Appendix B – Economics

River Road Aquatic Ecosystem Restoration

San Antonio, TX

Continuing Authorities Program

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US Army Corps
of Engineers®
Fort Worth District

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List of Acronyms

AAHU	Average Annual Habitat Unit
CE/ICA	Cost Effectiveness / Incremental Cost Analysis
EGM	Economic Guidance Memorandum
ICA	Incremental Cost Analysis
IDC	Interest During Construction
LWC	Low Water Crossing
NER	National Ecosystem Restoration
OMRR&R	Operations, Maintenance, Repair, Replacement, and Rehabilitation
UDV	Unit Day Value

1 Introduction

Comparing benefits and costs for ecosystem restoration provides a challenge to planners and decision makers because benefits and costs are not measured in the same units. Environmental restoration benefits can be measured in habitat units or some other physical unit, while costs are measured in dollars. Therefore benefits and costs cannot be directly compared. Two analyses are conducted to help planners and decision makers identify plans for implementation, though the analyses themselves do not identify a single ideal plan. These two techniques are cost effectiveness and incremental cost analysis. Use of these techniques are described in the Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies (U.S. Water Resources Council 1983).

Cost effectiveness compares the annual costs and benefits of plans under consideration to identify the least cost plan alternative for each possible level of environmental output, and for any level of investment, the maximum level of output is identified.

Incremental cost analysis of the cost effective plans is conducted to reveal changes in costs as output levels are increased. Results from both analyses are presented graphically to help planners and decision makers select plans. For each of the best buy plans identified through incremental cost analysis, an “is it worth it?” analysis is then conducted for each incremental measure or plan to justify the incremental cost per unit of output to arrive at a recommended plan.

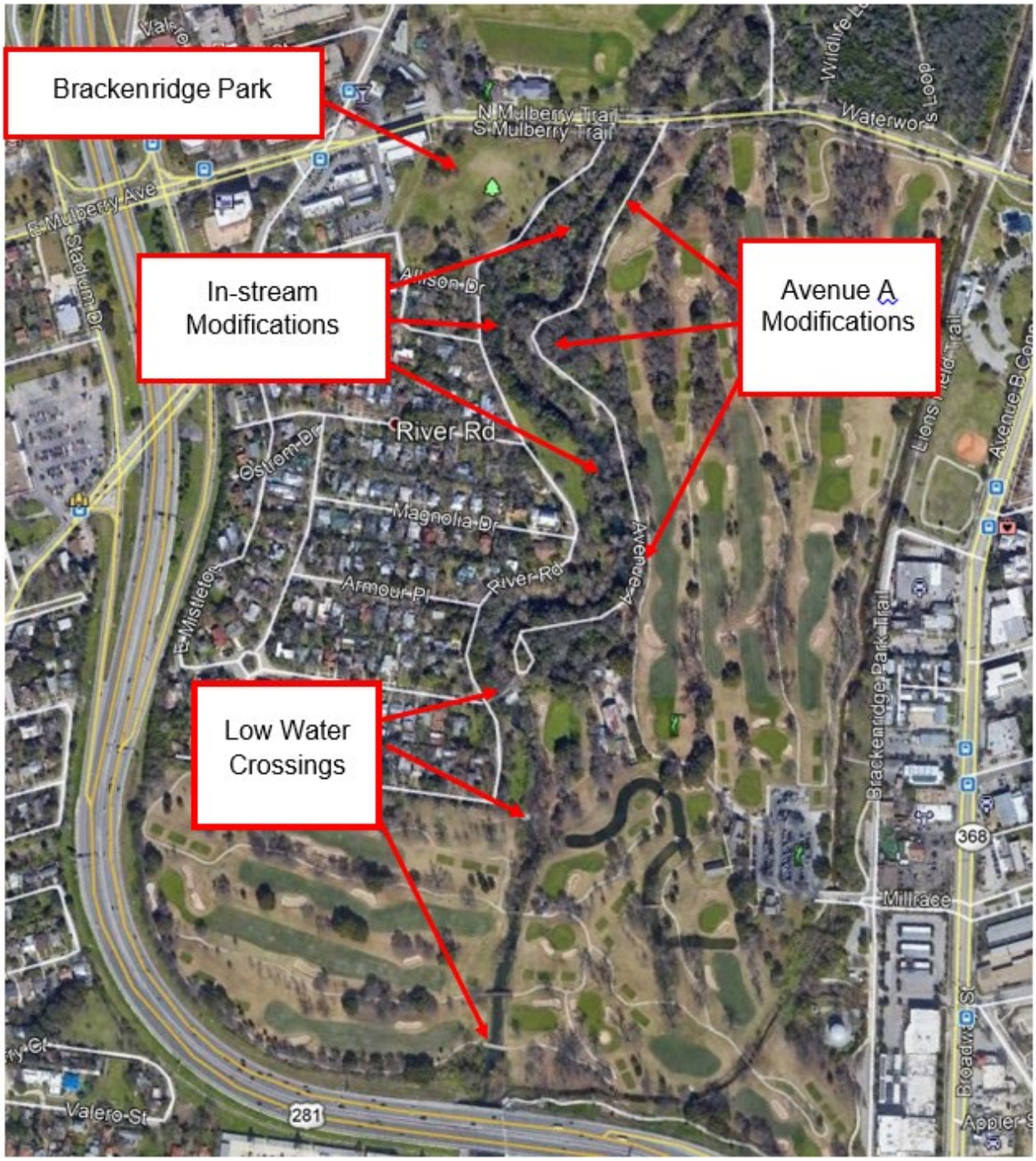
For this study, the environmental output is the average annual habitat unit (AAHU), which is derived from the product of a Habitat Suitability Index and an alternatives acreage. The development of the AAHU is discussed in detail in the Appendix C2 – Habitat Modeling.

2 Measures and Alternatives

2.1 Measures

A measure is defined as a means to an end; an act, step, or procedure designed for the accomplishment of an objective. In other words, a measure is a feature (structure), or an activity, that can be implemented at a specific geographic site to address one or more planning objectives. After the preliminary screening of management measures, the following management measures were carried forward. An overview of the general location of these features is shown in Figure 2-1, below.

Figure 2-1. Overview of Project Area and Measures



Direct Environmental Restoration Measures

- Low Water Crossing Modification – This would include removing existing concrete rip-rap and fill material. One 5'W x 4' H box culvert would be placed in the center of the low water crossing. Suitable fill material would be placed, compacted, and shaped accordingly and 6" of concrete rip-rap would be

positioned for appropriate slope. This measure would help restore the aquatic ecosystem function and structure by allowing for a more natural river system and water flow in the channel.

- Low Water Crossing Removal – Existing low water crossings would be demolished and the materials removed. Low water crossing 1 at East Woodlawn Avenue currently serves as a heavily utilized as a bridge for public access to both sides of the river. Removal would require mitigation with a bridge (included as a separate measure). This measure would help restore the aquatic ecosystem function and structure by allowing for a more natural river system and water flow in the channel.

- Instream Structures – Placement of instream structures such as j-hooks, pool/riffle/run, and rock vane features within the San Antonio River. This measure would improve aquatic habitat while also reducing the amount of sheer stress on the banks of the river. The features will also provide quality auditory benefits for the general public. This measure would help restore the aquatic ecosystem function and structure by allowing for a more natural river system and water flow in the channel.

- Rerouting River Road – Partial removal of River Road beginning at E Mulberry Avenue and ending at Allison Road. A Texas Department of Transportation approved road would be built within the boundary of the past alignment of Allison Road to the northwest (Reestablishment of Allison Drive). This measure would help restore the reduced riparian habitat by allowing for a larger space adjacent to the channel for native species plantings.

- Avenue A Partial Removal – This measure would include the removal of 621 cubic yards of road material and replacing it with native soil. This measure would help restore the reduced riparian habitat by allowing for a larger space adjacent to the channel for native species plantings.

- Avenue A Full Removal – This would include the complete removal of Avenue A, 1,921 cubic yards of road material and replacing it with native soil. This measure would help restore the reduced riparian habitat by allowing for a larger space adjacent to the channel for native species plantings.

- Habitat Structures – This measure would include the installation of structural habitat features such as bat boxes, bird boxes, and platforms.

- Native Species Plantings – Native aquatic and riparian vegetation would be planted within the specified project area. This measure would help restore the reduced riparian habitat by establishing native species in the area adjacent to the channel.

- Invasive Species Management – Invasive species would be removed and an invasive species management plan would be implemented within designated sites. This measure would help restore the reduced riparian habitat by removing invasive species that compete with native species adjacent to the channel.

Access Control Measures

- Boulder Barrier – A barrier consisting of 3' to 4' diameter boulders with 7' center to center spacing would be placed along the boundaries of River Road to protect restoration features from recreational vehicle use. This measure would help restore and maintain the reduced riparian habitat that currently exists by restricting public access and parking to restored project areas. Currently, public vehicles park in the riparian area that parallels both sides of the channel. Public usage on both side of the channel is currently unrestricted, contributing to the reduced riparian habitat.

- Gate Installation – This measure would include installation of a gate at the intersection of Avenue A and E Mulberry Avenue to restrict public vehicular access, but allow the golf course maintenance staff to access the golf course maintenance building (current access utilizes Avenue A). Depending on the alternatives implemented, a gate could also be installed at the entrance of the Brackenridge Golf Course golf cart path. This measure would help restore and maintain the reduced riparian habitat that currently exists by restricting public vehicular access and parking along Avenue A and the riparian habitat adjacent to Avenue A.

Access Mitigation Measures

This section includes recreation measures that would be required to mitigate the loss of existing access in the project area as a result of alternative plans. These measures were included in alternative formulation, evaluation, and comparison.

- *Golf Course Golf Cart Path Widening – The Brackenridge Park Golf Course is adjacent to the project area. A golf cart path runs parallel to Avenue A. This path would be expanded by two feet to accommodate vehicular traffic from the golf course maintenance staff. Removing access to Avenue A would remove

the golf course staff access to their maintenance building. The Golf cart path widening would mitigate for the lost access.

- *Bridges – This measure would be dependent upon the low water crossing removal measure. An Americans with Disabilities Act (ADA) compliant pedestrian bridge would be necessary for the East Woodlawn Avenue low water crossing while the bridges within the golf course would be utilized mostly for golf cart access. Currently, LWC 1 and Avenue A provide public access to both sides of the channel. Removal of Avenue A or LWC 1 would result in a loss of public access to the river. The Access path would mitigate for this loss as an additional measure to an alternative that partially or fully removes Avenue A.

Additional Recreation Features

This section includes recreation features that were considered as additions for all alternatives. These features are not included in the alternative formulation, evaluation, and comparison. A benefit-cost ratio will be developed for the recreation features following the selection of a TSP. The recreation components of the TSP are discussed in Section 3.7.7 Recreation.

- Access Path – A 2,450’ by 8’ Americans with Disabilities Act compliant asphalt path would be constructed along the original path of Avenue A if it were to be partially or completely removed. Currently, LWC 1 and Avenue A provide public access to both sides of the channel. Removal of Avenue A or LWC 1 would result in a loss of public access to the river. The Access path would mitigate for this loss as an additional measure to an alternative that partially or fully removes Avenue A.

- Fishing Access – This measure would include the installation of recreational fishing piers along the perimeter of the San Antonio River.

- Signage – Installation of signage to include restoration information, recreation information, and general rules and regulations.

- Trash Cans – Installation of single or clustered trash cans to focus litter disposal within a specified area.

- Bird Blinds - This measure would include the installation of bird blinds in the public access areas of the project

2.2 Alternatives

The final array of management measures were combined into alternatives that would address ecosystem restoration of the riverine and riparian forest habitats, as well as restore structure and function of the study area. Each of the alternatives listed below could be a standalone plan, or be combined with other alternatives to form a suite of plans. In addition, several scales of the alternatives were developed in order to achieve differing levels of captured and uncaptured benefits. All alternatives will also include recreation features, such as trash cans, signage, fishing access and enforcement.

- Instream Modification (Scales 1A, 1B, 1C, and 1D) – This alternative can include measures such as native species plantings, invasive species management, installation of habitat features, instream structures, low water crossing removal or low water crossing modification, and bridges. Scales 1A, 1B, 1C, and 1D differ due to the type of modification conducted upon Low Water Crossings (LWC) 1, 2, and 3.
    - Scale 1A – Removal of all low water crossings
    - Scale 1B – Removal of LWCs 2 and 3 with a box culvert modification of LWC 1
    - Scale 1C – Removal of LWC 1 with box culvert modification of LWCs 2 and 3
    - Scale 1D – Box culvert modification of all low water crossings
- Avenue A Modification (Scales 2A and 2B) – This alternative will include measures such as native species plantings, invasive species management, installation of habitat features, gate installation, Avenue A full removal or Avenue A partial removal, and a golf course golf cart path widening.
    - Scale 2A – Full removal of Avenue A
    - Scale 2B – Partial removal of Avenue A
- River Road Modification (Scales 3A and 3B) – This alternative will include measures such as native species plantings, invasive species management, installation of habitat features, and possible rerouting of River Road.
    - Scale 3A – Rerouting of River Road to historical Allison Avenue location
    - Scale 3B – Leave River Road as-is

3 Average Annual Habitat Units and Costs

In order to determine benefits of an environmental restoration plan, future with-project environmental outputs are compared to future without-project outputs. The difference between the two represents the benefits from project implementation. The Average Annual Habitat Units (AAHUs) were calculated using the Annualizer Tool in the Institute for Water Resources Planning Suite II. Appendix C2 – Habitat Modeling provides further documentation on how AAHUs were calculated for each Future-Without Project (FWOP) and Future-With Project (FWP) condition benefits.

3.1 Existing and Future-Without Project Average Annual Habitat Units

For this study, FWOP baseline conditions are assumed to be the same as existing conditions, given the existing habitat quality. Future-Without Project conditions were estimated by a team of biologists, including representatives from USACE, SARA, Texas Parks and Wildlife Department, and the Texas Commission on Environmental Quality.

3.2 Future-With Project Average Annual Habitat Units

Environmental restoration benefits are calculated by subtracting the FWOP AAHU from the FWP AAHU. For the comparison of measures, both environmental outputs and costs were annualized over a 50-year planning horizon. The resulting benefits are then used, along with annual costs, to identify cost effective plans and perform incremental cost analysis. The calculation of benefits (outputs) are shown in Table 3-1.

Table 3-1. Annual AAHU Benefits

Alternative	Scale	FWOP AAHU	FWP AAHU	AAHU Benefits	Acres
Alternative 1: Instream Modification	1A: Removal of Low Water Crossings 1, 3, & 3	7.6	12.9	5.3	16
	1B: Modification of Low Water Crossing 1 and Removal of Low Water Crossings 2 and 3	7.6	10.8	3.2	16
	1C: Removal of Low Water Crossing 1 and Modification of Low Water Crossings 2 & 3	7.6	11.7	4.1	16
	1D: Modification of Low Water Crossings 1, 2, & 3	7.6	9.6	2.0	16
Alternative 2: Avenue A Modification	2A: Complete removal of Avenue A	0.8	1.7	0.9	4.6
	2B: Partial removal of Avenue A	0.4	0.8	0.4	2
Alternative 3: River Road	3A: River Road Relocation and Planting in Davis Park	0.0	2.6	2.6	5.1
	3B: River Road As-Is and Planting in Davis Park	0.0	2.5	2.5	4.9

3.3 Costs

Total project economic costs were annualized using the annualizer tool in Institute for Water Resources (IWR) Planning Suite II. A period of analysis of 50 years was used, along with a federal

discount rate of 2.75% (per EGM 20-01 dated 31 October 2019). Prices are expressed in October 2019 dollars. Details of the development of costs can be found in the Cost Engineering Appendix.

Table 3-2 provides a summary of total and annual costs, including an initial estimate of annualized Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) for the plantings included in each alternative. Project first cost includes construction cost, plantings, planning, engineering, and design (PED), construction management, and a 10% contingency. Real estate cost was estimated on a per-acre basis for each alternative, and includes a 20% contingency. For CE/ICA only, construction durations were assumed to be 12 months for all alternatives for the purposes of calculating interest during construction (IDC). Interest during construction is combined with construction first cost and real estate cost to calculate the annual investment cost. The annual with-project OMRR&R is added to the annual investment cost to obtain the total annual cost.

Table 3-2. Cost Inputs for IWR Planning Suite CE/ICA Analysis

Alternative	Project First Cost	Real Estate	IDC	Economic Cost	Annual Investment Cost	Annual O&M	Total Annual Cost
Instream Modification							
Remove All LWCs	$3,554,940	$67,986	$49,592	$ 3,672,518	$136,033	$7,401	$143,434
Remove LWC 2 & 3, Mod LWC 1	$2,932,508	$67,986	$41,072	$ 3,041,566	$112,662	$7,401	$120,063
Remove LWC 2 & 3, Mod LWC 1	$2,262,263	$67,986	$31,897	$ 2,362,146	$87,496	$7,401	$94,897
Modification of all LWCs	$1,784,512	$67,986	$25,357	$ 1,877,855	$69,557	$7,401	$76,958
Avenue A Modification							
Complete Removal	$482,166	$20,340	$6,878	$ 509,384	$18,868	$2,123	$20,991
Partial Removal	$183,599	$8,406	$2,628	$ 194,633	$7,209	$930	$8,139
River Road							
Partial Removal, Relocate	$551,908	$46,260	$8,188	$ 606,356	$22,460	$2,378	$24,838
Leave as-is, Plantings	$158,437	$44,190	$229	$ 202,856	$7,514	$2,271	$9,785

3.4 Cost Effectiveness and Incremental Cost Analysis

To conduct the CE/ICA analysis, environmental restoration benefits (increase in with-project AAHUs) and annual costs (expressed in thousands of dollars) were entered into IWR Planning Suite II. This data is presented in Table 3-3. All areas are combinable, but scales within each alternative are mutually exclusive. No combinability and dependency relationships were entered into IWR Planning Suite. Using the management measures, the plan generator in the software was used to create all possible combinations of the measures. This resulted in 45 plans.

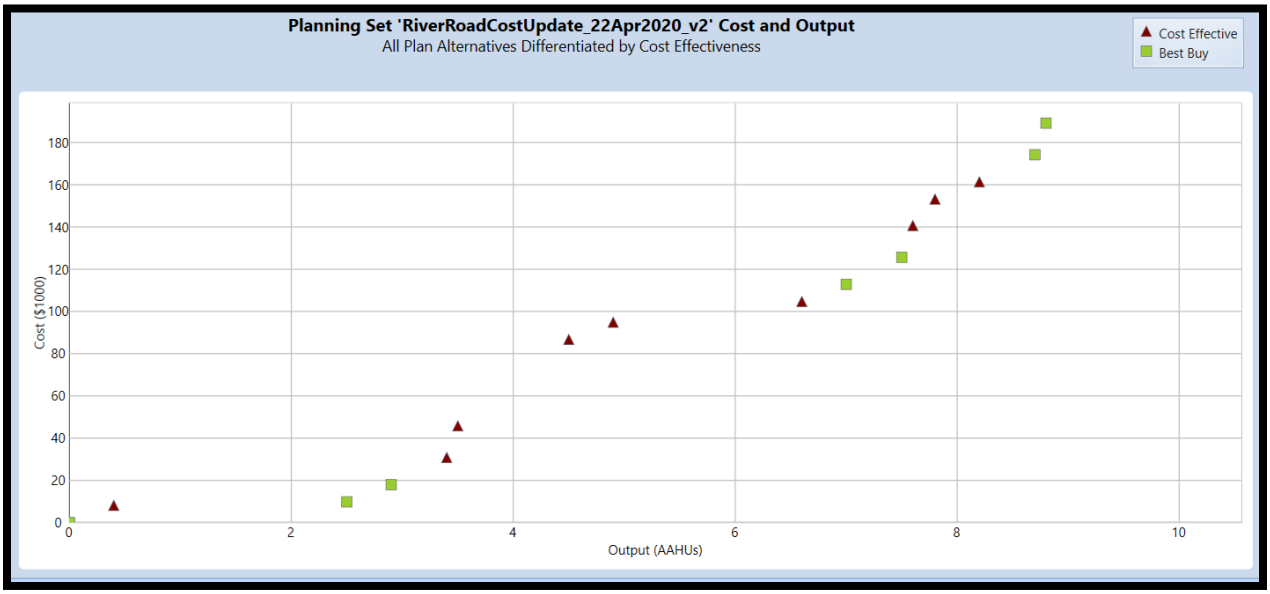
Table 3-3. Annual Benefits and Annual Cost for Each Alternative

Alternative	Scale	AAHU	Annual Cost ($1,000) October 2019 Prices
Alternative 1: Instream Modification	1A: Removal of Low Water Crossings 1, 2, & 3	5.3	$143.4
	1B: Modification of Low Water Crossing 1 and Removal of Low Water Crossings 2 and 3	3.2	$120.1
	1C: Removal of Low Water Crossing 1 and Modification of Low Water Crossings 2 & 3	4.1	$94.9
	1D: Modification of Low Water Crossings 1, 2, & 3	2.0	$77.0
Alternative 2: Avenue A Modification	2A: Complete removal of Avenue A	0.9	$21.0
	2B: Partial removal of Avenue A	0.4	$8.1
Alternative 3: River Road	3A: River Road Relocation and Planting in Davis Park	2.6	$24.8
	3B: River Road As-Is and Planting in Davis Park	2.5	$9.8

3.4.1 Cost Effective Plans

Using the generated plans, their costs and benefits, a cost effective analysis was performed using the IWR Planning Suite Software. Cost effective plans are defined as the least expensive plan for a given set of benefits, or environmental output. In other words, no other plan would provide the same or more benefits for a lower cost. Of the 45 plans (including various scales), 16 were identified as cost effective plans (including no action). The results are shown in Figure 3-1 and Table 3-4.

Note that cost effective plans (red triangles) include those identified as “Best Buy” plans (green squares), which will be discussed in the next section.



Note: Cost in this figure is the Total Annual Cost, including IDC and estimated OMRR&R

Figure 3-1. Cost Effective Results

Table 3-4. Cost Effective Plans

Cost Effective Plans	Output	Total Annual Cost ($1000s)	Average Cost
No Action Plan	0	0	0
S0A2R0	0.4	8.14	20.35
S0A0R2	2.5	9.79	3.92
S0A2R2	2.9	17.93	6.18
S0A1R2	3.4	30.78	9.05
S0A1R1	3.5	45.79	13.08
S4A0R2	4.5	86.75	19.28
S4A2R2	4.9	94.89	19.37
S3A0R2	6.6	104.69	15.86
S3A2R2	7	112.83	16.12
S3A1R2	7.5	125.68	16.76
S3A1R1	7.6	140.69	18.51
S1A0R2	7.8	153.22	19.64
S1A2R2	8.2	161.36	19.68
S1A1R2	8.7	174.21	20.02
S1A1R1	8.8	189.22	21.5
S0: No action on LWCs S1= Remove all LWCs S2= Modify LWC 1, Remove 2& 3 S3= Remove LWC 1, Modify 2&3		A0: No Action on Ave A A1= Complete removal of Ave A A2= Partial Removal of Ave A R0: No Action on River Road R1= Relocate River Road R2= Leave River Road as-is and add plantings	

Note: Cost in this table is the Total Annual Cost, including IDC and estimated OMRR&R.

3.4.2 Incremental Analysis and Best Buy Plans

The next step in the CE/ICA analysis is to perform an incremental cost analysis (ICA) on the cost effective plans. ICA compares the incremental cost per incremental benefit (output, or lift in environmental output) among the plans to identify plans that maximize the last dollar spent. Starting with the no action plan, the incremental cost per incremental benefit is calculated from the no action for each cost effective plan. The plan with the least incremental cost per incremental output is identified as the first of the “with-project” best buy plans. Then starting with that plan, the incremental cost per incremental benefit is calculated between that plan and each remaining cost effective plan, and the one with the least incremental cost per incremental benefit is identified as the next plan in the array of best buy plans. This process continues until there are there are no remaining plans. The last plan in the best buy array, is typically the “kitchen sink” plan, or the plan that contains all of the management measures being analyzed.

From the cost effective alternatives, seven were identified as “Best Buy” plans (including the No Action plan). The results of the analysis is shown graphically in Figure 3-2, and the plan numbers are labeled on the figure

The alternative Best Buy plans are:

Plan 1: No Action

Plan 2: River Road Scale 3B

Plan 3: River Road Scale 3B + Avenue A Scale 2B

Plan 4: River Road Scale 3B + Avenue A Scale 2B + Instream Modification Scale 1C

Plan 5: River Road Scale 3B + Instream Modification Scale 1C + Avenue A Scale 2A

Plan 6: River Road Scale 3B + Avenue A Scale 2A + Instream Modification Scale 1A

Plan 7: Avenue A Scale 2A + Instream Modification Scale 1A + River Road Scale 3A

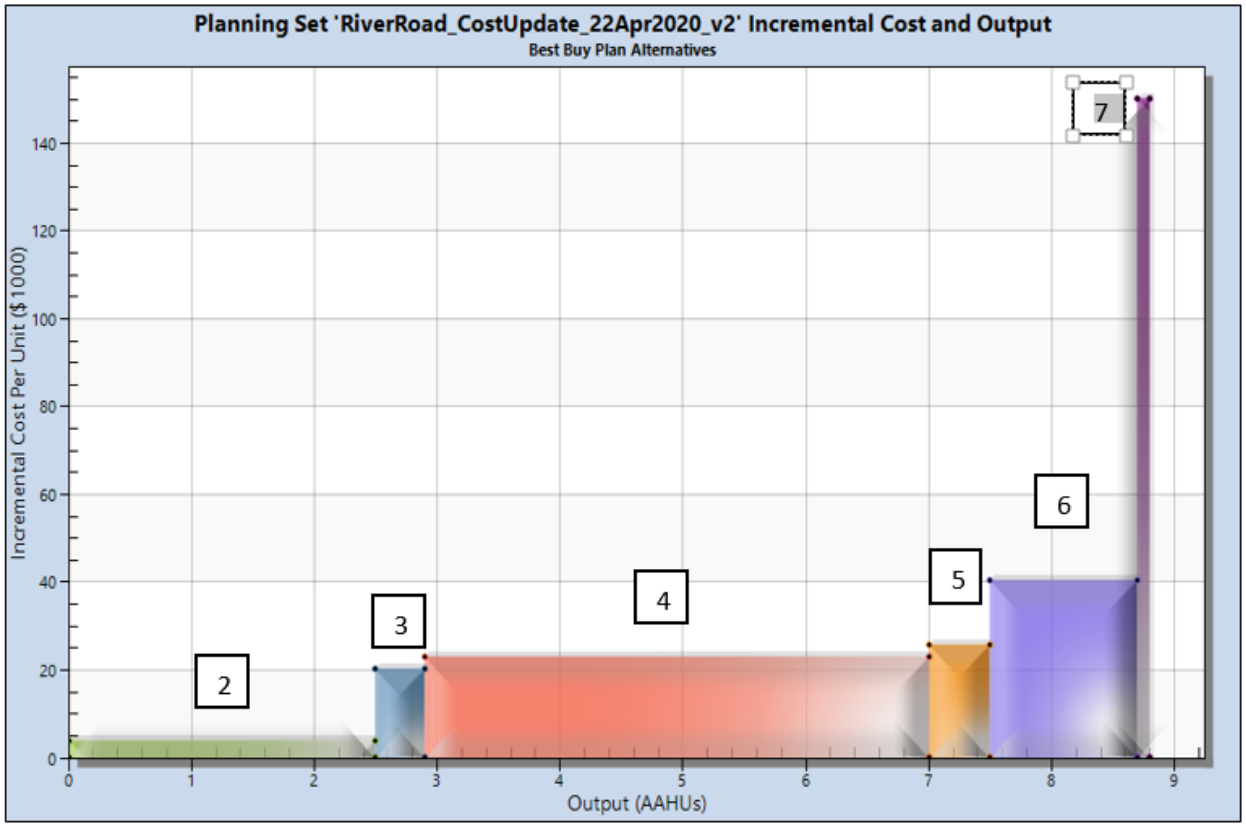


Figure 3-2. Incremental Cost Analysis Result

Table 3-5. Best Buy Plans

Plan	Output (AAHU)	Annual Cost ($1000)	Avg Annual Cost ($1000/AAHU)	Incremental Cost ($1000)	Incremental Output (AAHU)	Incremental Cost per Output	Plan First Cost
Plan 1: No Action Plan	0	0	0	0	0	0	$-
Plan 2: River Road Scale 3B	2.5	9.79	3.916	9.79	2.5	3.916	$202,627
Plan 3: River Road Scale 3B & Avenue A Scale 2B	2.9	17.93	6.183	8.14	0.4	20.35	$394,632
Plan 4: River Road Scale 3B & Avenue A Scale 2B & Instream Modification Scale 1C	7	112.83	16.119	94.9	4.1	23.146	$2,724,881
Plan 5: River Road Scale 3B & Instream Modification Scale 1C & Avenue A Scale 2A	7.5	125.68	16.757	12.85	0.5	25.7	$3,035,382
Plan 6: River Road Scale 3B & Avenue A Scale 2A & Instream Modification Scale 1A	8.7	174.21	20.024	48.53	1.2	40.442	$4,328,059
Plan 7: Avenue A Scale 2A & Instream Modification Scale 1A & River Road Scale 3A	8.8	189.22	21.502	15.01	0.1	150.1	$4,723,600

4 Is It Worth It Analysis on the Final Array of Plans

4.1 Plan 1 (No Action)

The No Action Plan would leave the River Road study area in its existing condition and would not address the study objectives of restoring habitats that would benefit migratory, breeding, and wintering neotropical birds, waterbirds, and water fowl and aquatic organisms. The significant national loss of habitats that is occurring for these species would continue and no efforts to offset the magnitude of these losses would occur for the study area. Migratory birds key in on aquatic habitats such as the San Antonio River when identifying resting and refueling areas during their annual migrations, especially in the more arid regions of the western U.S. This is an evolutionary response for these species as riparian and aquatic habitats generally have higher biodiversity and biomass than upland habitats. These resources are especially important during times of high energy demands such as migration and preparation for the breeding season. Although the River Road study area continues to attract a large number of migratory birds due to its attractive aquatic environments, the low quality habitat and low habitat diversity cannot adequately support the energy needs of the migratory birds the river attracts. Therefore, migratory birds must expend additional, limited energy resources in search of food elsewhere. In addition to the lack of suitable habitat for a diverse range of migratory birds, the river itself is currently impacted by extreme amounts of pooling leading to an inadequate amount of pool/riffle/run features for aquatic species

prosperity. Therefore, the No Action Plan is ineffective to improve habitat for the nationally significant migratory bird and aquatic wildlife populations within the study area.

4.2 Plan 2 (River Road Scale 3B)

The change from non-native herbaceous vegetation to a restored native riparian forest would be a hydraulically neutral action. Restoration of Davis Park would partially address the restoration objective for River Road by providing some increased vertical structure diversity in the existing non-native herbaceous dominated park. Some increased insect biomass production and ancillary water quality benefits will occur. Davis Park is located within the floodplain, so increasing vegetative diversity could allow for some filtering of storm and runoff drainage before entering the San Antonio River. By increasing the vegetation that can create a buffer between the urban landscape and the river, there will be improved erosion and sedimentation conditions.

This plan increases the AAHUs by 2.5 over the No Action Plan with an incremental cost per incremental output of $3,916. This plan's estimated first cost is $202,627 with an average annual cost of $9,785.

Although this plan addresses stormwater runoff and adds riparian habitat in the study area, it does not effectively address the goals and objectives within the study area.

4.3 Plan 3 (River Road Scale 3B + Avenue A Scale 2B)

The River Road reach of the San Antonio River is heavily utilized by the general public. Severe erosion and sedimentation on the eastern bank of the river has been caused by pooling and the amount of vehicular traffic along Avenue A. By removing a small portion of this road, USACE and the NFS can improve upon the adverse impacts from recreational use.

Although Scale 2B of this alternative would only remove the lower loop of Avenue A, it would still be beneficial to the project by reducing erosion and sedimentation in the area. The lower loop of Avenue A acts as supplemental parking and its removal would most likely reduce the amount of nonpoint source pollution occurring due to idling vehicles.

This plan includes the restoration benefits of planting native species in Davis Park as well as planting and maintaining vegetation on the "southern" alignment of Avenue A past the Brackenridge Golf Course maintenance building.

This plan creates a total AAHU of 2.9 over the No Action Plan, and an increase of 0.4 AAHUs over the previous plan. The incremental cost per incremental output increases to $20,350. The first cost of River Road Scale 3B + Avenue A Scale 2B is $394,632, an increase of $192,005 from the previous plan. The estimated average annual cost for this plan is $17,930.

Although there is a significant difference in cost by adding Avenue A Scale 2B, the effects of this restoration alternative will have long-term beneficial impacts on not only the riparian buffer zone of the San Antonio River, but also within the river itself through reduced pollution and sedimentation. Although the plan addresses the increase of additional riparian habitat along with increased control of vehicular access within a small segment of the study area; it is ineffective in addressing all of the goals and objectives of the project.

4.4 Plan 4 (River Road Scale 3B + Avenue A Scale 2B + Instream Modification Scale 1C)

River Road Scale 3B + Avenue A Scale 2B + Instream Modification Scale 1C incorporates the full scale removal of Low Water Crossing (LWC) 1 and the modification of LWCs 2 and 3. Removal of LWC 1 will have a significant impact because it will reduce the extreme pooling that occurs in the river from E Mulberry Avenue to the low water crossing itself. Reduced pooling will encourage stream flow, thereby improving oxygenation and other abiotic factors within the river. Improved connectivity within this reach of the river will improve aquatic habitat through increased natural pool/riffle/run and transport of debris. Introduction of manmade instream structures such as j-hooks and pool/riffle/run features will provide increased benefits for aquatic wildlife by providing additional areas for foraging and cover.

Increased connectivity within the river will provide better habitat conditions for native fish, such as channel catfish (*Ictalurus punctatus*), yellow bullhead (*Ameiurus natalis*), and largemouth bass (*Micropterus salmoides*) through increased aquatic plant diversity and improved habitat structure. Pool/riffle/run features acting in a more natural capacity assist ecosystem restoration in a variety of ways. Pools can protect smaller fish or provide shelter during dry conditions and also allow sediment and organic materials to settle within the streambed because the river moves more slowly. Riffles also assist in the protection of smaller species from predators while also acting as a unique food source. Riffles are a good source of habitat for caddisflies, stoneflies, and mayflies; indicator species for river health. Smaller fish, unable to adequately compete in pools, are more likely to utilize runs because of the quick moving water over shallower areas. Due to the complexity of pool/riffle/run features, each segment acts as its own micro habitat providing protection and forage for a variety of species.

This plan creates 7 AAHUs over the No Action Plan, an increase of 4.1 AAHUs over the previous plan. The incremental cost per incremental output increases to $23,146. The estimated first cost of this plan is $2,724,881, an increase of $2.3 million from the previous plan. The estimated average annual cost for River Road Scale 3B + Avenue A Scale 2B + Instream Modification Scale 1C is $112,821. Because this plan adds habitat features that provide increased benefits for aquatic species, migratory birds, and local wildlife while also improving the overall health of the San Antonio River, the plan is worth the Federal and local investment.

4.5 Plan 5 (River Road Scale 3B + Instream Modification Scale 1C + Avenue A Scale 2A)

River Road Scale 3B + Instream Modification Scale 2C + Avenue A Scale 2A is similar to the last plan; however, this plan includes the complete removal of Avenue A. Avenue A scale 2A incorporates expanding the riparian buffer zone along Avenue A from 10 to 30 feet for its entirety. By including Avenue A scale 2A, USACE will not only increase ancillary water quality benefits from improved runoff filtering, but will also provide additional riparian habitat for migratory birds

and other wildlife within San Antonio through added habitat connectivity and improved ecological modifications.

Throughout the United States, roads have negatively impacted natural ecological functions of wildlife through habitat fragmentation and alteration. Roads impact wildlife through a reduction of habitat structures like; snags, downed logs, increased edges, vehicular mortality, and altered movement. Avenue A has adversely affected aquatic and riparian habitat within the study area. Its removal will restrict vehicular access to the site and will also minimize erosion, reduce impacts to riparian vegetation, reduce pollution, restore natural drainage, and increase bank stability.

Avenue A can also be a contributor to the introduction of sediment into the San Antonio River. The introduction of sediment is due to constant disturbance and erosion due from vehicles driving and parking on Avenue A. The obvious lack of vegetation on a roadway also decreased the amount of cover and shading for terrestrial and aquatic wildlife. Sedimentation caused by roadways can negatively impact aquatic species through direct mortality and hindrance of visibility, egg and larvae development, natural movements, and natural feeding behaviors (Switalski et. al 2004). Restoring vegetative cover on old roadways is an integral step to ecosystem restoration and can immediately produce results benefitting wildlife. Native vegetation can serve as food and cover for invertebrates, while also benefitting larger organisms that prey on these species. Vegetation assists in protecting soil from stormwater runoff as well. Trees can act as a protectant through their root system, canopies, and transpiration. Roots can bind loose soil together; stabilizing the tree, reducing erosion, and improving drainage. They allow for a slower disbursement of water, so rain can be adequately absorbed by soil. Roots can also prevent soil compaction, which can decrease the soil's ability to absorb moisture and increase runoff. Tree canopies have a similar effect by reducing the impact of rain onto soil by absorbing the initial force, allowing water to slowly drain down its base onto the ground. Canopies may also reduce the effects of wind, which could cause additional adverse sedimentation into the San Antonio River during large storm events (Shaw 2020).

Roads can also be a conduit for pollutants into the environment. Tire debris, deicing salts, oil, and gasoline all have the potential to mortality wound wildlife upon their entrance into an ecosystem. This pollution can impact locomotor function, directly altering an animal's ability to catch prey or elude predators. Light and noise pollution from vehicles traveling along roads can be detrimental to communication between wildlife, especially birds and amphibians, by interfering with warning and breeding calls. Artificial light exposure to nocturnal animals can be confusing and can impact animals that rely on light cues to initiate certain behavioral patterns. Roads may also facilitate the spread of non-native invasive species, due to the lack of competition (Hill 2020).

Impervious surfaces, such as Avenue A, can affect the San Antonio River through water quality and flooding characteristics. Impervious surfaces reduce the area in which water infiltration can occur; therefore, more runoff from storms occurs. Due to its proximity to the river, runoff flows directly into the San Antonio River off of Avenue A; thereby increasing erosion and adverse sedimentation. Because the water enters the stream much more quickly than it would with

vegetation filtration, there is a higher chance that more frequent and severe flooding will occur (Hill 2020).

Although adding riparian habitat is a significant benefit, removing the road itself will not only reduce nonpoint source pollutant but will also decrease the intensity of runoff flowing into the river by removing the impervious surface throughout the entire eastern edge of the project area. Impervious surfaces can create “heat island” effect causing increases in temperatures up to 22ºF (U.S. Environmental Protection Agency 2020). The heat island effect can cause adverse impacts, such as increased energy consumption, elevated air pollutant and greenhouse gas emissions, compromised human health and comfort, and impaired water quality. Impaired water quality due to the heat island effect can increase the temperature of stormwater runoff. Rapid temperature changes in aquatic ecosystems can be stressful and prove fatal to aquatic life. Avenue A Scale 2A will nullify these factors on the eastern boundary of the study area through increased shading, habitat quality, and biodiversity.

In addition to the riparian habitat impacts, the complete removal of Avenue A will also terminate vehicular access to the area. Thereby, improving erosion effects from the eastern bank of the river that have contributed to poor sediment transport and water flow. Removing a road adjacent to the San Antonio River that does not have any direct access to neighboring communities or publicly accessible infrastructure is an ecologically sound approach to improving aquatic and riparian habitat.

This plan creates 7.5 AAHUs over the No Action Plan, an increase of 0.5 AAHUs over the previous plan. The incremental cost per incremental output increases to $25,700. The estimated first cost of this plan is $3,035,382, an increase of $310,501 from the previous plan. The estimated average annual cost for River Road Scale 3B + Instream Modification Scale 1C + Avenue A Scale 2B is $125,673. This plan is worth the Federal and local investment because it contributes not only to wildlife species utilizing riparian habitat, but also to the aquatic ecosystem through improved impacts from water runoff, erosion, sedimentation, and pollution.

4.6 Plan 6 (River Road Scale 3B + Avenue A Scale 2A + Instream Modification Scale 1A)

River Road Scale 3B + Avenue A Scale 2A + Instream Modification Scale 1A incorporates all of the habitat benefits and measures described by the previous plan. Instream Modification Scale 1A; however, removes LWC 2 and 3 and replaces those structures with a pedestrian bridge. The removal of LWCs 2 and 3 significantly improves stream flow and habitat connectivity. Removal of these stream obstructions will address the problems of erosion and poor sediment transport within the study area.

The low water crossings are significant obstructions within the San Antonio River. Although LWCs 2 and 3 have some river flow, the culverts can be easily blocked by debris. Bank degradation has begun to occur due to the limited flow through the existing culverts. Slow moving water can lead

to oxygen deprivation and high water temperature within a stream. It is expected that the river will return to a more natural setting and conditions will improve for aquatic organisms.

The Texas pimpleback (*Quadrula petrina*) and Texas fatmucket (*Lampsiilis bracteata*), federally listed candidate mussels, are likely to occur within the study area; however, current conditions of this reach of the San Antonio River would be unsuitable for their success and survival. Mussels are sensitive and act as indicators of poor water quality, dying when there are significant changes in sedimentation, temperature, and other abiotic factors. Mussels play an important function in aquatic stream habitat through filter feeding and can filter sediment and contaminants before releasing cleansed byproducts downstream. The removal of all three low water crossings will significantly improve the flow of the San Antonio River; thereby, improving habitat conditions for sensitive aquatic species. Demolishing and removing the low water crossings will allow the stream bed to return to a more natural condition in the study area by allowing appropriate shape, material, and pooling. Stream beds are an integral function of a riverine system, provide aquatic organisms with appropriate cover and serve as locations for foraging and hunting. A natural streambed is a more continuous feature that is less likely to be scoured during large storm events.

In addition to aquatic habitat, safety for recreationalists will also be increased. This plan will remove the physical barriers for recreationalists attempting to navigate through the San Antonio River. This plan creates 8.7 AAHUs over the No Action Plan, an increase of 1.2 AAHUs over the previous plan. The incremental cost per incremental output increases to $40,442. The estimated first cost of this plan is $4,328,059, an increase of $1,292,677 from the previous plan. The estimated average annual cost for River Road Scale 3B + Avenue A Scale 2A + Instream Modification Scale 1A is $174,210. This plan is worth the Federal and local investment because it contributes not only to wildlife species utilizing riparian habitat, but also to the aquatic ecosystem through improved impacts from water runoff, erosion, sedimentation, and pollution. This plan will support the ecosystem restoration objectives of the project by addressing the lack of aquatic shading, reduced allochthonous material inputs, lack of stratification of vertical structure, lack of terrestrial shading, and lack of soft and hard mast diversity. The complete removal of all three low water crossings will be the most effective method of restoring instream conditions of the San Antonio River.

4.7 Plan 7 (Avenue A Scale 2A + Instream Modification Scale 1A + River Road Scale 3A)

Avenue A Scale 2A + Instream Modification Scale 1A + River Road Scale 3A adds to the previous plans habitat measures. It incorporates the relocation of River Road to the original alignment of Allison Drive and would implement the native species plantings measure within this area. This plan would increase the riparian buffer on the northwestern edge of the study area; improving habitat quality through increased vegetative diversity, decreasing the velocity of stormwater runoff entering from E Mulberry Avenue and Davis Park, and improving erosion impacts from decreased vehicular traffic on River Road.

The estimated first cost of Avenue A Scale 2A + Instream Modification Scale 1A + River Road Scale 3A is $4,723,600, with an incremental cost per output of $150,100. Due to the high

incremental cost per output, the expenditure of Federal and local funds to implement Avenue A Scale 2A + Instream Modification Scale 1A + River Road Scale 3A is not justified.

5 National Ecosystem Restoration Plan

Migratory birds, riparian and riverine systems, and aquatic wildlife are the resources of national significance identified within the study area. Based on historical descriptions and existing conditions of the San Antonio River outside of urban areas, this portion of the river would have been extremely valuable stopover habitat for migrating birds, provided excellent connectivity between riparian systems, and would have been unobstructed for the movement of aquatic species, sediment, debris, and other natural materials. The recreation of expanded riparian buffers, along with improved riverine habitat are critical to improving habitat for migratory birds, local wildlife, and aquatic species.

Plan 6, which includes River Road Scale 3B + Avenue A Scale 2A + Instream Modification Scale 1A, is the recommended National Ecosystem Restoration (NER) plan. This plan provides:

- Two distinct habitat types (riparian and riverine) out of the two targeted habitat types;
- Resilient habitat for migratory birds;
- The creation of a complex of pool/riffle/run features that can be managed to improve water quality as an ancillary benefit;
- The restoration of the San Antonio River through improved channel flow, sedimentation, and erosion.
- The restoration of 99.2% of the proposed restoration areas;
- An estimated incremental cost per incremental output of approximately $40,442 over the previous plan (Plan 5);
- An approximate first cost of $6.4 million.
- 8.7 AAHUs, and a project first cost per AAHU of $740,460.

5.1 Plan Selection

Based on the Is It Worth It Analysis in Section 4, Plan 6 is the NER Plan because it restores a majority of the study area. The in-depth discussions of the ecosystem restoration benefits of River Road Scale 3B and Avenue A Scale 2A can be found in Sections 4.2 and 4.5. The selected NER Plan combines the alternatives River Road Scale 3B, Avenue A Scale 2A, and Instream Modification Scale 1A to meet the objectives of the River Road ER through the restoration of Davis Park, Avenue A, and the San Antonio River.

The River Road reach of the San Antonio River is heavily degraded due in part to severe pooling and sedimentation. This pooling, caused by LWCs 1, 2, and 3, has decreased the efficiency of natural pool-riffle-run features within the river, negatively impacting aquatic habitat and causing severe erosion on the river banks. LWCs 2 and 3 allow for some minor stream flow, but water continues to pool causing additional erosion on the inflow and outflow of the structures. The NER Plan incorporates the removal of the low water crossings which will allow for open flow of the river,

improve sediment transport, decrease erosion, and improve overall aquatic connectivity of the San Antonio River. Once the crossings have been removed, water will be allow to flow unimpeded. A more natural river flow will allow for natural processes to return such as sediment transport and connectivity which have significant controls over habitat characteristics for flora and fauna. Animals that have evolved based on the natural processes of the river will greatly benefit through the implementation of this plan as well as native plant seed dispersal. The pool-riffle-run features will be placed throughout the upstream portion of the study area in predetermined locations to restore aquatic habitat for fish and invertebrate species.

A 50-foot riparian zone will be established on both banks of the river with native herbaceous, shrub, and tree species. Riparian species will assist ecosystem restoration in several ways 1) roots of vegetation will hold in the soil and slow down runoff, decreasing the amount of erosion and effectively decreasing the amount of sedimentation buildup within the river, 2) additional vegetation will provide shade within the river, improving the temperature, 3) increase biodiversity of insects and microorganisms near the river effectively improving foraging opportunities for aquatic and terrestrial wildlife, and 4) provide a multiple of cover for aquatic and terrestrial wildlife through their various features, such as roots and limbs.

The River Road reach of the San Antonio River is loved by the general public; however, the recreational use of this area has caused severe degradation to the banks of the river. Avenue A encourages the public to park and/or utilize the banks of the river with vehicles and other heavy equipment. This factor, along with unauthorized cutting, trimming, and/or trampling of vegetation has caused severe erosion – leading to increased sediment accumulation in the river. The base of Avenue A will be removed and replaced with appropriate soil. Increased vegetative cover will reduce nonpoint source pollution and the intensity of stormwater runoff by capturing and storing rainfall in the canopy and releasing water into the atmosphere through evapotranspiration. Trees, shrubs, and herbaceous species will also slow and temporarily store runoff, which further promotes filtration and can decrease downstream flooding and erosion impacts. The reduction of impervious surfaces will also add to the ancillary water quality benefits, by replacing those surfaces with vegetation increasing shade, biodiversity, and habitat quality. Restoration of Avenue A will also restrict vehicular access adjacent to the river, which will terminate one of the significant problems addressed by this study. This modification, along with areas adjacent to Avenue A will be planted with native riparian species. This effort will assist in ecosystem restoration by filtering runoff, improving sedimentation through erosion, increasing shade, and providing diverse habitat for migratory birds and other wildlife.

This scale of the River Road Modification entails planting native vegetation and conducting non-native invasive species management within Davis Park. Planting native riparian species will expand the riparian zone 600 feet on the western bank of the San Antonio River for 0.15 miles, while also reducing the polluting effects of runoff coming from nearby businesses and U.S. Highway 281. Restoration of Davis Park will provide increased vertical structure diversity in an area that is dominated by non-native invasive vegetation. The efforts conducted within Davis Park should assist in filtering storm and runoff drainage from adjacent businesses and impervious

surfaces before entering the San Antonio River. Increased vegetative cover and diversity will provide high quality habitat for local and migratory birds and wildlife.

5.2 Resource Significance Summary for NER Plan

The proposed project area is small in size but holds tremendous resource significance for the citizens and wildlife of San Antonio and is heavily utilized by the public. This stretch of the San Antonio River has been impacted by the urbanization and its encroachment upon aquatic and riparian habitats. The urban setting of the project area means that the availability of open land to restore is limited. Given the small project area, the nominal habitats units calculated via the habitat modeling are relatively low. However, there are benefits to implementing this project that are not captured in the habitat modeling, particularly those related to the removal of the low water crossings (as summarized in Section 5.2.2).

5.2.1 Migratory Bird Habitat

The San Antonio River is positioned on a natural migratory route and serves as a resting point for hundreds of thousands of birds each year. Despite its degraded conditions and ecological losses, the high-quality opportunity of the ecosystem is evident as the area currently remains a hotspot for birding. Due to the San Antonio River Channel Improvement Project (SACIP), migratory birds are now able to utilize areas along the San Antonio River within city limits that were previously unsuitable. The TSP would contribute to the success of the other projects constructed on the river; thereby, synergistically improving the ecological output of the project due to connectivity between other migratory bird habitats.

The proposed River Road Aquatic ER Feasibility Study makes a significant contribution to a larger migratory bird conservation and restoration effort being implemented by Bexar County, City of San Antonio, the San Antonio River Authority, and USACE. The above entities have made commitments to improving habitat across the San Antonio River watershed, approximately 1-3 miles from River Road.

5.2.2 Aquatic Habitat and the San Antonio River

The River Road study area is a prime example of the adverse effects caused by inadequate culvert systems. There are significant differences between culvert channel flow and open stream flow. The proposed NER Plan institutes an open channel flow that requires the removal of the low water crossings and subsequent replacement with bridges that will reduce the environmental complications caused by culvert interference in the natural stream flow. An open stream bed is the preferred environmental alternative to culvert-style low water crossings in the San Antonio River. A major contributing factor to the degradation of the River Road study area is the amount of sedimentation and erosion caused by human alterations to aquatic and riparian habitat. The comparison of an open stream bed and modified low water crossing can be separated into geometry, sediment and debris loading, bed integrity, and impacts on aquatic life (Singley and Hotchkiss, 2012). The main feature of a low water crossing on channel flow is its culvert. The culverts create unnatural conditions in high discharge events due to the geometry of the structure. Flow into the entrance of a culvert can lead to increased pressure and sheer stress. In addition,

culverts can constrict stream flows; thereby, creating a wide array of other issues on aquatic habitat. Constricted flows can lead to increased rates of submerged inlets and unsubmerged outlets, which can increase erosion rates, sediment deposition, and debris at the entrance of the culvert.

This adverse effect of an unsuitable culvert has already occurred within the River Road study area. In an open stream bed scenario, high flows are more likely to transport sediment and debris downstream. Open stream beds have the beneficial aspect of maintaining vegetation along the channel. Natural vegetation can allow stream flows to have more flexibility compared to a concrete structure as shown in the Manning's N value and can provide additional habitat for a wide array of aquatic life. Additionally, the presence of culverts would require water to pool until it is high enough to pass through. In the absence of culverts and due to SARA's low-flow requirement, the natural streambed would ensure constant free-flowing water with no pooling.

Stream conditions cannot be easily replicated by manmade structures. Natural stream beds have varying sizes and structure of sediment (Singley and Hotchkiss, 2012). Artificial beds in culverts are more likely to scour than a natural stream bed and can alter natural fish passage and adversely affect aquatic habitat connectivity. In addition, natural stream beds have a continuous light source due to their open structure and can promote vegetative growth through sunlight. Increased vegetation due to available sunlight promotes habitat connectivity and protection for aquatic species from predators.

6 Risk and Uncertainty

The following risks were considered during alternative and plan formulation, and are related to the CE/ICA outputs.

Risk 1: Habitat units are calculated differently for each habitat type. Alternatives that include restoration of one specific habitat may be weighted differently than one with a different habitat type. If the quantification of a specific habitat's quality is biased, alternatives that include a specific habitat type may be selected over a habitat that has a higher habitat value.

- Likelihood: Low
- Consequence Rating: Low
- Risk Management: Utilize the best available models for quantifying the study habitats, Develop site and habitat specific models. For the study, the models' metrics are highly correlated to the exact restoration targets, so the relative quality resulting from the different models should be comparable.

7 Recreation

There is an opportunity to incorporate recreation alongside the River Road ecosystem restoration project. The project area is located within San Antonio's Brackenridge Park. The park provides opportunity for walking/jogging, picnicking, and fishing, including within the project area. The purpose of these recreation features is to allow the public to continue to access the area while

preserving the ecosystem recreation features. The additions to the existing recreation are compatible with the ecosystem restoration project and would enhance the experience for visitors of Brackenridge Park by providing ease of access to the ecosystem restoration areas and additional wildlife viewing opportunities. The proposed recreation features are described below, and the costs of these features are summarized in Table 7-1. Note that the asphalt path will likely be upgraded to a concrete path by the City of San Antonio.

- **Access Path** – An approximately 2,450'x8' Americans with Disabilities Act (ADA) compliant asphalt path would be constructed along the alignment of Avenue A. This path will run from E Mulberry Avenue to the "dead-end" point of Avenue A in order to maintain recreational access for the public parallel and across the San Antonio River.
- **Signage** – Installation of signage to include restoration information, recreation information, and general rules and regulations to decrease human impacts to restoration areas.
- **Trash Cans** – Installation of single or clustered trash cans to focus litter disposal within the restoration areas to avoid impacts to vegetation and wildlife species.
- **Fishing Access** – This measure would include the installation of recreational fishing piers along the perimeter of the San Antonio River.
- **Bird Blinds** - This measure would include the installation of bird blinds in the public access areas of the project.

Table 7-1. Recreation Features

Recreation Features	First Cost
ADA Compliant Asphalt Path (2,450 LF)	Construction: $328,000 PED & CM: $75,000 **Total: $403,000**
Misc Amenities	
Bird Blinds	

The cost would be shared equally (up to 10 percent of the total federal restoration costs) between the Federal Government and the Local Sponsor per USACE guidance.

The formulation of the recreational features is based on the educational and social potential afforded by the restoration project. The justification for federal participation in recreational features as part of the recommended plan is defined in Policy Guidance Letter No. 59, Recreation Development at Ecosystem Restoration Projects.

The formulation of recreational features was conducted within the following framework:

- are totally ancillary (i.e., project was not formulated solely for recreation)
- take advantage of the project's recreation potential
- are not vendible
- could not stand alone, without losing any of its utility or value, in absence of the project

7.1 Demand

The San Antonio Parks Department updated their master plan in 2019. The research and surveys conducted for the update provided insight related to the demand for recreation activities similar to those proposed for the River Road ecosystem restoration study.

The demand-based needs survey completed for the 2019 Master Plan found that:

1. 84% of respondents considered natural areas very important to San Antonio's quality of life
2. 40% of respondents visited parks very often (more than 1X/week)
3. Key priorities included:
    - Expanded bike and trail network (and park connectivity); respondents supported the creation of hiking, biking, and walking trails
    - Increase programs for all, with emphasis including nature and science
4. Across all park staff and public engagement activities, five needs stood out:
    - Increase trail network (biking, walking)
    - Expand opportunities for exercise and play (biking, walking)
    - Improve Safety
    - Provide innovative, updated programs and facilities
    - Increase access to nature for all

The key priorities and needs detailed in the Master Plan align with the type of recreation opportunities that will be created via the River Road Ecosystem Restoration and Recreation projects, including increased trails and access to nature for all.

The proposed trail meets the priority of expanding the bike/trail network and park connectivity by increasing the length of available trail in Brackenridge Park. In addition, the trail meets the need for improved safety by establishing a pedestrian trail adjacent to the river and blocking vehicular access.

The trail in conjunction with the restoration features and related signage meets the priority of increased access to nature and science for all.

7.1.1 Expected Annual Visits

To estimate expected annual visits of the project area, the overall Brackenridge Park visitation numbers were used to extrapolate a visitation number for the recreation project site. For the purposes of applying the Unit Day Value (UDV) method to calculate a Benefit-Cost Ratio (BCR) for the recreation improvements in the study area, 23,000 visits per year is estimated. A reduction in benefits due to transfer was not calculated, as the FWOPC and FWPC visitation number is held constant. This number is in line with another recreation analysis in the region that stated that the average number of visitors for this type of trail is 57,000 per year per mile. The proposed trail is just short of half a mile, and estimated visitation is slightly lower than half of the per mile estimate used in the other study in the region.

7.2 Unit Day Value

The national economic development (NED) benefit evaluation procedures contained in ER 1105-2-100 (22 Apr 2000), Appendix E, Section VII, include three methods of evaluating the beneficial and adverse NED effects of project recreation: travel costs method (TCM), contingent valuation method (CVM), and unit day value method. The UDV method was selected for estimating recreation benefits for River Road ecosystem restoration study.

As directed by ER 1105-2-100, Appendix E, Section VII, the value of recreational opportunities is assessed for both with and without project conditions using the UDV method following the guidelines provided in Economics Guidance Memorandum (EGM) 20-03.

First, point values are assigned to each condition based on selective criteria for both the future with-project condition (FWPC) and the future without-project condition (FWOPC). Then, these points were converted to dollars to determine the unit day value of the proposed recreation.

Table 4 illustrates the criteria, judgment factors, and point range used for assigning a rating to a particular "general" recreation activity. The points assigned to the FWOPC and the FWPC recreation experience are noted in the first column. Points are assigned based on five criteria: (1) the quality of the recreation experience; (2) availability of substitute recreation opportunities in terms of travel time; (3) carrying capacity determined by level of facility development; (4) accessibility as affected by road and parking conditions; and (5) environmental quality based on aesthetics. The total possible points that can be assigned to each criterion are as follows: (1) Recreation Experience – 30; (2) Availability of Opportunity – 18; (3) Carrying Capacity – 14; (4) Accessibility – 18; and (5) Environmental – 20. Rationale for the points selected in Table 7-2 is outlined below. The FWOPC was assigned 20 points; the FWPC was assigned 44 points, for a difference of 24 points. Therefore, 24 points is the amount that will be converted to a unit day value (UDV) dollar amount.

1. Recreation Experience – The River Road ecosystem restoration project would enhance the recreation experience in the project area. Though several general recreation activities are possible in the FWOPC and the FWPC, the presence of the ecosystem restoration and the recreation project will increase the value of these activities. The installation of a dedicated trail (and elimination of vehicular traffic), bird blinds, and a fishing pier will improve the walking/hiking experience as well as the safety of the experience. The presence of riparian plantings and native species will further enhance the experience.
2. Availability of Opportunity –The availability of this activity does not change in the future-with project condition. Located in the San Antonio metro area, there are several opportunities for similar recreation activities within a 1 hour travel time and a few within 30 minutes. However, as described in Section 7.1, above, the demand for such activities still exists in the San Antonio area.
3. Carrying Capacity – The River Road recreation carrying capacity point values are estimated to increase with the additional recreation implementation. Current access to the river using Avenue A allows vehicular access, which can cause congestion and the potential risk to public safety. Creation of new pedestrian trails creates optimal hiking and wildlife viewing conditions, as well as access to the proposed bird blinds and fishing pier.
4. Accessibility – Accessibility to the site does not change in the FWOPC and FWPC. River Road (which provides access to site) is in good condition; E Mulberry is in good condition; however, Avenue A, which is the road mostly utilized by public to access the recreation activities, is in disrepair. The trail (formerly Avenue A) is being upgraded to a pedestrian trail, which will provide access to fishing pier and bird blinds within the project area.
5. Environmental Quality – In its current state, and thus in the FWOPC, the quality of the road and vegetation give the project area a poor quality aesthetic. In the FWPC, the riverine and riparian native species plantings will increase the aesthetic quality, and the vegetation will block the non-natural infrastructure from view.

Table 7-2. Unit Day Value Points for General Recreation

Criteria	Judgment Factors				
1. Recreation Experience *FWOPC Points: 6* *FWPC Points: 10*	Two general activities *0-4*	Several general activities *5-10*	Several general activities: one high quality value activity *11-16*	Several general activities; more than one high quality high activity *17-23*	Numerous high quality value activities; some general activities *24-30*
2. Availability of Opportunity *FWOPC Points: 3* *FWPC Points:* 3	Several within 1 hr travel time; a few within 30 min. travel time *0-3*	Several within 1 hr travel time; none within 30 min. travel time *4-6*	One or two within 1 hr travel time; none within 45 min. travel time *7-10*	None within 1 hr travel time *11-14*	None within 2 hr travel time *15-18*
3. Carrying Capacity *FWOPC Points: 3* *FWPC Points:* 10	Minimum facility for development of public health and safety *0-2*	Basic facility to conduct activity(ies) *3-5*	Adequate facilities to conduct without deterioration of the resource or activity experience *6-8*	Optimum facilities to conduct activity at site potential *9-11*	Ultimate facilities to achieve intent of selected alternative *12-14*
4. Accessibility *FWOPC Points: 6* *FWPC Points:* 11	Limited access by any means to site or within site *0-3*	Fair access, poor quality roads to site; limited access within site *4-6*	Fair access, fair road to site; fair access, good roads within site *7-10*	Good access, good roads to site; fair access, good roads within site *11-14*	Good access, high standard road to site; good access within site *15-18*
5. Environmental Quality *FWOPC Points: 2* *FWPC Points: 10*	Low aesthetic factors that significantly lower quality *0-2*	Average aesthetic quality; factors exist that lower quality to minor degree *3-6*	Above average aesthetic quality; any limiting factors can be reasonably rectified *7-10*	High aesthetic quality; no factors exist that lower quality *11-15*	Outstanding aesthetic quality; no factors exist that lower quality *16-20*

The recreation to be implemented in the FWPC increases the recreation unit day value by 24 points, which translates to a value of $5.85 (interpolated). The conversion of recreation points to dollar values, as prescribed by EGM 20-03, is shown in Table 7-2, below. The annual visitation estimate multiplied by this dollar value results in the annual benefit estimate of $134,550.

Table 7-3. Recreation Points to Dollars Conversion

Point Values	General Recreation Values
0	$4.21
10	$5.00
20	$5.53
30	$6.32
40	$7.90
50	$8.95
60	$9.74
70	$10.27
80	$11.32
90	$12.11
100	$12.64

7.3 Recreation BCR

To calculate the BCR for the recreation features, the recreation first cost, $403,340 (including construction, PED, and CM), was annualized over the 50-year period of analysis using the FY 2021 interest rate of 2.5% to develop an average annual equivalent (AAEQ) cost, which is $14,250. Using the annual recreation benefit of $134,550, the BCR is 9.44 to 1, as displayed in Table 7-3.

Table 7-4. Recreation Benefit-Cost Ratio

Construction Cost (Recreation)	$328,000
PED + CM (Recreation)	$75,340
Estimated First Cost (Recreation)	$403,340
Annual Interest Rate	2.5%
Period of Analysis (years)	50
Construction Period (months)	2
Annual Recreation Benefits	$134,550
Recreation AAEQ Cost	$14,250
Recreation BCR	9.44
Note: Based on FY 2021 price level and interest rate	

8 Economic Summary

The economic cost summary is displayed in Table 8-1 below. The table displays project first cost (including costs for recreation features), interest during construction based on a 12 month construction period, and total average annual equivalent (AAEQ) costs. AAEQ OMRR&R is annualized over the 50-year period of analysis and includes estimated maintenance of plantings for years 1 through 10 and in-stream structures for years 1 through 3.

Table 8-1. Economic Cost Summary

Project First Cost	**$6,442,000**
Fish & Wildlife and Floodway/Diversion Structures	**$2,416,000**
Relocations	**$1,723,000**
Recreation Construction	**$328,000**
Lands & Damages	**$198,000**
Planning, Engineering & Design	**$1,264,000**
Construction Management	**$513,000**
Interest During Construction	**$53,300**
Total Investment	**$6,495,300**
AAEQ Total Investment	**$229,000**
AAEQ OMRR&R*	**$12,300**
Total AAEQ Cost	**$241,300**
FY 2021 Price Level and 2.5% discount rate; OMRR&R annualized over 50 year period of analysis using 2.5% discount rate; IDC is based on a construction period of 8 months and does not include adaptive management	

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