool impoundment area, located along the downstream portion of lands owned and managed by the Idaho Foundation for Parks and Lands. Actions in this site emphasize restoration of floodplain, riparian, and wetland functions, consistent with study objectives 2 and 3.



Figure 3-1. Wetland Mosaic Alternative shown in green

The site is generally defined by a large depositional landform composed of sand and silt, with relic scour patterns extending adjacent to the main channel near Barber Dam. These areas are predominantly uplands, where vegetation consists mainly of grasses and shrubs, with scattered cottonwoods and other riparian species. The riverbank along this reach is characterized by steep, sparsely vegetated slopes, making it vulnerable to ongoing erosion. Wetland communities occur primarily as emergent wetlands in the lowest depressions, while shrub- and tree-dominated wetlands are limited, occurring only in small, isolated patches.

The primary factor contributing to adverse conditions in this area is an elevated floodplain that no longer connects with seasonal groundwater tables or overbank flooding. This hydrologic separation has led to a shift in the landscape toward non-native species and a decline in native woody vegetation, particularly cottonwood stands. The Wetland Mosaic would emphasize study objectives 2 and 3 and would incorporate the following measures and sites:

- Measure 1 - Vegetation plantings
- Measure 3 - Installation of BDA's and PALS
- Measure 6 - Excavation to upland wetlands
- Measure 7 - Filling of open channel segments

- Site 8 – Floodplain Connectivity
- Site 10 – Wetland Creation
- Site 11 – Wetland Creation

Generally, this action would occur as follows:

Upland depressional areas would be excavated to a target depth of approximately one foot above the estimated groundwater table. These excavated features would be at a depth above the OHWM but allow overbank flooding in some years. Nature-based structures such as BDA's or post-line wicker weaves could be installed within the excavated area increase the lateral and vertical influence during high-water years. Excavated topography would be graded to blend with the surrounding terrain, supporting the establishment of a mosaic wetland system dominated by Palustrine Shrub-Scrub (PSS) and Palustrine Forested (PFO) communities.

Within the modified landscapes, intensive native vegetation plantings would be implemented to increase species diversity, habitat value, and soil stabilization. Plantings would be applied through broadcast seeding as well as woody stem and container stock, selected to align with the targeted hydrological gradients. Pollinator-friendly species and native grasses would be used in adjacent upland zones, transitioning to facultative shrubs and native tree species in wetter areas to restore natural vegetation structure and function.

Assumptions and Uncertainty

Access to the area to conduct these proposed actions is assumed to occur through an existing service road along the New York Canal. Temporary easements would be secured by the Non-Federal Sponsor. A takeoff road would be constructed from the Main Road to a staging area and haul roads would be constructed within the area to support construction. Work would occur in the fall, when water is the lowest, and timing would be influenced by an active bald eagle nest within the area. Construction is assumed to occur across at least two work seasons.

Design elevations within the excavated uplands would utilize the mean pool elevations for the Barber Dam + 1 ft to support predictable ground water elevations establishment of the target class of wetlands (PSS PFO). This is specific to this area as it is within the influenced area of the Dam.

Alternative Location Details

Total Acres – Approx 6.3 acres

Material Excavated - Approx 8,000 CY

Fill material - 11,500 CY (8,000 CY Ex, 1,500 Cap Material, 1,000 CY Riprap)

Property Owners – 1, Idaho Foundation for Parks and Lands

3.3 ALTERNATIVE: MAIN CHANNEL 1 (MC1)

Main Channel 1 focuses on a low-lying floodplain located along the right descending bank of the Boise River (Figure 3-2).

The site includes lands owned and managed by the Idaho Foundation for Parks and Lands, Ada County Parks and Recreation, and Boise State University. Proposed actions in this area would restore in-channel aquatic habitat as well as floodplain, riparian, and wetland functions, addressing Study Objectives 1, 2, and 3.

The site is generally characterized by a low-elevation floodplain that receives overbank flooding during high-flow events. Historic side channels in the upstream portion of the site have filled in over time, while downstream segments remain hydrologically connected to the Boise River. Vegetation across the site includes scattered cottonwoods with an understory of upland grasses and shrubs. Lower-elevation areas support patches of wetland shrubs and emergent vegetation. The riverbank along this reach is largely unvegetated and highly erodible, contributing to ongoing instability.



Figure 3-2. Main Channel 1 shows within the white polygon.

The following measures and sites would be implemented within this alternative site:

- Measure 1 - Vegetation Plantings
- Measure 3 - Installation of BDAs and PALS
- Measure 4 - Excavation of recently filled-in side channels to flow perennially
- Measure 5 - Excavation of inactive floodplain channels
- Measure 6 - Excavation of uplands to wetlands
- Measure 8 - Construction of controlled access points

- Site 3 – Floodplain Connectivity
- Site 4 – Side Channel
- Site 12 – Wetland Creation

Generally, this action would occur as follows:

A recently filled side channel would be excavated along with its historical alignment to reconnect with the active channel and restore perennial flow. This reestablished side channel would be designed to enhance fish habitat, incorporate gentle sinuosity, and integrate instream habitat features. A control structure or rock weir may be installed to reduce capture, or as needed to document compliance with water rights.

Further inland, a low-elevation upland area would be excavated to create wetlands that connect with the reestablished side channel. Elevations would target approximately one foot above the estimated groundwater table and tie into the surrounding terrain to establish a wetland mosaic composed of PSS and PFO communities.

Additionally, a floodplain channel would be excavated from the main channel to the wetland complex to allow seasonal flow. The channel would be set above the OHWM and only flow during certain high-water events. Nature-based structures such as BDAs or post-line wicker weaves may be installed to expand the lateral and vertical influence of seasonal flows and extend their duration through the floodplain and wetland (Figure 3-3).

Assumptions and Uncertainty

Access to the area to conduct these proposed actions is assumed to occur through an easement held by Boise State University on an old access road. This road would need to be redeveloped and cross the existing paved Greenbelt. A takeoff road would be constructed from the Main Road to a staging area and haul roads would be constructed within the area to support construction. Work would occur in the fall, when water is the lowest. Construction is assumed to occur across at least two work seasons.

Design elevations are generally within 3 feet of surface and are estimated to include less material. There is currently not a beneficial repurpose for material and it is assumed all material will be hauled off site.

The control structure at the upstream end of the perennial channel may be required to be shut off during some portions of the year. The bottom surface elevations are expected to be below groundwater elevations and are expected to remain wet, and flowing like a reference channel constructed upstream in 2021.

Alternative Location Details

Total Acres – Approx 14.9 acres

Material Excavated - Approx 4,800 CY

Fill material – Concrete Box Culvert CY, Channel Material Repurposed

Property Owners – 3, Idaho Foundation for Parks and Lands, Ada County, Boise State University.

3.4 ALTERNATIVE: MAIN CHANNEL 2 (MC2)

Alternative main channel 2 (MC2) is located on Boise State University's Intermountain Bird Observatory (IBO) property and represents the most upstream project area within the BPCA. Actions at this site would focus on restoring in-channel habitat, as well as riparian and wetland functions, consistent with Study Objectives 1, 2, and 3 (Figure 3-4).



Figure 3-3. Main Channel 2 is shown in two polygons along the Boise River

The site is generally characterized by a low-elevation floodplain that supports one of the most intact and diverse multi-class wetlands in the BPCA, including a mosaic of vegetation communities and a previously restored side channel completed by the project sponsor. Despite these conditions, degradation is evident in the form of a heavily eroded and unstable bankline, as well as upland berms dominated by invasive grasses. Measures and sites incorporated within this alternative include the following:

- Measure 1 - Vegetation Plantings
- Measure 2 - Placement of Instream Structures/Bioengineered Bank Stabilization
- Measure 6 - Excavation of Uplands to Wetlands
- Measure 7 - Filling of Open Channel Segments
- Measure 8 - Construct Controlled Access Points

- Site 7 – In-channel aquatic habitat
- Site 13 – Wetland Creation

Generally, this action would occur as follows:

Uplands would be excavated to create wetlands that connect to existing habitat. Elevations would target approximately one foot above the estimated groundwater table, allowing for seasonal flooding. Excavated material would be beneficially re-used to construct a bioengineered riparian shelf at a heavily eroded bankline. This feature would be stabilized and enhanced with root wads, riprap, and other imported material to improve bank stability and habitat complexity.

Within the modified landscapes and within low lying areas high-density native vegetation plantings would be implemented to increase biodiversity, enhance habitat conditions, and stabilize soils. Plantings would consist of broadcast seeding and woody stem/container stock, with species selected to match targeted hydrologic conditions. Upland areas would be planted with native grasses and pollinator-friendly species, transitioning into facultative shrubs and trees within wetter zones. In select areas near public-use zones, dense and thorny native plants such as Woods Rose (*Rosa woodsii*) or Coyote Willow (*Salix exigua*) would be established to discourage formation of unmanaged trails

Because this site lies within the BPCA public use zone, measures to manage recreation and protect restored areas would be included. A designated pathway would be constructed along higher-elevation terrain to connect with existing trails, encouraging controlled public access and reducing erosion and habitat disturbance. Additionally, the pathway would provide opportunities for education and conservation awareness, aligning with the public significance of the BPCA.

Assumptions and Uncertainty

Access to the area to conduct these proposed actions is assumed to occur through an existing access road managed by Boise State university. This road would need to be

extended to excavate material from the site. Work would occur in the fall, when water is the lowest, Construction is assumed to occur across at least two work seasons.

Alternative Location Details

Total Acres – Approx 3.4 acres

Material Excavated - Approx 700 CY

Fill material – 700 CY Cut material, 150 CY Cap material, 500 CY Riprap

Property Owners – 1, State of Idaho, Boise State University

3.5 ALTERNATIVE: MAIN CHANNEL 3 (MC3)

This alternative targets near-vertical, eroded banks along the western portion of the study area on lands owned and managed by the Idaho Foundation for Parks and Lands. Restoration actions at this site focus on improving in-channel habitat, floodplain reconnection, and riparian/wetland functions (Study Objectives 1, 2, and 3).

The site is characterized by a large depositional landform of sand and silt, with steep, unvegetated banks rising more than 10 feet above the OHWM (Figure 3-5).



Figure 3-4. Map of Alternative 4 (Main Channel 3) shown in blue polygons.

Vegetation is largely absent, though emergent wetlands occur along the river fringe and within two intermittent channels that drain westward. The primary driver of adverse conditions is the historic alteration of the hydraulic regime, which elevated the floodplain and disconnected it from regular river flows. This condition is reflected in the vertical bank structure and localized sedimentation issues. Measures and sites to be incorporated within this alternative include:

- Measure 1 – Vegetation
- Measure 2 - Placement of Instream Structures
- Measure 7 - Filling of Open Channel Segments
- Measure 9 - Excavation of banklines

- Site 7 – In-channel aquatic habitat
- Site 8 – Inset Floodplain
- Site 9 – Inset Floodplain

Generally, this action would occur as follows:

A section of the vertical bank would be excavated landward to create an inset floodplain. This location would tie-in with existing low elevation features to promote a continuous aquatic and riparian corridor along the bank. To stabilize the new bankline and enhance aquatic habitat, root wads and other natural materials would be incorporated as instream structures.

Excavated material would be beneficially reused to backfill a heavily eroded section of the main channel and establish an inset floodplain. This is the same area that would be used in Floodplain Reconnection, and Wetland Mosaic. The backfilled area would be capped with imported gravel and riprap, and habitat would be created with the inclusion of root wads and plantings.

Within the modified elevation of and, and the bankline between these features, native vegetation plantings would be established to enhance biodiversity, stabilize soils, and improve habitat quality. Plantings would include a mix of broadcast seeding and woody stem/container stock, selected to match targeted hydrologic conditions. Upland areas would be planted with native grasses and pollinator-friendly species, transitioning downslope into facultative shrubs and trees, with emphasis on riparian species adapted to the Boise River corridor.

Assumptions and Uncertainty.

Access to the area to conduct these proposed actions is assumed to occur through an existing service road along the New York Canal. Temporary easements would be secured by the Non-Federal Sponsor. A takeoff road would be constructed from the Main Road to a staging area and haul roads would be constructed within the area to support construction. Work would occur in the fall, when water is the lowest, and timing would be influenced by an active bald eagle nest within the area. Construction is assumed to occur across at least two work seasons.

The excavated area will to a target depth of 1 ft above estimated ground water. Excavated areas will extend to the river channel to allow overbank flooding, however elevations would stay above the OHWM.

Alternative Location Details

Total Acres – Approx 5 acres

Material Excavated - Approx 12000 CY

Fill material – 1200CY Cut material, 1500 CY Cap material, 1000 CY Riprap

Property Owners – 1, Idaho Foundation for Parks and Lands

SECTION 4 - ANALYSIS AND RESULTS

4.1 FACSTREAM SCORING AND ALTERNATIVE ANALYSIS

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 SV 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.

Letter grades numerical values were assigned for each subvariable across site plans and maturation time steps. The FACStream model then provided the subvariable score roll-up (Table 2-1) 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.

The 6 alternatives yielded 28 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.

4.1.1 Model Input Data

Input data for FACStream models were based on most recent and available information that could be found. A lot of the data for this BPCA was collected through the use of available data (Table 4-1) from Richardson and Guilinger (2015). Data acquisition included existing reports, LiDAR (Light Detection and Ranging) topography and bathymetry, existing hydraulic models, gauge data, GIS relative data sets, and on-site observations.

Table 4-1. Boise Diversion to Barber Dam Existing Conditions quantified by Richardson and Guilinger (2015).

REACH 1 – Boise Diversion Dam to Barber Dam	
Channel Metric	Existing Conditions
Sinuosity (ft/ft) Channel length along the thalweg divided by valley length	1.2

REACH 1 – Boise Diversion Dam to Barber Dam	
<p>Montgomery-Buffington Channel Morphology Classification system specific to the processes and forms of mountainous streams (Montgomery and Buffington, 1997)</p>	Plane-Bed
<p>Rosgen Classification Classification system specific to channel forms and bed composition (Rosgen, 1998)</p>	F3 Entrenchment ratio <1.4
<p>W:D Ratio (ft/ft) Representative bankfull channel width divided by average channel depth</p>	45
<p>Bed Composition: D50, D85, D100 (in) D50 = median grain size of bed, D85 = 85% of material is finer, D100 = upper threshold of material transported in stream (based on ocular estimates)</p>	Upstream of Barber Pool: 2.5, 5, 12 Within Barber Pool: Predominantly Sand
<p>Embeddedness Qualitative measurement of sand/silt filling interstitial space of bed material on a relative scale from Low to High</p>	Low
<p>Bed Armoring Qualitative measurement of the amount of coarse material covering finer material on the bed on a relative scale from Low to High</p>	Moderate immediately below Boise Diversion Dam; Low above Barber Dam
<p>Channel gradient (ft/ft) Average slope of channel defined as thalweg length divided by elevation difference</p>	0.0005
<p>In-channel Structure In-channel structures obstruct flow (e.g.: boulders and woody material) Low (Primarily lacking) to High (Prevalent)</p>	Low
<p>Bank Composition Average grain size of bank material</p>	Gravel and sand become primarily sand upstream of Barber Dam
<p>Riparian Condition Riparian vegetation type and continuity of riparian buffer</p>	Grass-Shrub dominated; continuous
<p>Average Floodplain Width (ft) Width of active floodplain on both sides of the channel (excluding the channel width)</p>	Less than 50ft
<p>Meander Belt Width (ft) Equivalent to a single active meander amplitude; may be truncated by levees/riprap</p>	325
<p>Floodplain Features Off-channel features within the active floodplain (e.g.: side channels, alcoves, sloughs and wetlands)</p>	High-flow side channels and perennial wetlands

REACH 1 – Boise Diversion Dam to Barber Dam	
Drainage Density Area of main channel and tributaries divided by total drainage area. A high drainage density may correspond with a flashier hydrograph	Not Measured
Primary Landuse	Undeveloped

4.2 FACSTREAM SCORES

4.2.1 Future Without Project

The future without project (FWOP) FACStream Subvariable (SV) scores shown below in Table 4-2. The score justifications, assumptions, descriptions, and comments on the BPCA

Table 4-2. FACStream Scores for Future without Project at the BCPA

FWOP Subvariables	Year 0	Year 10	Year 25	Year 50
<i>SV 1.1 Total Volume</i>	50	50	50	50
<i>SV 1.2 Peak Flows</i>	55	55	55	55
<i>SV 1.3 Base Flows</i>	70	70	70	70
<i>SV 1.4 Flow Variability</i>	65	65	65	65
<i>SV 2.1 Land Erosion</i>	80	79	78	77
<i>SV 2.2 Channel Erosion</i>	75	74	73	72
<i>SV 2.3 Transport</i>	55	55	55	55
<i>SV 3.1 Temperature Regime</i>	65	64	63	62
<i>SV 3.2 Organics / Nutrients</i>	65	64	63	62
<i>SV 3.3 Inorganics / Toxins</i>	65	64	63	62
<i>SV 4.1 Saturation Frequency</i>	60	60	60	60
<i>SV 4.2 Floodplain Width</i>	60	60	60	60
<i>SV 4.3 Saturation Duration</i>	60	60	60	60
<i>SV 5.1 Woody Vegetation Structure</i>	50	50	50	50
<i>SV 5.2 Herbaceous Vegetation Structure</i>	50	50	50	50
<i>SV 5.3 Species Diversity</i>	60	60	60	60
<i>SV 6.1 Large Woody Debris</i>	50	50	50	50
<i>SV 6.2 Detritus</i>	50	50	50	50
<i>SV 7.1 Evolutionary Stage</i>	59	57	55	54
<i>SV 7.2 Planform</i>	60	60	60	60
<i>SV 7.3 Dimension</i>	55	55	55	55
<i>SV 7.4 Profile</i>	50	50	50	50
<i>SV 8.1 Dynamic Equilibrium</i>	60	60	60	60
<i>SV 8.2 Resilience</i>	60	60	60	60
<i>SV 9.1 Hydraulic Structure</i>	55	55	55	55
<i>SV 9.2 Coarse Scale</i>	55	54	53	52

FWOP Subvariables	Year 0	Year 10	Year 25	Year 50
SV 9.3 Fine Scale	60	60	60	60
SV 10.1 Biotic Structure	67	67	67	67

SV 1.1 Total Volume Score Year 0: 50; Year 10, 25, and 50: 50,50,50

The scoring from one grade to another is 10% and the data suggests nearly 10% lower depletion than this score's category, so I am choosing the lowest possible: 50 (F - Non-functioning, Profound Impact) Net change from augmentations and depletions more than 40% of the total annual volume. Including partial years 2007 and 2025 (Table 4-3), the average is 48%. Actually 48.46%. i.e. New York Canal is taking off 48.46% of the total Lucky Peak Outflow. Excluding the partial years the average is 47.7%.

Table 4-3. Time Series of total volumes of flow from Lucky Peak Dam and the New York Canal.

Year	NY Canal ac-ft	Lucky Peak ac-ft	NYC/LUC	Notes
2007	3831964	6145769	0.62	* starting 24 July
2008	10891791	20386948	0.53	
2009	11129648	21222252	0.52	
2010	11177004	19868790	0.56	
2011	10628613	29633336	0.36	
2012	10591639	24895040	0.43	
2013	5912315	11215214	0.53	
2014	9338698	16646250	0.56	
2015	7518436	14597427	0.52	
2016	8494021	17635997	0.48	
2017	8873013	27504425	0.32	
2018	8248386	18693066	0.44	
2019	7968374	20820808	0.38	
2020	7875864	14485223	0.54	
2021	6996197	13065734	0.54	
2022	7649853	14834590	0.52	
2023	8523421	21402188	0.40	
2024	8220141	17009583	0.48	
2025	1054950	2245604	0.47	*ending 13 May

As the diversion continues to account for almost half of the water flow, the total volume remains consistently low and is unlikely to change without intervention. Hence, no significant changes in the coming years are anticipated, maintaining the score of 50 through Year 50.

SV 1.2: Peak Flows Score Year 0: 55; Year 10, 25, and 50: 55,55,55

The dams and the canal lower the 66.7% AEP flow magnitude (1.5 yr return flow, or a possible placeholder for “bank-full” flow) 60% from 9,938 cfs down to 3,989 cfs. Peak flow patterns do not resemble the natural hydrograph. Highly altered flow regimes. Bankfull discharge is altered by more than 40%.

Lucky Peak outflow minus the New York Canal diversion gives the flow magnitude experienced in the Barber Pool reach. This time series was compared against the sum of the instantaneous (15-min) flow data for the same period of record from three USGS gauges upstream of the three dams regulating the Boise River: Mores Creek gauge (13200000), Twin Springs gauge (13185000), and South Fork gauge near Featherville (13186000). This comparison can be considered unregulated (upstream of the dams) versus regulated (downstream of the NY Canal diversion). Instantaneous data for the upstream gauges were summed, peaks extracted, then flow frequency analysis performed in HEC-SSP v2.3 with the resulting 0.667 Annual Exceedance Probability (1.5 yr return event) flow magnitude reported below.

Comparing the flows at Barber Pool against the sum of the three gauges upstream of any regulation (i.e. inflows into the reservoirs) is assumed to provide a direct illustration of hydrologic signature of the dams and the large New York Canal diversion on the flow experienced at Barber Pool. A better way to “un-regulate” the flow would be to create a RAS model of the watershed with the three upstream gauges as inflow boundaries and no dams or diversions in the model geometry. This would account for travel time and peak attenuation between the gauges and Barber Pool.

However, time and funding constraints limited the initial feasibility level analysis to this coarser estimate of an unregulated time series. Values in the Habitat model are informed by this comparison. Peaks at Barber Pool are less than they would be if unregulated. Flow frequency analysis using the Bulletin 17C approach in HEC-SSP on the Barber Pool data set yielded a 1.5 yr return event flow magnitude of 3,989 cfs for the regulated time series, and 9,938 cfs for the unregulated time series.

The regulatory flow patterns from the dams and the diversion from New York Canal severely alter the natural peak flow characteristics. Since no new interventions are planned to address these peak flow issues, the score remains static from Year 0 to Year 50.

SV 1.3: Base Flows Score Year 0: 70; Year 10, 25, and 50: 70,70,70

Baseflow magnitude decreased > 40%, but the reach consistently has 250 cfs so it does not run dry. This fits best into C - Functioning, Significant Impact: Typical low flow discharge is uniformly decreased by 20-40%, critically low flows occur occasionally. Naturally ephemeral or intermittent streams that are converted to perennial also fit this category.

Given the consistent baseflow provided by upstream reservoirs and the canal, it is assumed that this value will not fluctuate significantly over time. Therefore, the baseflow remains stable from Year 0 to Year 50, keeping the score at 70.

SV 1.4: Flow Variability Year 0 Score: 65; Year 10, 25, and 50: 65,65,65

Timing of high and low flows is seasonally out of phase with natural runoff processes, or rates of change are extremely altered. Rapid daily fluctuations are not common. At Barber pool the timing of peak and return to baseflow is out phase with the unregulated hydrograph. Rates of change in the current, regulated flow regime are a stepped hydrograph with steps commonly 500 cfs. Rapid daily fluctuations are rare. The unregulated time series is plotted against the regulated time series below to illustrate the last three years. Flow variability in Barber Pool is influenced by the timing of releases from the dams and the regulated flows from the New York Canal. The hydrograph is significantly out of phase with the natural runoff cycles, leading to altered peak and low flow patterns (Figure 4-1).

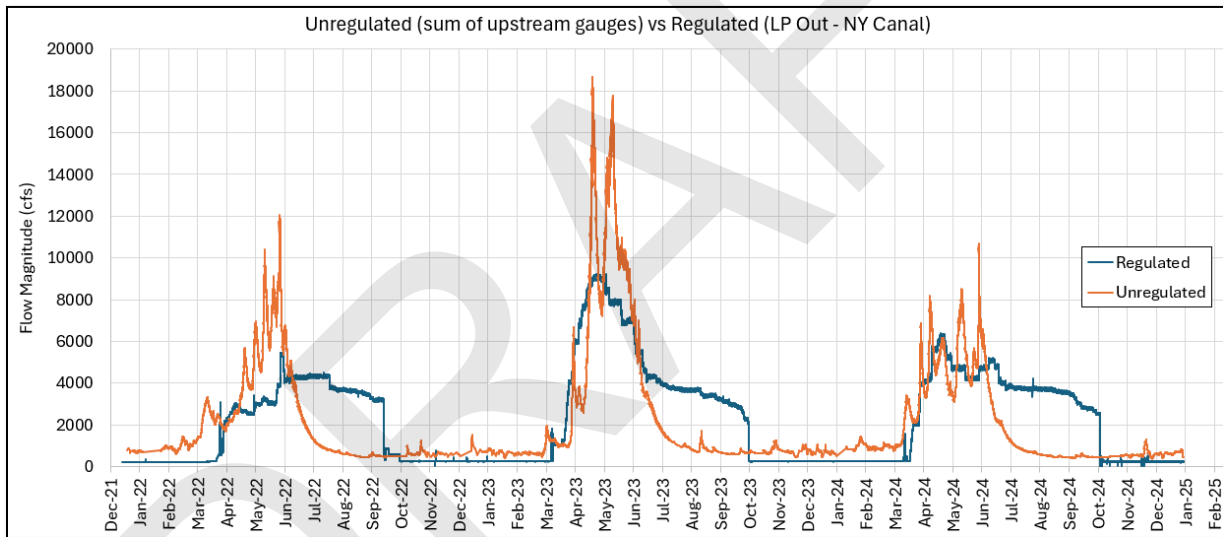


Figure 4-1. The combined hydrograph showing the sum of the three USGS gauges on the Boise River upstream from the reservoirs. Unregulated Mores Cr, the North, Middle, and South Forks of the Boise vs Regulate output from the Lucky Peak Dam plus New York Canal.

As the release patterns and diversions are unlikely to change over time without major capital investments or operational changes, the score remains consistent from Year 0 to Year 50

SV 2.1 - Land Erosion Score Year 0: 80; Year 10, 25, and 50: 79,78,77

This score seemed a good fit as the upstream dams trap a lot of sediment. Significant stressors are present, and rates of surface erosion and mass erosion events moderately impacted. The land erosion in the area is relatively low due to dam and canal regulation,

which reduces natural flood events that would otherwise cause land erosion. The score reflects mild impairment with a strong functioning system.

Over time, natural processes of erosion could slowly resume, especially as vegetation reestablishes. Although significant changes in land use are not expected, mild degradation due to natural processes leads to a slight decrease in score by Year 50.

SV 2.2 - Channel Erosion Score Year 0: 75; Year 10, 25, and 50: 74,73,72

This score seems best fit for this area as the guideline states: Widespread accelerated bank erosion in the watershed or along adjacent contributing reaches; or localized areas with major instability, incision, and/or gully formation that are not adjacent to the assessment reach but within the contributing area. Similar to land erosion, the channel erosion in Barber Pool has been significantly reduced by dam operations and the diversion of water. However, localized erosion still occurs in response to the flow alterations caused by the dams.

As sediment supply from upstream is reduced due to dam sediment trapping, the channel stability will gradually decline. Over time, this would likely result in further erosion and channel instability, leading to a slight decrease in score by Year 50.

SV 2.3 – Transport Score Year 0: 55; Year 10, 25, and 50: 55,55,55

Scored low as there are two upstream dams for this reach. Scoring Guideline description: Major impediments to sediment transport trap most or all incoming sediment, supplying the reach with "clear water discharge". Examples include tail waters where major dams are located close upstream from the assessment reach.

As the upstream conditions remain unchanged, the severe limitations on sediment transport will persist. This stable condition results in a score of 55 throughout the 50 years.

SV 3.1 - Temperature Regime Year 0 score 65; Year 10,25, and 50: 64,63,62

The Barber pool reach is 303d Listed for temps so 65 is reasonable. Scoring guidelines for this score state that temperature regime is altered to a degree that is known to affect natural aquatic biota, and/or standards are frequently exceeded. 303d listed reaches should be scored in this category or lower.

Given that the upstream reservoirs and canal operations are unlikely to change, the temperature regime will likely continue to worsen as it is expected to keep getting warmer in the future so slight decline through Year 50.

SV 3.2 - Organics / Nutrients Year 0 score 65; Year 10,25, and 50: 64,63,62

Given the development I believe water quality is altered to a degree that is known to affect natural aquatic biota, and/or standards are frequently exceeded. 303d listed

reaches should be scored in this category or lower. Nitrogen, phosphorous, and suspended sediment are secondary WQ concerns noted in MacCoy (2006). These issues are due to agriculture, wastewater treatment plants, and urban development (MacCoy 2006) which have significantly increased since 2006.

Nutrient and organic inputs are altered by agriculture, wastewater treatment facilities, and urban runoff. These alterations significantly affect the aquatic food chain. This is expected to conute and probably grow so slight decline over the next 50 years.

SV 3.3 - Inorganics / Toxins Year 0 score 65; Year 10,25, and 50: 64,63,62

IBI scores for the Boise River have been negatively correlated with water temperature, specific conductance, and suspended sediment (MacCoy 2006). Water quality is altered to a degree that is known to affect natural aquatic biota, and/or standards are frequently exceeded. 303d listed reaches should be scored in this category or lower. Wastewater treatment plant effluent contributes to declines in sculpin (sentinel species) populations (MacCoy 2006, Mullins 1998b). IBI scores for macroinvertebrates and fish were generally higher upstream of wastewater treatment facilities (USGS 1998). Two sculpin species were abundant upstream of wastewater treatment facilities while none were found downstream in 1995 and only 2% were found downstream in 1996.

The Boise River is impacted by urban runoff and wastewater treatment plant effluent, contributing to elevated inorganic levels and toxins in the water. Slight decline in wastewater management or pollution controls as it is anticipated that the population will only get bigger in the near future, keeping this score slowly dropping throughout the time periods.

SV 4.1 - Saturation Frequency Year 0 Score 60; Year 10,25, and 50: 60,60,60

F3 Rosgen score from Richardson and Guilinger 2015 notes the Barber pool reaches' Rosgen Classification as F3 with an entrenchment ratio <1.4. The Rosgen system is a standardized, hierarchical method used by scientists and engineers to classify streams based on their physical morphology. An F3 stream is a deeply entrenched, meandering, riffle-pool channel with a low gradient and a bed predominantly made of cobble. 5-10 year returns of flooding to reach that height would be the largest floods that have around 5-year gaps between them, when the gaps develop so 60 is a fair and conservative score (Figure 4-2).

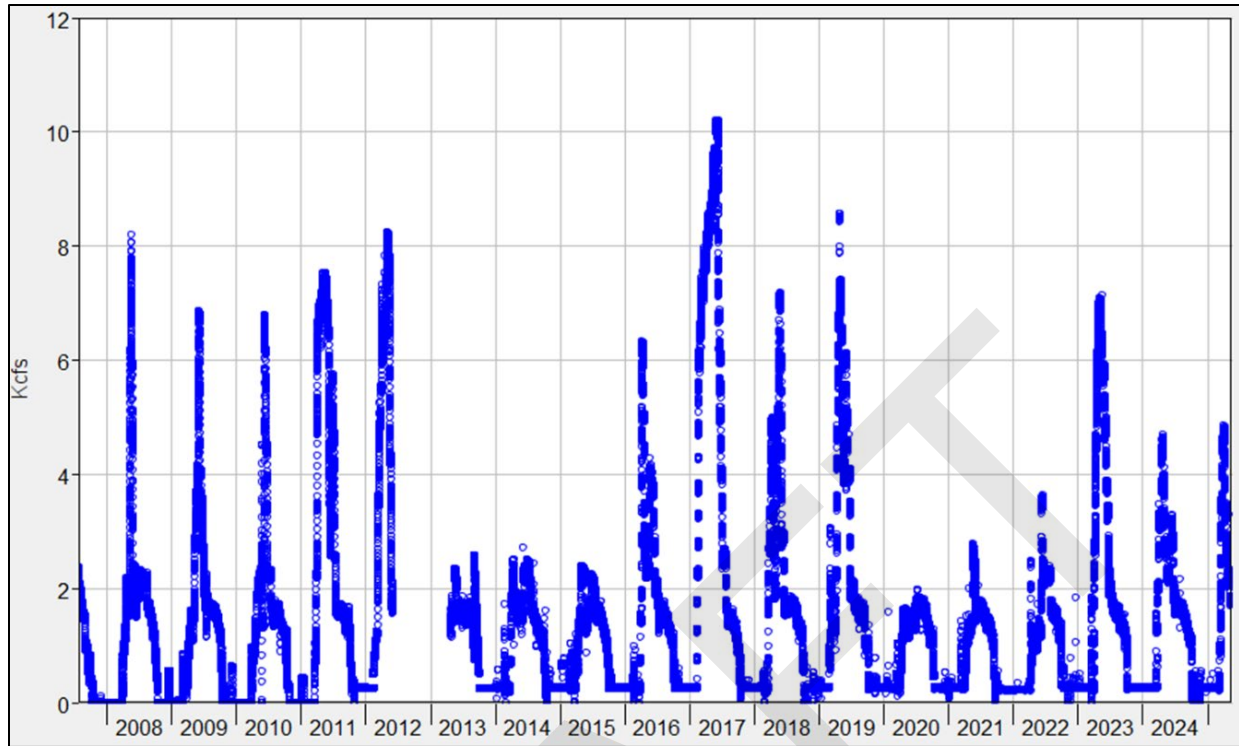


Figure 4-2. Hydrograph with kfcfs over years at Barber Pool Dam showing flooding event frequency.

The access of water to the floodplain is limited by structural alterations such as the dam and channelization. Water only occasionally reaches the floodplain during peak flows. The floodplain connectivity remains limited due to ongoing dam regulation and canal diversions, leading to a consistent score throughout the 50 years.

SV 4.2 - Floodplain Width Year 0 Score 60; Year 10,25, and 50: 60,60,60

Floodplain extent is diminished 50 - 70% (30 - 50% intact). The floodplain consists of seasonal side channels scoured into first terrace surface (evidenced by active sand deposition within channels), backwater inundated downstream sections of side channels. Side channels augmented by beaver activity (Richardson and Guilinger 20215). Average flood plain width is less than 50ft so a score of 60 is reasonable. Especially since lowering the Barber Dam caused so much of the flood plane to reduce.

Floodplain width is severely impacted by the presence of levees, dams, and the canal. This has led to a significant reduction in the lateral extent of the floodplain. As no new floodplain restoration measures are proposed, the width of the floodplain remains unchanged throughout the 50 years.

SV 4.3 - Saturation Duration Year 0 Score 60; Year 10,25, and 50: 60,60,60

The active floodplain is unnaturally dry for most of the growing season, or complete seasons go by without any saturation at all. The diversion and controlling of the floods

lead to this phenomenon in the reach so a score of 60 is justified. The duration of floodplain saturation is minimal due to flood control measures that reduce time of inundation events from outflow stepping. This leads to reduced wetland functions.

Similar to floodplain width, the duration of floodplain saturation remains limited due to ongoing hydrological alterations, leading to a stable score over the next 50 years

SV 5.1 - Woody Vegetation Structure Year 0 Score 50; Year 10,25, and 50: 50,50,50

The National Landcover dataset shows that woody wetland and forest account for 6 percent of the 520 acre site so this was scored as low as possible. It would more than conservative to say that Woody vegetation cover is decreased by more than 60%, or multiple structural characteristics are profoundly altered. Woody vegetation cover is decreased by more than 60%, or multiple structural characteristics are profoundly altered. Richardson and Guilinger (2015) stat that the riparian condition is grass-shrub dominated as well.

The riparian vegetation is primarily grass and shrub-dominated, with woody vegetation severely limited due to historical land use practices. Woody vegetation reestablishes slowly over time, the structure is not expected improve anytime soon so the score remains stable.

SV 5.2 - Herbaceous Vegetation Structure Year 0 Score: 50; Year 10,25, and 50: 50,50,50

Herbaceous vegetation accounts for 36% of the 520 acre site so a 50 is about right. Herbaceous vegetation cover is decreased by more than 60% is the threshold for the category.

Herbaceous vegetation covers a significant portion of the floodplain but is subject to ongoing disturbance from land use activities. While some natural recovery of herbaceous vegetation may occur, it is unlikely to reach full functional levels without active restoration efforts, so the score remains stable.

SV 5.3 - Species Diversity - Year 0 Score 60; Year 10,25, and 50: 60,60,60

Shrub-steppe is not normally what is for the area i.e. riparian upland wetland cottwood gallery forest. Most reference species are not present. Non-native species or bare ground make up less than 60% of cover. Most reference species are not present. Non-native species or bare ground make up less than 60% of cover.

Diversity is moderate but still affected by the prevalence of non-native species and disturbance in the riparian zone. As with vegetation structure, species diversity is impacted by the current land use and hydrological conditions, so no significant change is expected without further intervention.

SV 6.1 - Large Woody Debris - Year 0 Score: 50; Year 10,25, and 50: 50,50,50

Scored as low as possible given the multiple dams upstream do not allow for LWD to arrive in the area. LWD supply is decreased by more than 75% is the scoring guideline for this grade score and we feel this meets that ratio with confidence. The supply of large woody debris is significantly limited by upstream dam regulations that prevent natural tree recruitment.

Without active restoration measures such as tree planting or removing barriers to natural wood recruitment, this score remains unchanged.

SV 6.2 - Detritus - Year 0 Score: 55; Year 10,25, and 50: 55,55,55

Scored as low as possible given the dams upstream do not allow detritus to arrive in the area. Detritus supply is decreased by more than 75% but there are some trees in the area so slight bump to 55 was reasonable.

The lack of natural sediment and wood transport will maintain low detritus levels in the system for the foreseeable future.

SV 7.1 Evolutionary Stage – Year 0 Score: 59; Year 10,25, and 50: 57,55,54

According to Richardson and Guilinger 2015 this stretch of river is F3 in Rosgen Classification. With the sand bluffs that keep falling into the river we expect this section to keep widening and degrading the score is conservative and reasonable.

With ongoing channel evolution due to bank erosion and sediment deposition. As the channel continues to evolve, it is expected that this will lead to further degradation, pushing the evolutionary stage into a less functional state over time.

SV 7.2: Planform – Year 0 Score 60; Year 10,25, and 50: 60,60,60

The planform SV deals with gross changes to stream pattern including anastomosis, branching patterns, and sinuosity.

Sinuosity according to Richardson and Gulinger 2015 is 1.2 for this reach. Since this is a single channel with some tiny side channels I scored 60.

Sinuosity and meandering patterns have been somewhat reduced by the dams, leading to a relatively low score. The planform of the reach remains consistent as the channel continues to be regulated, so no significant changes are anticipated in the next 50 years.

SV 7.3: Dimension – Year 0 Score: 55; Year 10,25, and 50: 55,55,55

Richardson and Gulilnger 2015 Lots of sand and bank erosion with the lack of rougher material from the Dams, this section is degrading as the only sediment recruitment

seems to come from the bank. Entrenchment Ratio <1.4 which is an F in the scoring guidelines.

The cross-sectional area and width-to-depth ratios are altered due to the dam's impact on the river profile. Given the lack of intervention in this area, the dimensional characteristics of the river remain unchanged over time.

SV 7.4: Profile – Year 0 Score 50; Year 10,25, and 50: 50,50,50

We calculated it to be an 86% change thanks to the barber dam which well justifies the score. Severe changes to slope are evident. Examples include anastomosed or meandering streams that were straightened, or streams with very large structures that maintain stepped profile over all flows up to bank full.

The profile is steeply altered by the Barber Dam, which has significantly changed the gradient of the river. The profile will continue to be impacted by the dam's presence, with no major restoration measures planned for the future.

SV 8.1: Dynamic Equilibrium - Year 0 Score 60; Year 10,25, and 50: 60,60,60

The Year 0 score seemed to fit best it is really shallow for the width and erosion with the sand. Excess deposition, scour, or widespread bank erosion are common. Indicators include common avulsions on meandering streams, complete pool filling, reach wide aggradation, or recent head cuts. Artificially hardened channels in unconfined alluvial valleys also meet this.

The dynamic equilibrium of the system is unstable, with the river struggling to maintain balance due to altered flow regimes. Without significant interventions, the equilibrium of the river remains disturbed, maintaining a steady score through Year 50.

SV 8.2: Resilience - Year 0 Score 60; Year 10,25, and 50: 60,60,60

Score 60 seemed to fit best it is shallow for the width and erosion with the sand. Limited resilience. Examples include reaches that depend upon artificial stabilization or structures to maintain form, limited floodplain connectivity, very poor riparian vegetation, or water source impairment that strongly affects peak flows and effective discharge.

Resilience to disturbance is low due to ongoing human interventions and altered natural processes. As no large scale in-river restoration efforts are expected, the resilience of the reach remains low, leading to a consistent score throughout the timeline.

SV 9.1: Hydraulic Structure - Year 0 Score: 55; Year 10,25, and 50: 55,55,55

Highly controlled so 55 is reasonable. Homogenous velocity and/or depth conditions that are outside tolerance of most native aquatic organisms. The hydraulic structure SV represents the amount of deviation from characteristic distribution of water depth and

velocity in the stream. It is a primary physical habitat parameter for most organisms living within the water column.

The hydraulic structure is controlled, leading to homogenous flow patterns and poor habitat conditions for aquatic organisms. With the current management approach, no major changes are expected to the hydraulic structure.

SV 9.2: Coarse Scale – Year 0 Score: 55; Year 10,25, and 50: 54,53,52

Scored this sub-variable 55 as Richardson 2015 Classified this reach as Plane-Bed. Severely altered coarse-scale structural diversity. Examples include reaches with severely homogenized physical characteristics such as unnatural plain-bed morphology.

The coarse-scale physical structure is highly altered, with significant reductions in the natural diversity of bedforms and bank types. As the reach remains heavily managed, there is little to no expected improvement in the coarse-scale structure so slight drop as there maybe problems with sand encroachment from local sources.

SV 9.3: Fine Scale – Year 0 Score 60; Year 10,25, and 50: 60,60,60

Mostly sand not much silt so 65 is reasonable as the dams upstream capture a lot of fines. Fine-scale structural diversity is significantly limited. Examples include gravel or cobble-bed streams with bimodal materials distribution, increased embeddedness, sediment starved reaches that lack fine sediment and reaches lacking characteristic detritus or LWD.

Fine-scale physical structure is moderately impacted, with limited diversity in substrate and sediment transport. Without sediment transport and natural processes, fine-scale structure remains static over time.

SV 10.1 Biotic Structure Year 0 Score 67; Year 10,25,50: 67,67,67

Five communities represent SVs 10.1 through 10.5 (Microbes, Macrophytes, Macroinvertebrates, Fish & Amphibians, and Other Animals). Microbes Score: 65 303d Listed for temps so 65 is reasonable. Community structure is severely altered and may include a preponderance of exotic species, major loss of diversity or severely limited keystone species. One or more important functional guilds are impacted or poorly represented. Reaches with nonfunctional V3 scores. Known microbial infestation. 303d listed reaches. *Macrophytes*. Score 70 seemed to fit. Community structure is altered. Exotic species may be common, diversity lacking, and/or species distributions skewed, but exotic species generally fill natural niches. Important functional guilds are appropriately represented even when composed of nonnative species. Highly unnatural density of macrophytes, significant presence of exotic aquatic plants. *Macroinvertebrates* Score 70. Mostly tolerant species, diminished diversity, specific guilds over or underrepresented with more instream structure or woody debris or detritus it could be better. *Fish and amphibians*: Score: 70 Managed game fisheries, highly altered native fish community, major fish passage barriers. Community structure

is severely altered and may include a preponderance of exotic species, major loss of diversity or severely limited keystone species. One or more important functional guilds are impacted or poorly represented. *Other animals (Including birds):* 70 Typical species diminished presence, keystone species diminished e.g. beavers

The biotic structure is somewhat impaired by non-native species, but a functioning community of aquatic organisms is still present. Given that no large-scale improvements to habitat are planned, the biotic structure is assumed to remain relatively constant for the next 50 years.

4.2.2 Wetland Mosaic

Several FACStream subvariables remain unchanged across this alternative's relative to the Future Without Project (FWOP) condition. The parameters are primarily influenced by basin-scale hydrology and geomorphic drivers, including regulated dam releases, major diversions (e.g., New York Canal), and valley-scale confinement—that are not directly affected by localized restoration measures. The proposed actions within the Barber Pool Conservation Area (e.g., floodplain reconnection, wetland excavation, instream wood placement, and vegetation plantings) target habitat complexity, hydrologic connectivity, and ecological structure at the reach scale, rather than altering systemwide flow regimes or sediment supply.

Things like total annual water volume, peak and base flow magnitudes, sediment delivery from upstream, and macrochannel geometry remain governed by existing infrastructure and flow management. Large-scale hydraulic structure, channel profile, and dimension parameters are maintained within current physical boundaries, as project actions are confined to secondary and floodplain channels rather than the mainstem conveyance corridor. Therefore, while the alternatives improve ecological and geomorphic function locally, they do not produce measurable changes in these regional hydrologic and structural variables.

In the Wetland Mosaic alternative, several FACStream subvariables show measurable improvement compared to the Future Without Project (FWOP) condition (Table 4-4).

Table 4-4. FACStream Scores for Alternative 1: Wetland Mosaic at the BCPA with changes from FWOP in bold.

Wetland Mosaic Subvariables	Year 0	Year 10	Year 25	Year 50
<i>SV 1.1 Total Volume</i>	50	50	50	50
<i>SV 1.2 Peak Flows</i>	55	55	55	55
<i>SV 1.3 Base Flows</i>	70	70	70	70
<i>SV 1.4 Flow Variability</i>	65	65	65	65
<i>SV 2.1 Land Erosion</i>	80	79	78	77
<i>SV 2.2 Channel Erosion</i>	75	74	73	72
<i>SV 2.3 Transport</i>	55	55	55	55
<i>SV 3.1 Temperature Regime</i>	65	64	63	62

Wetland Mosaic Subvariables	Year 0	Year 10	Year 25	Year 50
<i>SV 3.2 Organics / Nutrients</i>	70	72	74	70
<i>SV 3.3 Inorganics / Toxins</i>	70	74	74	72
<i>SV 4.1 Saturation Frequency</i>	65	65	65	65
<i>SV 4.2 Floodplain Width</i>	65	65	65	65
<i>SV 4.3 Saturation Duration</i>	65	65	65	65
<i>SV 5.1 Woody Vegetation Structure</i>	50	50	50	50
<i>SV 5.2 Herbaceous Vegetation Structure</i>	55	60	60	60
<i>SV 5.3 Species Diversity</i>	65	65	65	65
<i>SV 6.1 Large Woody Debris</i>	50	50	50	50
<i>SV 6.2 Detritus</i>	55	55	55	55
<i>SV 7.1 Evolutionary Stage</i>	59	57	55	54
<i>SV 7.2 Planform</i>	60	60	60	60
<i>SV 7.3 Dimension</i>	55	55	55	55
<i>SV 7.4 Profile</i>	50	50	50	50
<i>SV 8.1 Dynamic Equilibrium</i>	60	60	60	60
<i>SV 8.2 Resilience</i>	65	65	65	65
<i>SV 9.1 Hydraulic Structure</i>	55	55	55	55
<i>SV 9.2 Coarse Scale</i>	55	54	53	52
<i>SV 9.3 Fine Scale</i>	60	60	60	60
<i>SV 10.1 Biotic Structure</i>	71	73	75	76

Overall, the Wetland Mosaic alternative yields measurable functional lift, particularly in nutrient processing, floodplain hydrology, vegetation diversity, and biological productivity—through synergistic effects of plantings, terrain modifications and habitat features. These actions restore the wetland–floodplain continuum that drives higher ecological function while maintaining hydrologic stability within the regulated Barber Pool reach.

SV 3.2 (Organics/Nutrients), scores improve from 65 in FWOP to 70 at Year 0 and peak at 74 by Year 25 before stabilizing around 70 by Year 50. Excavation of uplands to wetlands and installation of BDAs create slow-water environments that trap organic matter and recycle nutrients. Vegetation plantings supply litter and root material that enrich soil carbon, allowing nutrient cycling to mature through Year 25 and remain stable over the long term.

SV 3.3 (Inorganics/Toxins), scores rise from 65 to 70 initially and reach 74 by Year 25 before a slight decline to 72 at Year 50. Wetland creation and channel backfill improve water-quality filtration by promoting sedimentation and adsorption of metals within organic soils. BDAs enhance residence time, allowing further chemical attenuation.

SV 4.1 (Saturation Frequency) increases from 60 to 65 and remains stable. Floodplain excavation brings groundwater closer to the surface, increasing the frequency and

duration of soil saturation. BDAs disperse high-flow pulses across the new mosaic, maintaining consistent soil moisture as vegetation matures.

SV 4.2 (Floodplain Width) improves from 60 to 65 and stabilizes thereafter. The combination of regrading and wetland excavation expands the lateral extent of floodplain inundation, enabling seasonal connection to the active hydrologic corridor.

SV 4.3 (Saturation Duration), scores increase from 60 to 65 and remain there through Year 50. The interplay of BDAs and excavated depressions creates topographic variation that prolongs surface and subsurface retention, while peat-forming soils and deep roots maintain high moisture through time.

SV 5.2 (Herbaceous Vegetation Structure) rises from 50 to 55 initially and reaches 60 by Year 10, sustaining that level thereafter. Dense native plantings introduce hydrophytic grasses and sedges suited to fluctuating moisture. The herbaceous layer stabilizes banks and fosters continuous cover, maintained by moisture and disturbance from BDAs.

SV 5.3 (Species Diversity) improves from 60 to 65 and remains stable. Plantings and wetland excavation create a variety of hydrologic conditions that support diverse riparian and wetland species. Structural heterogeneity peaks around Year 25 as woody and herbaceous layers mature, providing habitat for pollinators and birds.

SV 6.2 (Detritus) increases from 50 to 55 and remains constant over time. BDAs and new wetlands slow water, allowing organic matter accumulation and supporting microbial and invertebrate production. By Year 25, the system achieves a balanced detrital cycle sustained by annual litter inputs.

SV 10.1 (Biotic Structure) improves from 67 to 71 at Year 0 and rises steadily to 76 by Year 50. The combined influence of vegetation plantings, wetland creation, and BDAs establishes a complex trophic structure supporting microbes, plants, amphibians, fish, and birds. Habitat complexity and hydrologic reliability foster full community occupation by Year 25 and a self-sustaining, mature biotic mosaic by Year 50.

4.2.3 Main Channel 1

Several FACStream subvariables remain unchanged across this alternative's relative to the Future Without Project (FWOP) condition. The parameters are primarily influenced by basin-scale hydrology and geomorphic drivers, including regulated dam releases, major diversions (e.g., New York Canal), and valley-scale confinement—that are not directly affected by localized restoration measures. The proposed actions within the Barber Pool Conservation Area (e.g., floodplain reconnection, wetland excavation, instream wood placement, and vegetation plantings) target habitat complexity, hydrologic connectivity, and ecological structure at the reach scale, rather than altering systemwide flow regimes or sediment supply.

Things like total annual water volume, peak and base flow magnitudes, sediment delivery from upstream, and macrochannel geometry remain governed by existing

infrastructure and flow management. Large-scale hydraulic structure, channel profile, and dimension parameters are maintained within current physical boundaries, as project actions are confined to secondary and floodplain channels rather than the mainstem conveyance corridor. Therefore, while the alternatives improve ecological and geomorphic function locally, they do not produce measurable changes in these regional hydrologic and structural variables.

In the MC1 alternative, several FACStream subvariables demonstrate meaningful improvement over the Future Without Project (FWOP) condition due to a suite of measures that restore floodplain hydrology, channel complexity, and riparian vegetation (Table 4-5).

Table 4-5. Main Channel 1 FACStream Scores

<i>MC1 Subvariables</i>	<i>Year 0</i>	<i>Year 10</i>	<i>Year 25</i>	<i>Year 50</i>
<i>SV 1.1 Total Volume</i>	50	50	50	50
<i>SV 1.2 Peak Flows</i>	55	55	55	55
<i>SV 1.3 Base Flows</i>	70	70	70	70
<i>SV 1.4 Flow Variability</i>	65	65	65	65
<i>SV 2.1 Land Erosion</i>	80	79	78	77
<i>SV 2.2 Channel Erosion</i>	75	74	73	72
<i>SV 2.3 Transport</i>	55	55	55	55
<i>SV 3.1 Temperature Regime</i>	65	64	63	62
<i>SV 3.2 Organics / Nutrients</i>	70	72	74	70
<i>SV 3.3 Inorganics / Toxins</i>	70	74	74	72
<i>SV 4.1 Saturation Frequency</i>	65	65	65	65
<i>SV 4.2 Floodplain Width</i>	64	65	66	66
<i>SV 4.3 Saturation Duration</i>	63	65	65	65
<i>SV 5.1 Woody Vegetation Structure</i>	54	58	59	59
<i>SV 5.2 Herbaceous Vegetation Structure</i>	54	56	56	56
<i>SV 5.3 Species Diversity</i>	63	64	64	64
<i>SV 6.1 Large Woody Debris</i>	50	60	70	70
<i>SV 6.2 Detritus</i>	50	60	65	65
<i>SV 7.1 Evolutionary Stage</i>	59	57	55	54
<i>SV 7.2 Planform</i>	63	63	64	64
<i>SV 7.3 Dimension</i>	55	55	55	55
<i>SV 7.4 Profile</i>	53	53	53	53
<i>SV 8.1 Dynamic Equilibrium</i>	60	60	60	60
<i>SV 8.2 Resilience</i>	65	65	65	65
<i>SV 9.1 Hydraulic Structure</i>	55	55	55	55
<i>SV 9.2 Coarse Scale</i>	55	54	53	52
<i>SV 9.3 Fine Scale</i>	60	60	60	60
<i>SV 10.1 Biotic Structure</i>	72	74	76	77

In the MC1 alternative, several FACStream subvariables demonstrate meaningful improvement over the Future Without Project (FWOP) condition due to a suite of measures that restore floodplain hydrology, channel complexity, and riparian vegetation. The MC1 alternative yields broad improvements across hydrologic, geomorphic, and biological parameters, driven by reconnection of side channels and floodplain areas, natural material recruitment, and resilient riparian vegetation communities.

SV 3.2 (Organics/Nutrients), scores rise from 65 under FWOP to 70 in Year 0 of MC1, peaking at 74 by Year 25 before settling at 70 by Year 50. Excavation of uplands and floodplain channels combined with BDAs increases the retention and processing of organic material by creating low-velocity wetland areas. Vegetation plantings further contribute to nutrient cycling through litterfall and root decay. These improvements accelerate through Year 25 as vegetation matures and microbial communities expand, with slight stabilization over time as sedimentation fills some depressional features.

SV 3.3 (Inorganics/Toxins) also improves from 65 to 70 initially and reaches 74 by Year 25 before a minor decline to 72 by Year 50. Wetland and channel reconnection measures filter fine sediments and contaminants as water travels through reestablished overbank zones. BDAs promote settling of suspended particulates and adsorption of metals in organic-rich soils. This filtering process is most effective by Year 25, when plant and microbial systems are fully established, maintaining long-term improvements to water quality.

SV 4.1 (Saturation Frequency), scores increase from 60 to 65 and hold steady. Excavating inactive floodplain channels and creating new wetland connections bring the water table closer to the surface, allowing more frequent soil saturation. BDAs disperse flows and extend floodplain inundation periods, helping maintain soil moisture through varied seasonal conditions.

SV 4.2 (Floodplain Width) rises from 60 to 64 in Year 0, gradually increasing to 66 by Year 50. The excavation of secondary and floodplain channels and low-lying wetlands increases the lateral extent of flow, reconnecting isolated floodplain areas and creating broader hydrologic connectivity. These effects remain stable as new vegetation anchors the expanded floodplain zone.

SV 4.3 (Saturation Duration) improves from 60 to 63 in Year 0 and reaches 65 by Year 10, holding steady thereafter. Seasonal hydrologic reconnection from BDAs and floodplain excavation lengthens the period that wetland soils remain saturated. As organic material accumulates and hydric soils develop, these areas retain water longer each year, creating more stable wetland conditions by Year 25 and beyond.

SV 5.1 (Woody Vegetation Structure), scores increase from 50 to 54 initially, reaching 59 by Year 25 and maintaining that level. Dense woody plantings along the channel margins and wetlands accelerate riparian canopy development. The excavation measures that reconnect the floodplain promote seed dispersal and recruit native tree and shrub species, enhancing vertical structure over time.

SV 5.2 (Herbaceous Vegetation Structure) improves from 50 to 54 at Year 0 and 56 by Year 10, maintaining that value through Year 50. Extensive seeding and planting establish diverse grasses and sedges that stabilize soils, increase cover density, and support long-term persistence through hydrologic variability.

SV 5.3 (Species Diversity) rises from 60 to 63 at Year 0 and 64 by Year 10, maintaining stability thereafter. The combined actions of wetland creation, BDAs, and floodplain excavation increase microhabitat diversity, allowing a greater variety of species to colonize and persist. This structural heterogeneity is sustained through self-seeding and natural regeneration by Year 25.

SV 6.1 (Large Woody Debris), scores climb sharply from 50 in FWOP to 60 by Year 10 and 70 by Year 25, remaining high through Year 50. BDAs and perennial side channel excavation promote wood deposition, while riparian plantings provide long-term sources of large woody material. This influx of wood improves channel stability, creates pool-riffle complexity, and enhances fish habitat.

SV 6.2 (Detritus) also improves from 50 to 60 by Year 10 and reaches 65 by Year 25, sustained through Year 50. As vegetation and woody debris accumulate, organic inputs stabilize nutrient cycling and support benthic communities.

SV 7.1 (Evolutionary Stage) exhibits a modest short-term decline from 59 to 57 by Year 10 and stabilizes at 54 by Year 50. The system initially undergoes disturbance due to excavation and regrading, but this is followed by stabilization and maturation into a more diverse and dynamic channel–floodplain complex.

SV 7.3 (Dimension) improves slightly from 55 to 56 by Year 25 and 55 by Year 50, reflecting more natural channel geometry within the newly excavated perennial side channels. These modifications restore appropriate depth-to-width ratios, improving hydraulic conditions for aquatic species.

SV 8.2 (Resilience) increases from 60 to 65 and remains stable through Year 50. The combination of riparian plantings and controlled access strengthens bank stability and minimizes recreational disturbance. The site becomes more resistant to erosion and flood impacts as vegetation matures.

SV 9.1 (Hydraulic Structure) maintains its baseline through Year 10 but shows localized improvement in flow variability and habitat structure due to the introduction of BDAs and side channel excavation. These structures diversify hydraulics and enhance energy dissipation during high flows.

SV 10.1 (Biotic Structure) improves from 67 in FWOP to 72 in Year 0 and reaches 77 by Year 50. The synergistic effects of BDAs, perennial channel reconnection, wetland creation, and plantings foster a mosaic of habitats that support amphibians, fish, and avian species. By Year 25, ecological guilds are well established, and by Year 50 the site functions as a mature, self-sustaining habitat complex with robust trophic interactions.

4.2.4 Main Channel 2

Several FACStream subvariables remain unchanged across this alternative’s relative to the Future Without Project (FWOP) condition. The parameters are primarily influenced by basin-scale hydrology and geomorphic drivers—including regulated dam releases, major diversions (e.g., New York Canal), and valley-scale confinement—that are not directly affected by localized restoration measures. The proposed actions within the Barber Pool Conservation Area (e.g., floodplain reconnection, wetland excavation, instream wood placement, and vegetation plantings) target habitat complexity, hydrologic connectivity, and ecological structure at the reach scale, rather than altering systemwide flow regimes or sediment supply.

Things like total annual water volume, peak and base flow magnitudes, sediment delivery from upstream, and macrochannel geometry remain governed by existing infrastructure and flow management. Large-scale hydraulic structure, channel profile, and dimension parameters are maintained within current physical boundaries, as project actions are confined to secondary and floodplain channels rather than the mainstem conveyance corridor. Therefore, while the alternatives improve ecological and geomorphic function locally, they do not produce measurable changes in these regional hydrologic and structural variables

In the MC2 alternative, several FACStream subvariables show measurable improvement compared to the Future Without Project (FWOP) condition (Table 4-6). The proposed measures Vegetation Plantings, Instream Structures and Bioengineering Bank Stabilization, Excavation of Uplands to Wetlands, Filling of Open Channel Segments, and Controlled Access Points jointly enhance channel stability, hydrologic connectivity, riparian vegetation, and habitat complexity across the Boise State University property reach.

Table 4-6. Main Channel 2 FACStream scores.

<i>MC2 Subvariables</i>	<i>Year 0</i>	<i>Year 10</i>	<i>Year 25</i>	<i>Year 50</i>
<i>SV 1.1 Total Volume</i>	50	50	50	50
<i>SV 1.2 Peak Flows</i>	55	55	55	55
<i>SV 1.3 Base Flows</i>	70	70	70	70
<i>SV 1.4 Flow Variability</i>	65	65	65	65
<i>SV 2.1 Land Erosion</i>	80	79	78	77
<i>SV 2.2 Channel Erosion</i>	77	77	77	77
<i>SV 2.3 Transport</i>	55	55	55	55
<i>SV 3.1 Temperature Regime</i>	65	64	63	62
<i>SV 3.2 Organics / Nutrients</i>	68	68	68	68
<i>SV 3.3 Inorganics / Toxins</i>	68	68	68	68
<i>SV 4.1 Saturation Frequency</i>	65	65	65	65
<i>SV 4.2 Floodplain Width</i>	64	65	66	66
<i>SV 4.3 Saturation Duration</i>	63	65	65	65

MC2 Subvariables	Year 0	Year 10	Year 25	Year 50
<i>SV 5.1 Woody Vegetation Structure</i>	54	58	59	59
<i>SV 5.2 Herbaceous Vegetation Structure</i>	54	56	56	56
<i>SV 5.3 Species Diversity</i>	63	64	64	64
<i>SV 6.1 Large Woody Debris</i>	50	56	56	56
<i>SV 6.2 Detritus</i>	50	56	56	56
<i>SV 7.1 Evolutionary Stage</i>	59	57	55	54
<i>SV 7.2 Planform</i>	63	63	64	64
<i>SV 7.3 Dimension</i>	55	55	55	55
<i>SV 7.4 Profile</i>	50	50	50	50
<i>SV 8.1 Dynamic Equilibrium</i>	60	60	60	60
<i>SV 8.2 Resilience</i>	65	65	65	65
<i>SV 9.1 Hydraulic Structure</i>	65	70	70	70
<i>SV 9.2 Coarse Scale</i>	65	65	65	65
<i>SV 9.3 Fine Scale</i>	66	64	66	68
<i>SV 10.1 Biotic Structure</i>	72	73	75	77

The MC2 alternative provides broad ecosystem benefits focused on bank stabilization, organic matter accumulation, and channel–wetland connectivity. The synergistic use of alternative measures results in measurable gains across hydraulic, vegetative, and biotic parameters. Early gains (Years 0-10) derive from structural stability and hydrologic reconnection, while long-term improvements (Years 25-50) reflect maturing vegetation, organic buildup, and enhanced habitat complexity that sustain ecosystem function and resilience.

SV 2.2 (Channel Erosion)

Channel erosion improves modestly from 75 under the FWOP to 77 under MC2, reflecting a measurable reduction in erosive forces along vulnerable banks. This change is driven primarily by the application of bioengineering and instream structures, which combine root-wad revetments, riprap toe protection, and strategically placed roughness elements to diffuse near-bank hydraulic energy. These treatments are reinforced by the channel fill and shelf construction measure, which creates a vegetated buffer at the base of the bank, further reducing shear stress. Over the following decades, vegetation plantings ensure long-term stabilization through dense root matrices that knit the soil together. By Year 50, the bankline remains structurally secure and functionally stable, with minimal risk of renewed channel incision.

SV 3.2 (Organics / Nutrients)

Organic and nutrient dynamics improve from 65 to 68 and hold steady through Year 50. The excavation of uplands to wetlands under increases the frequency and duration of inundation, promoting sediment deposition and organic accumulation. Channel fill and shelf construction enhances nutrient retention by slowing flow and creating depositional

environments, while vegetation plantings introduce dense root networks and litter inputs that foster denitrification and microbial processing. As soils mature, these wetlands and benches act as long-term nutrient sinks, maintaining the improved condition across the planning horizon.

SV 3.3 (Inorganics / Toxins)

This subvariable rises from 65 to 68 and remains stable over 50 years. The installation of instream structures reduces flow velocity, allowing fine particles and adsorbed metals to settle out of suspension. Simultaneously, organic soils formed within the new wetlands bind heavy metals and other inorganic compounds, improving filtration efficiency. Dense vegetation from enhances these processes by increasing surface area for sorption and stabilizing soils that would otherwise remobilize contaminants. As vegetation matures, the reach maintains a self-sustaining filtration capacity that outperforms FWOP conditions.

SV 4.1 (Saturation Frequency)

Saturation frequency increases from 60 to 65 and stays consistent through Year 50. The excavation of shallow wetland cells reconnects the floodplain to groundwater, creating zones that wet more often and stay saturated longer after high-flow events. adds low benches that intercept and hold water during seasonal floods, raising the frequency of saturation in adjacent soils. By Year 10, a new hydrologic balance is achieved, and by Year 50, the interaction between shallow groundwater and vegetation ensures persistent wetland function even during drier cycles.

SV 4.2 (Floodplain Width)

Floodplain width expands from 60 to 64 at Year 0 and reaches 66 by Year 50, representing a gradual physical widening of the active hydrologic corridor. Wetland excavation and channel fill physically regrade the oversteepened bank and expand the floodplain's cross-sectional area, improving lateral connectivity with the main channel. As vegetation matures and root networks consolidate soil stability, the widened area becomes a permanent hydrologic feature. This sustained lateral connectivity improves sediment storage and floodwater attenuation through the project life.

SV 4.3 (Saturation Duration)

Saturation duration improves from 60 to 63 initially and reaches 65 by Year 10, maintaining that value thereafter. Wetland excavation and bench creation lengthen the hydroperiod by increasing the depth and retention time of inundation. These conditions foster the formation of hydric soils capable of storing water well beyond the immediate flood cycle. By Year 25, accumulated organic matter enhances soil porosity, allowing the system to retain moisture and sustain wetland vegetation during lower flow periods.

SV 5.1 (Woody Vegetation Structure)

Woody vegetation structure increases from 50 to 54 at Year 0 and progresses to 59 by Year 25, holding steady through Year 50. High-density riparian plantings accelerate recruitment of native trees and shrubs, while shelf construction provides stable substrates for establishment. These early plantings mature into a layered canopy that improves shading, root reinforcement, and habitat complexity. By Year 25, the corridor exhibits a more structurally diverse woody community that stabilizes soils and enhances wildlife use.

SV 5.2 (Herbaceous Vegetation Structure)

Herbaceous structure improves from 50 to 54 initially and reaches 56 by Year 10, maintaining this through Year 50. The dense seeding of native grasses, rushes, and sedges creates immediate cover and root cohesion on freshly graded surfaces. These species thrive under periodic flooding, reducing erosion and adding organic material to the soil. Over time, periodic inundation maintains vigorous herbaceous growth that reinforces riparian stability and ecological productivity.

SV 5.3 (Species Diversity)

Species diversity rises from 60 to 63 at Year 0 and reaches 64 by Year 10. Diverse hydrologic gradients created by wetland excavation and shelf construction establish a range of habitats for both upland and facultative wetland species. Plantings introduce an array of native plants suited to these gradients, supporting pollinators and wildlife. By Year 25, plant communities reach equilibrium, with stable species turnover that reflects a healthy, self-sustaining riparian mosaic.

SV 6.1 Large Woody Debris

Large woody debris scores increase from 50 to 56 by Year 10 and remain stable thereafter. Instream structures install rootwads and logs that immediately improve in-channel habitat and flow variability, while vegetation plantings lay the groundwork for future woody input as riparian trees mature. These additions enhance habitat complexity and create hydraulic refugia for fish. By Year 50, recurring wood recruitment maintains this improved structural diversity.

SV 6.2 (Detritus)

Detritus increases from 50 to 56 by Year 10 and remains at that level through Year 50. Reduced velocities behind instream features allow organic material to accumulate, while Vegetation Plantings contributes annual leaf and litter input that fuels microbial and invertebrate communities. By Year 25, these processes stabilize into a functioning detrital system that sustains nutrient cycling and base-level food-web productivity.

SV 7.2 (Planform)

Planform complexity increases slightly from 60 to 63 by Year 0 and 64 by Year 25. Bioengineered shelves and minor flow re-routing introduce gentle sinuosity and promote secondary flow paths along the floodplain edge. While the main channel alignment remains unchanged, local hydraulic variability increases, producing a more dynamic near-bank zone. By Year 25, sediment deposition and vegetation reinforce these subtle adjustments, stabilizing the improved planform.

SV 8.2 (Resilience)

Resilience increases from 60 to 65 and remains constant thereafter. The combination of vegetative root reinforcement and structural stabilization fortifies banks and floodplain surfaces against flood disturbance. Access management limits human-induced degradation, allowing vegetation to establish and recover naturally after high-flow events. By Year 25, the reach exhibits a self-maintaining resilience that minimizes future maintenance needs.

SV 9.1 (Hydraulic Structure)

Hydraulic-structure scores rise sharply from 55 to 65 at Year 0 and reach 70 by Year 10, remaining high through Year 50. Instream structures introduces riffles, pools, and woody complexity that diversify flow velocity and depth, creating high-quality aquatic habitat. Channel fill adds marginal shelves that act as secondary flow channels during moderate floods, enhancing hydraulic diversity. These features naturalize over time, with vegetation growth and organic deposition reinforcing their stability. By Year 50, MC2 sustains a diverse hydraulic regime far superior to FWOP conditions.

SV 9.2 (Coarse Scale)

Coarse-scale structure improves from 55 to 65 and remains steady through Year 50. Included measures together reshape near-bed features and introduce gravel-cobble variability, restoring riffle–run transitions lost under FWOP. As the channel stabilizes, substrate heterogeneity persists, creating a mosaic of flow environments that support multiple aquatic guilds. By Year 50, the reconfigured substrate maintains both stability and functional diversity.

SV 9.3 (Fine Scale)

Fine-scale complexity rises from 60 to 66 at Year 0 and gradually increases to 68 by Year 50. Woody placements under and variable sediment deposition create intricate microtopography that improves habitat quality for benthic invertebrates and juvenile fish. Vegetation roots and litter inputs continue to modify small-scale flow patterns, incrementally enhancing fine-scale heterogeneity. By Year 50, the microhabitat diversity is well established and self-perpetuating.

SV 10.1 (Biotic Structure)

Biotic structure improves from 67 to 72 at Year 0 and climbs to 77 by Year 50. The interplay of vegetation plantings, instream structures, and wetland creation produces diverse habitats spanning aquatic, riparian, and upland zones. Fish and amphibians benefit from increased hydraulic variability, while birds and pollinators utilize the developing riparian canopy. By Year 25, trophic networks strengthen, linking detrital, primary-producer, and predator guilds. At Year 50, the reach supports a mature, resilient community indicative of a fully functional ecosystem.

4.2.5 Main Channel 3

Several FACStream subvariables remain unchanged across this alternative's relative to the Future Without Project (FWOP) condition. The parameters are primarily influenced by basin-scale hydrology and geomorphic drivers—including regulated dam releases, major diversions (e.g., New York Canal), and valley-scale confinement—that are not directly affected by localized restoration measures. The proposed actions within the Barber Pool Conservation Area (e.g., floodplain reconnection, wetland excavation, instream wood placement, and vegetation plantings) target habitat complexity, hydrologic connectivity, and ecological structure at the reach scale, rather than altering systemwide flow regimes or sediment supply.

Things like total annual water volume, peak and base flow magnitudes, sediment delivery from upstream, and macrochannel geometry remain governed by existing infrastructure and flow management. Large-scale hydraulic structure, channel profile, and dimension parameters are maintained within current physical boundaries, as project actions are confined to secondary and floodplain channels rather than the mainstem conveyance corridor. Therefore, while the alternatives improve ecological and geomorphic function locally, they do not produce measurable changes in these regional hydrologic and structural variables.

The MC3 alternative provides a measurable improvement in hydrologic function, floodplain connectivity, and biotic diversity within the Barber Pool reach compared to the Future Without Project (FWOP) condition (Table 4-7).

Table 4-7. Main Channel 3 FACStream Scores

<i>MC3 Subvariables</i>	<i>Year 0</i>	<i>Year 10</i>	<i>Year 25</i>	<i>Year 50</i>
<i>SV 1.1 Total Volume</i>	50	50	50	50
<i>SV 1.2 Peak Flows</i>	55	55	55	55
<i>SV 1.3 Base Flows</i>	70	70	70	70
<i>SV 1.4 Flow Variability</i>	65	65	65	65
<i>SV 2.1 Land Erosion</i>	80	79	78	77
<i>SV 2.2 Channel Erosion</i>	75	74	73	72
<i>SV 2.3 Transport</i>	55	55	55	55
<i>SV 3.1 Temperature Regime</i>	65	64	63	62

MC3 Subvariables	Year 0	Year 10	Year 25	Year 50
<i>SV 3.2 Organics / Nutrients</i>	67	69	71	73
<i>SV 3.3 Inorganics / Toxins</i>	67	69	71	73
<i>SV 4.1 Saturation Frequency</i>	65	65	65	65
<i>SV 4.2 Floodplain Width</i>	65	65	65	65
<i>SV 4.3 Saturation Duration</i>	65	65	65	65
<i>SV 5.1 Woody Vegetation Structure</i>	50	50	50	50
<i>SV 5.2 Herbaceous Vegetation Structure</i>	55	60	60	60
<i>SV 5.3 Species Diversity</i>	65	65	65	65
<i>SV 6.1 Large Woody Debris</i>	50	50	50	50
<i>SV 6.2 Detritus</i>	55	55	55	55
<i>SV 7.1 Evolutionary Stage</i>	59	57	55	54
<i>SV 7.2 Planform</i>	60	60	60	60
<i>SV 7.3 Dimension</i>	60	60	60	60
<i>SV 7.4 Profile</i>	50	50	50	50
<i>SV 8.1 Dynamic Equilibrium</i>	65	65	65	65
<i>SV 8.2 Resilience</i>	65	65	65	65
<i>SV 9.1 Hydraulic Structure</i>	65	70	70	70
<i>SV 9.2 Coarse Scale</i>	65	65	65	65
<i>SV 9.3 Fine Scale</i>	60	60	60	60
<i>SV 10.1 Biotic Structure</i>	72	73	75	77

By widening the corridor and softening steep, eroded banks, MC3 restores lateral interaction between the Boise River and its floodplain, enhancing water retention, nutrient processing, and habitat complexity. Over time the combination of engineered structures and natural revegetation fosters a self-sustaining system that improves hydraulic diversity, water quality, and habitat conditions for aquatic and riparian species through Year 50.

MC3 combines several complementary measures to stabilize and expand the river–floodplain interface: Excavate bankline to expand floodplain and create riparian shelves, vegetation plantings, placement of instream structures, and filling of open channel segments to restore wetted benches. Together, these measures widen the active channel corridor, increase hydrologic exchange, reduce erosive forces, and establish vegetated benches that provide habitat and nutrient processing zones.

SV 3.2 (Organics / Nutrients)

At Year 0, MC3 increases the score from 65 to 67, with continuing gains through Year 50 as organic processes mature. The excavation of floodplain shelves introduces new low-elevation benches that extend water residence time and foster the accumulation of organic material. Vegetation established under contributes litter and root exudates that stimulate microbial activity and nutrient uptake, while roughness elements slow water

velocities and improve nutrient cycling within bioactive sediments. Over the years, these processes become more efficient as wetland soils deepen and riparian vegetation matures. By Year 50, the reach supports a self-regulating nutrient cycle that improves water quality and overall river health.

Section 5 - SV 3.3 – Inorganics / Toxins

MC3 improves this subvariable from 65 to 67 initially, reaching 73 by Year 50. The newly created benches trap fine sediments and enhance adsorption of metals and toxins onto organic-rich soils. Instream structures installed further slow flows, increasing deposition and sediment binding, while riparian plantings promote rhizosphere filtration of pollutants. These combined measures transform the floodplain into a natural biofilter that progressively improves in capacity as soils mature and vegetation density increases. By Year 50, sediment-bound contaminants are consistently captured and retained, reducing downstream transport and improving water quality.

Section 6 - SV 4.1 – Saturation Frequency

Compared to the FWOP condition (60), MC3 raises the score to 65 and maintains it throughout the analysis period. Floodplain excavation lowers elevations closer to groundwater levels, while benches allow for frequent inundation during seasonal flows. The hydrologic connection established through these measures ensures that the floodplain wets more regularly, recharging soils and supporting moisture-dependent vegetation. This improvement occurs immediately post-construction and remains consistent through Year 50, as stable channel geometry sustains periodic overbank flows and a balanced hydroperiod.

Section 7 - SV 4.2 – Floodplain Width

MC3 widens the effective floodplain from 60 to 65 and sustains this improvement through Year 50. Physical excavation reclaims eroded margins and reestablishes lateral connectivity to the river. Additional surface shaping provides gradual transitions between aquatic and terrestrial zones, enhancing floodplain function during variable flow events. As vegetation stabilizes the new surfaces, the corridor's functional width remains stable, increasing resilience to lateral erosion and promoting floodwater attenuation over the long term.

Section 8 - SV 4.3 – Saturation Duration

This subvariable rises from 60 to 65 under MC3 and remains elevated through Year 50. Floodplain shelves and low benches created retain water for longer periods, while roughness features slow drainage and create localized ponding zones. The vegetative cover enhances soil permeability and water-holding capacity, maintaining moisture during low-flow periods. As hydric soils develop and the vegetative canopy matures, extended wetness supports both riparian and wetland plant communities, providing lasting habitat and nutrient benefits.

Section 9 - SV 5.1 – Woody Vegetation Structure

Woody vegetation structure remains unchanged at 50 in the model, reflecting the limited spatial extent of tree establishment within MC3. While this action includes woody plantings, the alternative's primary emphasis is on hydraulic and geomorphic restoration rather than forest expansion. Over 50 years, localized tree growth may improve bank shading and root cohesion but will not significantly alter the reach-scale condition. Nevertheless, the few areas that do develop woody structure will contribute to microhabitat diversity and improve stability along newly created shelves.

Section 10 - SV 5.2 – Herbaceous Vegetation Structure

Herbaceous vegetation improves markedly from 50 to 55 at Year 0 and reaches 60 by Year 10, maintaining that level through Year 50. High-density planting establishes resilient grass and sedge communities on re-graded benches and shelves formed by alternative measures. These communities enhance soil stability, reduce erosion, and provide habitat for insects and small mammals. Over time, periodic inundation and natural recruitment sustain this vegetative layer, ensuring consistent cover and ecological function well into the project's design life.

Section 11 - SV 5.3 – Species Diversity

MC3 increases species diversity from 60 to 65, maintaining this improvement throughout the 50-year period. The varied topography and moisture gradients produced alternative measures create a mosaic of ecological niches, supporting both upland and wetland species. Native plantings further enrich diversity by introducing species suited to these gradients. The result is a stable, self-sustaining community that provides long-term habitat heterogeneity and improves pollinator and wildlife resources across the reach.

Section 12 - SV 6.1 – Large Woody Debris

No modeled change occurs for large woody debris, which remains at 50. Although this action introduces structural elements and some root-wads for stability, the scope of work does not include active LWD augmentation or sufficient riparian forest development to increase recruitment rates. Minor local gains may occur near installed structures, but these do not scale to the broader reach. Over time, as limited woody vegetation matures, small incremental inputs could enhance microhabitat complexity but not enough to alter the modeled outcome.

Section 13 - SV 6.2 – Detritus

Detritus increases modestly from 50 to 55, with sustained benefits through Year 50. Expanded vegetated benches and shelves generate more litterfall, while instream roughness features help trap organic material during flows. This combination supports the buildup of organic matter critical for benthic invertebrates and nutrient cycling. Over time, recurring litter deposition and decomposition stabilize, reinforcing the food web base and maintaining improved productivity throughout the reach.

Section 14 - SV 7.1 – Evolutionary Stage

This subvariable shows no change relative to FWOP, reflecting the stable fluvial context of the reach. MC3's targeted actions improve localized function but do not shift the evolutionary stage of the Boise River system. Given flow regulation and watershed controls, the geomorphic trajectory remains constant, though MC3 prevents further incision and maintains a balanced condition through Year 50.

Section 15 - SV 7.2 – Planform

The planform remains unchanged at 60. The measures under MC3 particularly bankline excavation and filling in open channel segments focus on lateral floodplain connection rather than large-scale channel realignment. While local curvature and bank variability increase, these adjustments are insufficient to alter overall channel geometry. The planform remains stable and functional throughout the 50-year timeframe.

Section 16 - SV 7.3 – Dimension

Channel dimension improves from 55 to 60, reflecting a more natural width-to-depth ratio and better bank stability. Excavation of steep banks and installation of benches reduce entrenchment and improve hydraulic cross-section form. Vegetation and roughness stabilize these dimensions over time, maintaining energy balance and reducing further channel enlargement. This improvement endures through Year 50 as the corridor achieves equilibrium.

Section 17 - SV 7.4 – Profile

No measurable change occurs in the longitudinal profile, which remains constant at 50. The MC3 measures focus on bank and floodplain geometry rather than vertical grade control. However, minor localized deposition behind instream structures may create small elevation variations that enhance habitat diversity without altering overall slope or bed profile.

Section 18 - SV 8.1 – Dynamic Equilibrium

MC3 raises this sub-variable from 60 to 65, reflecting improved balance between erosive forces and sediment supply. Added roughness and storage distribute hydraulic energy more evenly, stabilizing banks and maintaining sediment deposition patterns. As vegetation matures, these effects become self-reinforcing, preventing further degradation. By Year 50, the reach operates in a steady dynamic state where geomorphic processes and ecological functions remain in equilibrium.

Section 19 - SV 8.2 – Resilience

Resilience improves from 60 to 65 and remains steady through Year 50. The combination of a widened floodplain, vegetated stabilization, and structural reinforcement enhances resistance to high flows and accelerates recovery after disturbance. As vegetation root networks mature and soils strengthen, the system

becomes increasingly self-sustaining. By Year 50, MC3 exhibits strong capacity to absorb hydrologic variability without functional decline.

Section 20 - SV 9.1 – Hydraulic Structure

Hydraulic structure increases substantially from 55 to 65 at Year 0 and to 70 by Year 10, maintaining that level through Year 50. The addition of instream structures creates pools, riffles, and eddies, while excavation of banklines and filling open channel segments establish low benches that diversify depth and flow velocity. These enhancements immediately expand habitat niches and improve hydraulic connectivity between main and marginal channels. Over time, natural sediment deposition and vegetation reinforcement sustain these complex hydraulic patterns, preserving high functional performance over decades.

Section 21 - SV 9.2 – Coarse Scale

MC3 improves coarse-scale structure from 55 to 65 initially, holding that level through Year 50. The integration of roughness elements, riffle-run reconstruction, and variable bank forms restores channel-scale heterogeneity. As FWOP conditions would otherwise degrade through ongoing erosion and sediment loss, MC3 stabilizes coarse-scale habitat diversity, ensuring persistent complexity and energy dissipation throughout the reach.

Section 22 - SV 9.3 – Fine Scale

No change occurs in the fine-scale structure score, which remains at 60. While roughness and vegetation improve microhabitat conditions locally, the extent of modification is insufficient to influence the entire reach's fine-scale structure. Nevertheless, localized benefits, such as small pools and depositional areas near installed features, enhance habitat diversity in subtle but meaningful ways that complement broader structural gains.

Section 23 - SV 10.1 – Biotic Structure

Biotic structure improves markedly from 67 to 72.1 at Year 0, increasing to 77 by Year 50. The combined influence of instream habitat complexity, floodplain expansion, wetland bench creation, and vegetation plantings supports diverse aquatic and terrestrial species assemblages. Fish, amphibians, and macroinvertebrates benefit from new hydraulic niches, while riparian birds and pollinators utilize expanded vegetation zones. As plant communities mature and habitat connectivity improves, the Barber Pool reach evolves into a dynamic, biodiverse corridor that remains ecologically productive for decades.

4.3 AVERAGE ANNUALIZED HABITAT UNITS

The Average Annual Habitat Units (AAHUs) reflect the cumulative ecological performance of each restoration alternative over the 50-year analysis period, normalized by time. This metric integrates the combined effects of functional condition (FCI), area, and time—essentially summarizing how much ecological “lift” each project delivers compared to the FWOP. AAHUs for FWOP and alternatives (Table 4-8).

Table 4-8. Summary of the Habitat Units and Function Conditional Index of the FWOP and Alternatives.

Restoration Alternative / Measure	TY	Year Interval	FCI	Acres	HU at TY	Interval HUs	Cumulative HUs	AAHUs
FWOP	0	0	0.1645	520	85.54			
	10	10	0.160583	520	83.50333	845.2167	4094.5	81.9
	25	15	0.156667	520	81.46667	1237.275		
	50	25	0.152875	520	79.495	2012.021		
50	0	0.21645	520	112.554				
Wetland M.	0	0	0.21645	520	112.554		5912.4	118.2
	10	10	0.229183	520	119.1753	1158.647		
	25	15	0.2296	520	119.392	1789.255		
	50	25	0.226475	520	117.767	2964.488		
MC1	0	0	0.22945	520	119.314		6507.2	130.1
	10	10	0.247733	520	128.8213	1240.677		
	25	15	0.255658	520	132.9423	1963.228		
	50	25	0.252533	520	131.3173	3303.246		
MC2	0	0	0.223992	520	116.4757		6271.2	125.4
	10	10	0.237542	520	123.5217	1199.987		
	25	15	0.244083	520	126.9233	1878.338		
	50	25	0.247125	520	128.505	3192.854		
MC3	0	0	0.242908	520	126.3123		6633.889	132.7
	10	10	0.253258	520	131.6943	1290.033		
	25	15	0.256475	520	133.367	1987.96		
	50	25	0.259817	520	135.1047	3355.896		

All restoration alternatives show substantial improvement over the FWOP baseline. The MC3 alternative yields the highest ecological return with an AAHU of 132.68, representing roughly a 62% increase over FWOP. Close behind are MC1 (130.14, +59%) and MC2 (125.42, +53%), while the Wetland Mosaic alternative provides a moderate uplift (+44%). These results suggest all proposed measures substantially enhance ecosystem function within the Barber Pool reach, but with varying emphasis—Wetland Mosaic emphasizes wetland productivity, whereas the MC-series alternatives provide broader hydrologic and structural benefits.

4.4 ECONOMIC ANALYSIS AND PLAN SELECTION

The IDWR Suite Model (CE/ICA) is an approved planning model where you take component parts of a plan and combine them to determine incremental benefits/costs. This tool identifies cost effective and the best buy plan. The CE/ICA model identified 4 Best Buy Alternatives (Table 4-9); The No Action Plan, MC2 Only, MC1+MC2, and MC1+MC2+MC3.

Table 4-9. CE/ICA Results showing “Best Buy” Alternatives and Associated Costs and HU Benefits Identified by Cost Effectiveness/Incremental Cost Analysis *

Plan Description	AAC (\$1,000s)	Output	Cost Effective?
FWOP	\$0.00	0	Best Buy
MC2 Only	\$104.10	43.53	Best Buy
MC1 + MC2	\$245.53	91.78	Best Buy
MC1 + MC2+ MC3**	\$418.34	142.57	Best Buy
MC1 Only	\$141.43	48.25	Cost Effective
MC2 Only	\$172.81	50.79	Cost Effective
MC2 + MC3	\$276.91	94.32	Cost Effective
MC1 + MC3	\$314.24	99.04	Cost Effective
WM + MC1 + MC2	\$390.35	128.14	Cost Effective
WM Only	\$144.82	36.36	Non-Cost Effective
WM + MC2	\$248.92	79.89	Non-Cost Effective
WM + MC1	\$286.25	84.61	Non-Cost Effective

*FY25 OCT 2024 Price Level and 3.0 Percent FY25 Federal Discount Rate

**Tentative Sponsor-Preferred Plan

The Wetland Mosaic alternative did not prove to be cost-effective alternative (Table 4-9) therefore it was screen from further consideration. Cost effectiveness/incremental cost analyses is a process where USACE uses cost effectiveness to identify the least cost solution for each level of environmental output considered. Incremental cost analysis helps to identify and display variations in costs among different increments of restoration measures and alternative plans. Thus, it helps decision makers determine the most desirable level of output relative to costs and other decision criteria. Cost effectiveness and incremental cost analysis must be performed at an appropriate level of detail for each study to identify the most cost-effective plan within the identified constraints. USACE only carries forward the best buy plans.

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 the BPCA. Therefore, the team looked to select a plan inclusive of the most habitat units possible in the Best Buy category. So based on FACStream and CE/ICA modeling

results, the team identified Alternative Main Ch. 1 + Main Ch. 2 + Main Ch. 3 as the TSP (Table 4-10), providing 142 AAHU greater than the No Action Alternative and existing condition.

Table 4-10. Cost Effectiveness/Incremental Cost Analysis Results Showing the “Best Buy” Alternatives Including No Action

Alternative	Output (Net AAHUs)	Average Annual Cost (AAC)	Average Cost per AAHU	Incremental Cost	Incremental Output (AAHUs)	Incremental Cost/Output (\$/AAHUs)
FWOP	0.00	\$0	\$0	\$0	0.00	\$0
Main Ch. 2	43.53	\$104,097	\$2,391	\$104,097	43.53	\$2,391
Main Ch. 1 + Main Ch. 2	91.79	\$245,524	\$2,675	\$141,427	48.25	\$2,931
Main Ch. 1 + Main Ch. 2 + Main Ch. 3	142.57	\$418,330	\$2,934	\$172,806	50.79	\$3,403

The four alternatives represent a clear progression in ecological output and cost efficiency as restoration complexity increases. The FWOP provides no gain in habitat units and incurs no cost, serving as the baseline condition. Main Channel 2 (MC2) yields a net output of 43.53 AAHUs over the FWOP at an average annual cost of \$104,097, resulting in a cost of \$2,391 per AAHU. This is the most cost-efficient option in terms of cost per unit of benefit but provides the smallest overall ecological uplift. Adding Main Channel 1 (MC1) to MC2 substantially increases output to 91.79 AAHUs, with an incremental output gain of 48.25 AAHUs and an incremental cost of \$141,427. The incremental cost per AAHU rises modestly to \$2,931, remaining within the range of efficient ecosystem investment.

The most comprehensive alternative, Main Channel 1 + Main Channel 2 + Main Channel 3 (MC1+MC2+MC3), produces the largest ecological return with a total of 142.57 AAHUs, representing a gain of 50.79 AAHUs over the previous alternative. The incremental cost for this final addition is \$172,806, with an incremental cost per AAHU of \$3,403. While the cost per output unit increases slightly compared to the earlier plans, the improvement in ecological function is significant and proportionally justified.

This plan provides a balanced tradeoff between cost and ecological benefit by restoring floodplain connectivity, channel stability, and riparian vegetation across multiple reaches. The incremental costs reflect increasing physical work scope rather than inefficiency, and the incremental outputs demonstrate tangible, system-wide ecological benefits. Given the unique opportunity to restore the Barber Pool reach comprehensively and the Sponsor’s preference to maximize functional lift, the MC1+MC2+MC3 alternative represents the most effective and justified selection as

the TSP. It captures the greatest cumulative habitat gain, achieves broad ecosystem restoration objectives, and remains within acceptable cost-effectiveness thresholds for federal participation.

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SECTION 5 - TENTATIVELY SELECTED PLAN

The TSP for this study resulted out of the economics analysis. It is appropriate to combine MC1, MC2, and MC3 as the TSP because the FACStream model evaluated each alternative in distinct, non-overlapping spatial zones within the Barber Pool Conservation Area. Each Main Channel alternative represents a separate reach of the Boise River, each with unique geomorphic, hydrologic, and ecological attributes, and the modeled habitat functions do not overlap geographically or double-count restoration effects.

When the project delivery team (PDT) combined these alternatives, they were aggregating independent restoration reaches that contribute additive ecological lift to the overall system. The FACStream model quantifies functional capacity on a individual alternative basis using area-weighted Functional Capacity Indices (FCIs) multiplied by acreage, meaning that outputs such as Habitat Units and Average Annual Habitat Units can be summed directly when spatial overlap does not exist. Each Main Channel alternative targets different parts of the Barber Pool corridor, with MC1 focusing on floodplain benches and riparian shelves, MC2 emphasizing bank stabilization and wetland creation, and MC3 improving channel complexity and vegetative enhancement. Their modeled benefits are spatially independent yet ecologically complementary.

In this context, combining MC1, MC2, and MC3 is both analytically valid and ecologically justified. The summation of AAHUs across these reaches accurately represents the total ecosystem lift achievable by implementing all three restoration components together. The CE/ICA framework allows such combinations when model independence and additive outputs are confirmed, both of which apply in this case. Therefore, it is reasonable and technically sound for the PDT to treat MC1 + MC2 + MC3 as a composite Best Buy plan and to carry it forward as the TSP, representing the highest achievable restoration outcome within the Barber Pool study area.

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 TSP.

5.1 WITHOUT-PROJECT CONDITION ASSUMPTIONS

The future without-project condition (FWOP), or “No Action Plan,” represents the expected condition of the Barber Pool reach in the absence of any restoration measures beyond existing or previously authorized actions. Over a 50-year planning horizon, the Barber Pool Conservation Area is projected to remain a highly regulated and simplified section of the Boise River, shaped by upstream dam operations (Anderson Ranch, Arrowrock, and Lucky Peak) and the large New York Canal diversion. The regulated flow regime, depleted sediment supply, constrained floodplain, and limited riparian recovery will continue to restrict the system’s hydrologic, geomorphic, and ecological function. While some indicators remain stable, gradual declines in water quality, sediment transport, and biotic structure are expected as the system continues to age without intervention.

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

- *Hydrology*: Hydrology in the Barber Pool reach will remain strongly influenced by dam regulation and the New York Canal diversion. Peak flows are attenuated by roughly 60 percent compared to unregulated inflows, producing a flattened hydrograph and reduced floodplain activation. Base flows, though stable around 250 cfs, are artificially maintained and no longer reflect natural variability. Flow timing remains out of phase with seasonal runoff, and operational fluctuations occur in stepped increments of several hundred cubic feet per second. Consequently, the hydrologic scores remain static over the planning horizon, reflecting a stable but non-natural flow regime.
- *Sediment Transport*: Sediment supply and transport capacity are among the most impaired functions in Barber Pool. The upstream reservoirs trap the vast majority of incoming sediment, leaving the reach in a “clear-water” condition that promotes localized scour and bank instability. Channel erosion occurs where confined flows undercut sand and silt banks, while floodplain deposition is minimal. Over time, the continued sediment deficit and occasional high-energy events are expected to gradually degrade channel stability and increase near-bank erosion. Overall sediment-related functions exhibit slight decline but remain low and static relative to reference conditions.
- *Water Quality (Temperature, Nutrients, and Toxins)*: Water quality in the Barber Pool reach is moderately impaired and listed under Section 303(d) for temperature. Regulated flows, urban runoff, and wastewater effluent contribute to chronic warm-water and nutrient enrichment conditions. Upstream reservoirs, while buffering extreme temperatures, also lengthen residence times, promoting thermal loading during summer months. Nutrient and toxin inputs from surrounding urban and agricultural land uses continue to affect aquatic communities, with slow deterioration expected through Year 50. Overall, water quality remains fair but trending downward, with scores declining slightly across temperature, organic/nutrient, and inorganic/toxin variables.
- *Floodplain Function*: The floodplain within the Barber Pool area is highly constrained by levees, channel incision, and altered flow magnitude. The Rosgen F3 classification reflects an entrenched, low-gradient system with limited floodplain access. Overbank inundation occurs infrequently, typically during multi-year peak events, and duration of saturation is short. The lateral extent of the floodplain is less than 50 feet in most areas, representing a 50–70 percent loss of historical floodplain width. With no reconnection or grading activities planned, floodplain frequency, duration, and width remain static through the planning horizon, limiting hydrologic exchange and wetland formation.
- *Riparian Vegetation Structure and Diversity*: The riparian community remains dominated by herbaceous and shrub species, with woody vegetation comprising less than 10 percent of the 520-acre corridor. Cottonwood and other native

riparian trees show little regeneration due to altered flood disturbance and entrenched channel conditions. Herbaceous vegetation persists but lacks the structure and diversity typical of reference floodplain forests. Species diversity is moderate but increasingly influenced by non-native species and patchy cover. Without restoration, woody and herbaceous vegetation structure and diversity remain at impaired levels, contributing minimal shade, organic matter, or large wood recruitment to the stream.

- *Debris Accumulation:* Large woody debris (LWD) and detritus inputs are minimal due to the lack of mature riparian trees and the interception of upstream material by dams. Organic matter accumulates locally but is insufficient to maintain habitat complexity or nutrient cycling. Over time, the quantity and function of debris are expected to remain static, with no mechanisms in place for natural replenishment. Occasional windthrow or flood events may temporarily increase LWD, but these pulses will not meaningfully improve long-term function.
- *Stream Morphology and Stability:* The Barber Pool reach will continue to exhibit plane-bed morphology with over-wide, shallow cross sections and poor width-to-depth ratios. Sediment deficit and flow confinement reduce dynamic equilibrium, leading to slow channel widening and minor incision over time. Channel evolution (SV 7.1) gradually declines as bank failures persist along sand bluffs, but large-scale meander migration or recovery is unlikely. Stream dimension, planform, and profile remain largely unchanged, governed by the presence of Barber Dam and entrenched valley geometry. Overall, stream stability and resilience remain limited and show slow degradation.
- *Stream Physical Structure:* Physical habitat complexity remains poor under the regulated regime. Hydraulic structure is homogenous, with shallow runs dominating over riffle-pool sequences. Coarse-scale diversity (bedforms, bars, and backwaters) is minimal, and fine-scale habitat (microtopography and depositional pockets) remains limited by the lack of sediment supply. The absence of large wood, coupled with reduced floodplain interaction, prevents natural formation of scour pools and side channels. Minor declines are anticipated as sand encroachment continues from local erosion sources.
- *Biotic Diversity:* Aquatic and riparian biotic structure remains moderately impaired but stable. Fish and macroinvertebrate communities are dominated by tolerant taxa, with native guilds underrepresented. Sculpin, a sentinel species, remain scarce downstream of wastewater inputs. The simplified hydraulic environment, limited cover, and degraded temperature regime restrict habitat quality for most sensitive species. While some adaptive persistence occurs, overall biotic diversity and trophic complexity are expected to remain static at reduced function throughout the 50-year period.

Under the without-project condition, the Barber Pool Conservation Area persists as a heavily regulated, simplified reach of the Boise River. Hydrology remains predictable but unnatural, sediment processes remain impaired, and water quality continues gradual

decline. The floodplain stays largely disconnected, riparian forests fail to regenerate, and habitat structure and diversity remain low. Without active restoration, system resilience and ecological function are expected to remain static or decline incrementally through Year 50, reinforcing Barber Pool's status as a stable but degraded remnant of a once dynamic alluvial floodplain.

5.2 WITH-PROJECTS CONDITION ASSUMPTIONS

With the TSP constructed, 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.

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).

The TSP combines the measures and benefits of MC1, MC2, and MC3 to produce a highly integrated ecosystem restoration scenario for the Barber Pool reach. Together, these actions address hydrology, sediment dynamics, water quality, floodplain function, riparian diversity, and in-stream habitat complexity at multiple scales. Measures include bankline excavation and shelf creation, riparian and wetland plantings, instream structural enhancements, channel filling to reconnect floodplain elevations, and wetland excavation. When implemented across all three sub-reaches, these measures reinforce one another—expanding floodplain width, reconnecting groundwater and surface water, creating stable vegetated benches, and establishing a self-sustaining riparian corridor that improves both aquatic and terrestrial habitat functions.

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

- *Hydrology:* Hydrologic variables are expected to remain stable at the watershed scale, but local improvements in base flow connectivity and floodplain activation will occur immediately. The combination of excavation and regrading (MC2 & MC3) increases water residence time and improves floodplain saturation frequency and duration. As vegetated benches mature (MC1 & MC2), groundwater interaction strengthens, producing extended hydroperiods and small wetland pockets that moderate temperature and nutrient dynamics. By Year 50, the hydrologic regime of restored reaches will closely approximate natural seasonal variation even if the broader watershed remains controlled by upstream regulation.
- *Sediment Transport:* Sediment transport improves through increased hydraulic diversity and energy dissipation along reconstructed margins. Root-wad

revetments and roughness elements redistribute shear stress away from eroding vertical banks. Floodplain shelves capture fine sediments and promote gravel sorting, creating point bars and depositional benches. Although regional sediment supply remains similar, localized deposition and scour balance within each reach enhances channel stability and natural sediment cycling by Year 25 and remains self-maintaining by Year 50.

- *Water Quality (Temperature, Nutrients, and Toxins):* Water quality benefits arise from improved riparian shading, organic soil formation, and floodplain infiltration. Excavated wetlands and vegetated shelves trap fine sediments and adsorb metals and nutrients. Dense riparian vegetation provides continuous leaf litter inputs, root exudates, and biofilm surfaces for microbial processing. These processes expand longitudinally as all three sites mature, creating a distributed network of water-quality filtration zones. By Year 25, stable organic soils and hydric vegetation maximize nutrient uptake and denitrification efficiency; by Year 50, these conditions persist as a mature, self-sustaining water-quality buffer.
- *Floodplain Function:* Floodplain activation is one of the strongest benefits of the TSP. Together, MC1–MC3 establish a nearly contiguous series of low benches, wetland depressions, and regraded banks totaling approximately 10 acres of newly functional floodplain. These surfaces inundate during seasonal high water, slow flow velocities, promote sediment deposition, and recharge groundwater. As vegetation matures, roughness and root structure stabilize these surfaces, converting previously eroding margins into resilient, dynamic wetlands that provide amphibian, avian, and terrestrial wildlife habitat.
- *Riparian Vegetation Structure and Diversity:* The TSP reestablishes native riparian communities across a broad hydrologic gradient. Plantings include woody and herbaceous species matched to site hydrology—from facultative wetland sedges in low zones to willows, red-osier dogwood, and cottonwood along mid-bank and upland transitions. Over time, this gradient produces layered canopy structure and high species richness. By Year 25, the riparian corridor will resemble pre-settlement conditions, providing organic matter, shade, and future large-wood recruitment essential for aquatic productivity.
- *Debris Accumulation:* Detritus and large woody debris (LWD) accumulation will increase significantly as vegetation matures and floodplain activation expands. Initially, constructed features supply LWD directly; later, mature riparian trees contribute naturally through branch and trunk fall. Floodplain inundation mobilizes and redistributes these materials, forming debris jams and pool complexes that diversify habitat. By Year 50, detrital processes will operate as an integral part of the reach’s nutrient and energy cycles.
- *Stream Morphology and Stability:* Stream morphology and stability improve immediately through bank reshaping and instream structure placement. MC1’s excavation and MC3’s shelf creation restore natural width-to-depth ratios and channel planform complexity. Roughness features moderate flow energy, allowing deposition and scour to reach equilibrium. By Year 25, the system will display stable pool-riffle sequencing and channel geometry characteristic of

dynamically balanced streams. By Year 50, resilience to high-flow events will be well established, maintaining long-term stability with only minor adaptive maintenance needs.

- *Stream Physical Structure*: Physical structure benefits occur almost instantly. Placement of instream features and regrading produce well-defined riffle-run-pool sequences and side-channel complexity. Over the first decade, fine-scale habitat features—such as differential sediment sorting, undercut banks, and vegetated margins—develop naturally. By Year 25, structural variety reaches an optimal state, and by Year 50 the system exhibits mature geomorphic function where habitat complexity self-perpetuates through feedback between flow, vegetation, and sediment dynamics.
- *Biotic Diversity*: The integration of all three sub-reaches provides the most comprehensive biological uplift. Aquatic guilds (fish, amphibians, macroinvertebrates) benefit immediately from improved depth, velocity, and cover diversity. Terrestrial species gain new foraging and nesting habitat in the reconnected riparian corridor. As vegetation matures, cross-habitat linkages strengthen—supporting pollinators, songbirds, small mammals, and predatory species. By Year 50, the reach supports a diverse, resilient biotic community with multiple trophic levels and high overall productivity.

Anticipated Project Maturity:

Year 1: Immediate, visible improvements in channel morphology, hydraulic structure, and floodplain connectivity occur following construction. Instream roughness and regrading stabilize banks and form functional benches. Vegetation plantings are in early establishment; herbaceous cover provides initial erosion protection, though woody vegetation remains immature. Water quality and riparian function begin improving, but organic cycling and soil development are minimal.

Year 10: Hydraulic features “wear in,” forming natural riffle-pool sequencing and stable depositional zones. Herbaceous vegetation is dense, and woody species such as coyote willow and red-osier dogwood reach maturity, providing shade and root reinforcement. Sediment retention and nutrient filtration improve markedly. Early detrital inputs from riparian vegetation begin to support expanding invertebrate populations, and overall habitat complexity approaches optimal conditions.

Year 25: The riparian corridor is fully established with mature shrub layers and mid-story trees. Wetland and floodplain soils have developed substantial organic horizons, sustaining stable moisture regimes and nutrient cycling. Woody debris recruitment begins to replace constructed features naturally. Stream stability, resilience, and biotic diversity are near optimal, with balanced sediment transport and well-functioning hydrologic connectivity.

Year 50: The system exhibits a mature, self-sustaining ecosystem. Cottonwoods and larger hardwoods contribute significant LWD and canopy cover. Herbaceous and shrub diversity remain high, though minor successional shifts occur as older vegetation

declines and regenerates. Floodplain wetlands and riparian corridors maintain high saturation frequency and duration, while channel morphology remains stable with ongoing dynamic equilibrium. Biotic structure reaches its peak, supporting complex, interlinked aquatic and terrestrial communities representative of a fully functional, resilient river–floodplain ecosystem.

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SECTION 6 - CONCLUSION

FACStream and CE/ICA model results indicate that implementation of the Main Channel 1 + Main Channel 2 + Main Channel 3 (MC1+MC2+MC3) alternative would restore aquatic and riparian habitat quality, quantity, and ecological function throughout the Barber Pool Conservation Area. The combined plan would provide meaningful improvements in hydraulic complexity, floodplain connectivity, riparian diversity, and biotic structure, producing measurable benefits for native fish, amphibians, birds, and pollinators. Model results show that these enhancements would increase floodplain activation and habitat resilience, improving conditions for aquatic organisms and strengthening the long-term ecological stability of the Boise River corridor.

Plan implementation would yield significant gains in in-channel habitat complexity, sediment transport balance, and hydraulic structure diversity. Regrading and bankline excavation would restore floodplain access, while vegetation plantings and instream structures would enhance both stability and biological productivity. Over time, these improvements would promote natural hydrologic exchange, nutrient cycling, and organic matter accumulation, fostering a more self-sustaining ecosystem that supports native species assemblages.

While smaller alternatives such as MC2 or MC1+MC2 offer partial improvements, they do not achieve the same breadth of ecosystem benefits as the full composite plan. The incremental cost analysis confirms that MC1+MC2+MC3 remains cost-effective relative to its substantial ecological output, providing approximately 142 AAHUs above the without-project condition. The integration of all three channel segments creates a continuous and functional corridor that maximizes restoration efficiency and ecological return on investment.

Therefore, based on functional modeling, cost-effectiveness analysis, and ecological justification, MC1+MC2+MC3 is identified as the TSP. This plan represents the most balanced and comprehensive approach to restoring the hydrologic, geomorphic, and biological integrity of the Barber Pool reach, achieving the greatest ecosystem lift and ensuring long-term sustainability of restoration investments.

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