Appendix B – Cost Effectiveness / Incremental Cost Analysis

Mitchell Lake, San Antonio, TX

General Investigations Feasibility Study
Integrated Draft Feasibility Report and Environmental Impact Assessment

June 2021

US Army Corps of Engineers®
Fort Worth District

(NOTE: This page intentionally left blank.)

Table of Contents

List of Figures

List of Tables

List of Acronyms

AAHU	Average Annual Habitat Unit
CE/ICA	Cost Effectiveness / Incremental Cost Analysis
EGM	Economic Guidance Memorandum
FWP	Future With-Project
FWOP	Future Without-Project
ICA	Incremental Cost Analysis
IDC	Interest During Construction
NER	National Ecosystem Restoration
OMRR&R	Operations, Maintenance, Repair, Replacement, and Rehabilitation
UDV	Unit Day Value
WWTP	Wastewater Treatment Plant

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). The development of the AAHU is discussed in detail in the Appendix C - Environmental Resources.

2 Area Plans and Measures

Management measures were formulated incrementally for the study and measures were built in combination with one another in each area. These measures include: native riparian, submergent, and emergent wetland planting, invasive vegetation management, clearing and excavation, low quality vegetation removal, implementation of seasonal pulses, polder operational management, habitat structure augmentation, installation of nesting structures, berm construction, and pipeline installation.

In addition to management measures, sites were identified as feasible for project implementation. The measures were built in combination with one another based upon site conditions. More detailed information can be found in the Integrated Feasibility Report and Environmental Assessment.

2.1 Measures

2.1.1 Native Riparian Plantings

This measure entails increasing the vegetative structure and species diversity of riparian habitats along the Cottonmouth Creek below the Mitchell Lake Dam and along specified coves within Mitchell Lake. It would include planting a diverse community of high-quality native tree and shrub species, including mast producers, bald cypress, and other species native to the San Antonio area.

2.1.2 Native Emergent Wetland Plantings

The core areas of the existing wetland habitats are dominated by cattails or willow baccharis (*Baccharis salicina*) fringed by a single species of spike sedge. This measure entails the

planting of native high-quality emergent wetland species to increase the diversity and sustainability of the emergent wetland vegetation community.

2.1.3 Native Submergent Wetland Plantings

Submerged vegetation typically thrive along the perimeter and shallow areas of open water ponds and lakes. This measure entails the establishment of submerged aquatic wetland vegetation to provide feeding, reproduction and protective cover habitats for fish, invertebrate and bird species. The aquatic plants would be established as planted seedlings or plugs from site-specific, native, diverse submergent wetlands.

2.1.4 Invasive Vegetation Management

This measure includes the removal and management of invasive plant species to allow a native and diverse vegetative community to become established. Depending on the species, invasive species may be controlled by biological, mechanical, or chemical methods incorporating an integrated pest management approach. Larger non-native invasive trees could be treated with herbicide and left standing to provide standing snag habitat for numerous wildlife species.

2.1.5 Clearing/Excavation

In order to create the hydrology required for the target restoration habitats, excavation may be required to create suitable conditions to ensure sustainability for the ecosystem restoration. Excavation can include widening and deepening of wetland areas using machinery such as bulldozers, graders, and backhoes.

2.1.6 Low Quality Vegetation Removal

The vegetative communities in the Mitchell Lake study area are skewed towards low quality hackberry (*Celtis occidentalis*), huisache (*Vachellia farnesiana*), palo verde (*Parksonia spp*.), willow baccharis, and cattail (*Typha spp*.) dominated habitats depending on the area with little to no additional diversity. Most of the areas are dominated by one or two of these species. In order to increase the diversity of the communities, select trees and shrubs would be removed to provide room for the planting of additional site-specific native species. Similar to the invasive vegetation management, larger trees could be treated with herbicides and left standing in order to created habitats for numerous wildlife that utilize standing snag habitats. The creation of standing snags would remove the overstory canopy cover opening up gaps in the canopy for the establishment of seedling shrubs and trees.

2.1.7 Seasonal Pulses

This measure includes managing the flow of water through the Mitchell Lake study area to mirror natural historical flood/drought processes. The seasonal pulses would support wetland habitats through periodic inundation and desiccation required to support a diverse aquatic, wetland, and riparian community. Additionally, the control of water surface levels in the wetlands facilitates the control of cattails within the existing and/or proposed wetland areas in the study area. The seasonal pulse measure would be dependent on either the measures for relocating the Wastewater Treatment Plant (WWTP) outfall structure and/or the construction of a pipeline from Mitchell Lake to the upstream portions of the study area. The measure would also include the construction or modification of water control structures to allow manipulation of the flows and inundation of the wetlands.

2.1.8 Polder Operational Management

This measure entails the manipulation of water in the polders to manage the area for migratory shorebirds. By draining the polders on a periodic systematic schedule, mud flats would be exposed during migration providing foraging habitat for shorebirds. The inundation phase of the

polder management would ensure that vegetation would not become established within the polders reducing the shorebird foraging habitat quality. When the polders are inundated, habitat for waterfowl would be available. The polder management would require the modification and/or construction of water control structures to facilitate the draining and filling of the polders.

2.1.9 Habitat Structure Augmentation

This measure entails habitat improvement through the addition of habitat structures in the project area such as brush piles, fallen logs, root wads, rock piles, snags, etc. These structures could be aquatic or terrestrial (riparian) in nature and would provide cover habitat for fish and wildlife species. This measure would be dependent on the excavation and low-quality vegetation removal measures as these measures would provide the source material for the creation of these features.

2.1.10 Installation of Nesting Structures

This measure would include the installation of artificial nesting structures for bats, wood ducks (*Aix sponsa*), bluebirds (*Sialia spp*.), and other cavity nesting species in the study area.

2.1.11 Construction of Berms

This measure would entail reducing the size of the east and west polders to create a more manageable and appropriately sized mudflat in Area 6. The utilization of excavated materials from the creation wetland or offsite borrow material could be to create berms within these two polders to create additional mudflat cells. This measure would be dependent on the polder operational measure above. In addition, this measure would include the construction of berms at the downstream wetlands (Area 10) to create wetland cells to create and manage the wetlands.

2.1.12 Installation of Pipeline

This measure would entail the placement of a pipeline that would enable pumping of water from Mitchell Lake to the wetland areas at the upper portions of the Mitchell Lake watershed. The construction of a pipeline to the upper areas would provide a reliable water supply allowing better manipulation and sustainability of the wetlands.

2.2 Area Plans

An overview of the project areas considered is displayed in Figure 2-1, and each of the areas are described below.

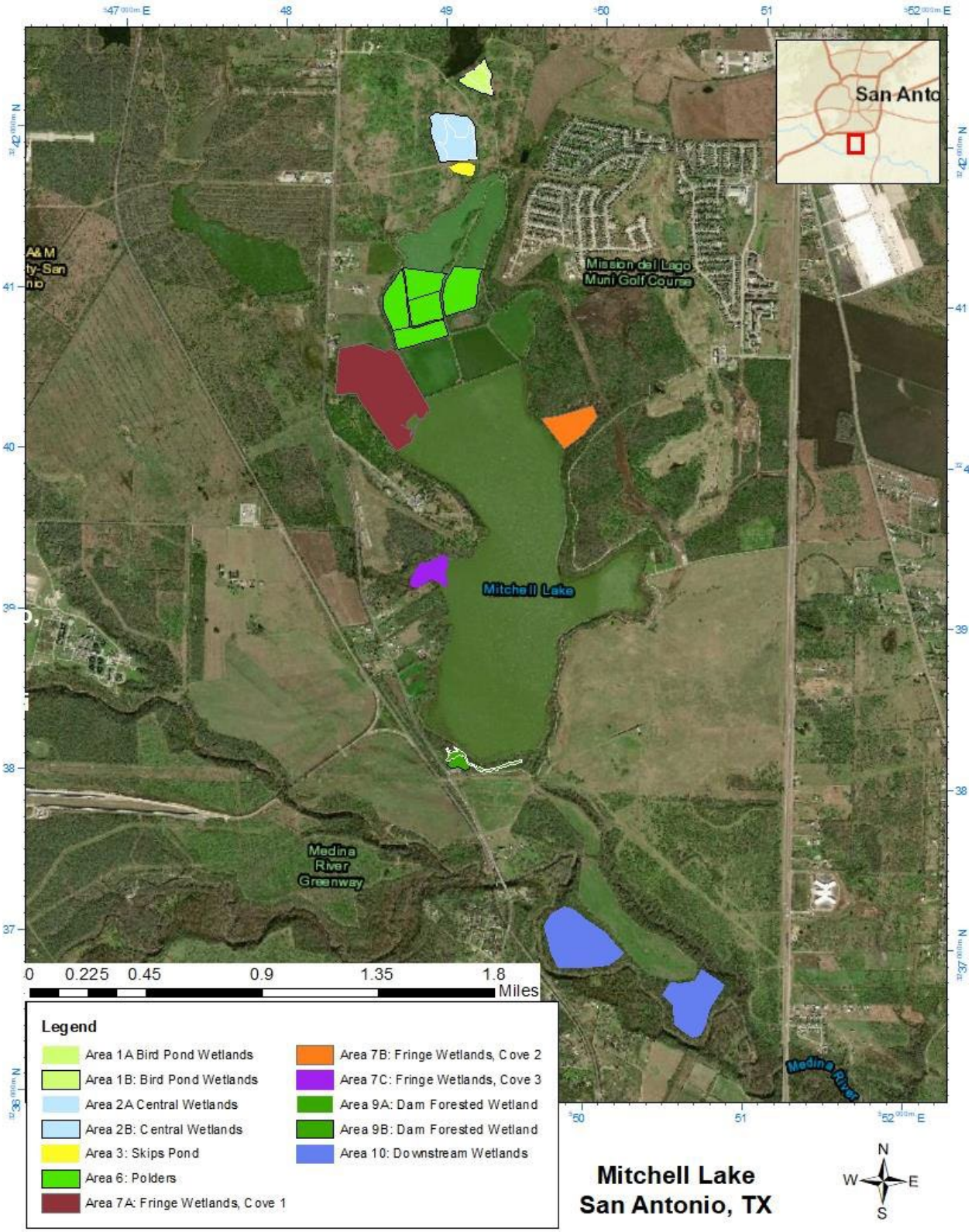


Figure 2-1. Project Areas Considered within the Study Area

2.2.1 Bird Pond Wetlands (Area 1)

Area 1 is located at the northern extent of the study area adjacent to Bird Pond near the Mitchell Lake Audubon Center. The small existing wetland is located east of the levee/road on the downstream end of Bird Pond. The existing wetland has limited habitat value due to the shallow surface water (<6") and a monoculture of cattails. The lack of water surface level fluctuations has contributed to the dominance of cattails in this wetland. Potential restoration goals for this site would include improving the vegetative diversity of the site and improving the hydrology of the system. The measures implemented for this area include: invasive vegetation management, clearing and excavating, low quality vegetation removal, native emergent wetland planting, implementation of seasonal pulses, habitat structure augmentation, installation of nesting structures, and pipeline installation.

2.2.2 Central Wetlands (Area 2)

Area 2 is south of Area 1 and the two wetland complexes are connected to each other by a shallow, nondescript drainage channel. The wetland consists of a complex of wetlands connected to each other by wetland swales with higher, upland areas interspersed in the wetland. Area 2 is part of the same wetland complex as Area 3 but is separated from that area by a pipeline right-of-way between the two areas; therefore, the areas are treated as separate areas. Area 2 is comprised of a shallow wetland with areas of deeper water (6-12" in depth) and dominated by cattails and willow baccharis. Potential restoration goals for this site would include improving the vegetative diversity of the site and improving the hydrology of the system. The measures that can be implemented in combination with one another at this site include: invasive vegetation management, clearing and excavating, low quality vegetation removal, native emergent wetland planting, implementation of seasonal pulses, habitat structure augmentation, installation of nesting structures, and pipeline installation.

2.2.3 Skip's Pond (Area 3)

As noted in the Area 2 discussion above, Area 3 is part of the same wetland complex as Area 2 but is separated from that area by a pipeline that transects the area. In addition, Area 3 is comprised of deeper water wetlands up to 2-feet in depth and supports different vegetation than Area 2. Therefore, this area was separated from the Central Wetland complex. Potential restoration goals for this site would include improving the vegetative diversity of the site and improving the hydrology of the system. Measure combinations for this area include: invasive vegetation management, clearing and excavating, low quality vegetation removal, native emergent wetland planting, native submergent wetland planting, implementation of seasonal pulses, habitat structure augmentation, installation of nesting structures, and pipeline installation.

2.2.4 Polders (Area 6)

This plan is focused on the structural modification and operational management of the water within the polder cells to increase the availability of mudflat habitat for shorebirds within the study area. Managing the water distribution within the polders and the creation of mud flat habitats would result in restoration opportunities for this area. Management measures for this area include: polder operational management, installation of nesting structures, and the construction of berms.

2.2.5 Fringe Wetlands (Area 7)

Area 7 includes the restoration of fringe emergent and submergent wetland habitats within three coves of Mitchell Lake. Future management of Mitchell Lake will result in the water surface elevation being lowered to 518.5'. Therefore, the restoration opportunities include the

restoration of emergent and submerged fringe wetlands in areas that are open water under the existing pool elevation. The measures identified for this area include: native riparian planting, native emergent wetland planting, native submergent wetland planting, invasive vegetation management, habitat structure augmentation, and installation of nesting structures.

2.2.6 Dam Forested Wetlands (Area 9)

The forested wetland areas below the Mitchell Lake Dam comprise the proposed restoration area for Area 9. The hydrology of these wetlands is maintained by seepage through the dam and are dominated by hackberry woodlands. The drainage below the dam forms a linear series of in channel wetlands with several ponded areas along the upstream section of the drainage. The combination of measures for this site include: native riparian planting, native emergent wetland planting, invasive vegetation management, clearing and excavating, low quality vegetation removal, habitat structure augmentation, and installation of nesting structures.

2.2.7 Downstream Wetlands (Area 10)

The Area 10 restoration plan entails the construction of a wetland complex adjacent to the proposed water quality treatment wetlands that would be constructed by SAWS. The Area 10 wetlands would contribute to the capture of synergistic benefits associated with combining the low habitat quality SAWS treatment wetlands with high habitat quality wetlands, creating an edge transition between the wetlands, and providing an opportunity to further filter and improve the water quality of water from the treatment wetlands. Implementation of this area plan would include utilizing measures such as: clearing and excavating, native emergent planting, implementation of seasonal pulses, habitat structure augmentation, installation of nesting structures, and berm construction.

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 C – Environmental Resources 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 conditions are assumed to be the same as existing conditions, given the existing habitat 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

Management Measure Area	Alternatives	FWOPC AAHU	FWPC AAHU	Annual Benefits AAHU	FWPC Acres
Bird Pond Wetlands	1A: Restoration of Existing Wetlands	0.86	2.39	1.53	3.17
	1B: Expansion/Restoration of Existing Wetlands and Improvement of Additional Wetlands	0.86	4.71	3.85	6.42
Central Wetlands	2A: Restoration of Existing Wetlands	2.85	7.88	5.03	10.46
	2B: Expansion/Restoration of Existing Wetlands and Improvement of Additional Wetlands	2.85	13.54	10.69	18.37
Skip's Pond	3: Restoration of Existing Wetlands	0.59	1.64	1.05	2.18
Polders	6: Management/Modification of Existing Polders/Basins	30.21	48.35	18.14	49.52
Fringe Wetlands	7A: Restoration of Cove 1 (Wetland/Riparian Plantings)	13.43	43.33	29.9	53.68
	7B: Restoration of Cove 2 (Wetland/Riparian Plantings)	2.96	9.56	6.6	11.84
	7C: Restoration of Cove 3 (Wetland/Riparian Plantings)	1.71	5.52	3.81	6.84
	7D: Combination of Coves 1 & 2	16.39	52.89	36.5	65.52
	7E: Combination of Coves 1 & 3	15.14	48.85	33.71	60.52
	7F: Combination of Coves 2 & 3	4.67	15.08	10.41	18.68
	7G: Combination of Coves 1, 2 & 3	18.1	58.41	40.31	72.36
Dam Forested Wetlands	9A: Restoration of Existing Wet Riparian Habitat	0.71	1.19	0.47	2.55
	9B: Expansion/Restoration of Existing Wet Riparian Habitat and Improvement of Additional Riparian Habitat	1.25	2.08	0.83	4.48
Downstream Wetlands	10: Creation of Wetlands Downstream of Mitchell Lake	0	13.6	13.6	19

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 2.5% (per EGM 21-01 dated 6 November 2020). Prices are expressed in

October 2020 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 Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R). Construction first cost includes construction cost and plantings, exclusive of planning, engineering, and design (PED), construction management, and contingency. Rough construction durations for CE/ICA were estimated by Cost Engineering (construction) and Environmental (plantings). For CE/ICA, interest during construction (IDC) was calculated based on the estimated construction durations, first costs, and real estate costs displayed in this table. Interest during construction is combined with construction first cost and real estate cost to obtain the economic cost for purposes of calculating the annual investment cost. The annual with-project OMRR&R is added to the annual investment cost to obtain the total annual cost.

In the table below, the description “Central Wetlands w/o Bird Pond 2A” and “Central Wetlands w/o Bird Pond 2B” appear to be a cheaper options than “Central Wetlands w/ Bird Pond 2A” and Central Wetlands w/ Bird Pond 2B”. This is due to attributing the cost of a water pipeline. The water pipeline must be installed for the Alternatives involving the Bird Pond Wetlands or Central Wetlands. If the Bird Pond Wetlands are included in the project, the costs of a pipeline will be attributed entirely to Alternative 1A or 1B. However; if the Bird Pond Wetlands are not included in the Plan, the costs of a pipeline will be attributed to Alternatives 2A or 2B. Attributing the cost to either the Bird Pond Wetland Alternatives or Central Wetland Alternatives was necessary in order to accurately conduct the CE/ICA.

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

Management Measure Area	Constr. Cost	Real Estate	Constr. Time (mos.)	IDC	Economic Cost	Annual Investment Cost	Annual OMRR&R	Total Annual Cost
Bird Pond 1A	$762,590	$38,040	6	$4,963	$805,593	$28,404	$2,029	$30,432
Bird Pond 1B	$939,554	$77,040	6	$6,302	$1,022,896	$36,065	$4,109	$40,174
Central Wetlands w/ Bird Pond 2A	$498,939	$125,520	1	$643	$625,102	$22,040	$6,694	$28,734
Central Wetlands w/o Bird Pond 2A	$741,021	$125,520	1	$906	$867,447	$31,043	$6,694	$37,737
Central Wetlands w/ Bird Pond 2B	$764,225	$220,440	1	$4,064	$988,729	$34,861	$11,757	$46,617
Central Wetlands w/o Bird Pond 2B	$1,006,307	$220,440	1	$5,063	$1,231,810	$43,431	$11,757	$55,188
Skip's Pond 3	$195,718	$6,540	0.75	$156	$202,414	$7,137	$1,395	$8,532
Polders 6	$170,577	$4,952	0.25	$45	$175,574	$6,190	$8,000	$14,190
Cove 1 7A	$766,172	$13,420	0.5	$401	$779,993	$27,501	$34,355	$61,856
Cove 2 7B	$170,161	$2,960	0.5	$89	$173,210	$6,107	$7,578	$13,685
Cove 3 7C	$98,936	$1,710	0.5	$52	$100,698	$3,550	$4,378	$7,928
Cove 1 & 2 7D	$934,832	$16,380	1	$980	$952,192	$33,572	$41,933	$75,505
Cove 1 & 3 7E	$863,607	$15,130	1	$905	$879,642	$31,015	$38,733	$69,747
Cove 2 & 3 7F	$267,597	$4,670	0.75	$210	$272,477	$9,607	$11,955	$21,562
Cove 1, 2, & 3 7G	$1,032,665	$18,090	1	$1,082	$1,051,837	$37,086	$46,310	$83,396
Dam Forested Wetland 9A	$606,339	$15,300	1.5	$961	$622,600	$21,952	$1,632	$23,584
Dam Forested Wetland 9B	$647,212	$26,880	1.5	$1,042	$675,134	$23,804	$2,867	$26,671
Constructed Wetlands 10	$10,926,092	$123,500	3	$34,180	$11,083,772	$390,793	$12,160	$402,953

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 alternatives within each site are mutually exclusive. Within IWR Planning Suite, some combinability and dependency relationships were entered. The distinction of Central Wetlands with and without Bird Pond was made to accurately attribute costs of a water pipeline to the appropriate area, as described in Section 3.3, above. The relationships are listed below.

Combinability:

- Central Wetlands with Bird Pond (Area 2) cannot be combined with Central Wetlands w/o Bird Pond (Area 2).
- Bird Pond (Area 1) cannot be combined with Central Wetlands w/o Bird Pond (Area 2)

Dependency:

- Central Wetlands w/ Bird Pond (Area 2) is dependent on Bird Pond (Area 1) AND Skip's Pond
- Central Wetlands without Bird Pond is dependent on Skip's Pond

Originally, Central Wetlands and Skip's Pond were treated as two separate areas, although in actuality it is one wetland complex that has a pipeline easement running beneath it. The two areas were separated in order to accurately measure the habitat units in the with- and without-project condition, ensuring that the pipeline easement was not included in the AAHU calculation. However, it was later determined that, ecologically, Central Wetlands should not be restored without also restoring Skip's Pond, as this scenario could have negative impacts on Central Wetlands. Per the IWR Planning Suite manual, a dependency relationship can be created between measures when one measure will improve the performance of another. As such, the Central Wetlands dependency on Skip's Pond was added to CE/ICA.

Using the management measures, the plan generator in the software was used to create all possible combinations of the measures. This resulted in 1,152 plans.

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

Management Measure Area	Alternatives	Annual Benefits AAHU	Annual Cost ($1,000) October 2020 Prices
Bird Pond Wetlands	1A: Restoration of Existing Wetlands	1.53	$30.43
	1B: Expansion/Restoration of Existing Wetlands and Improvement of Additional Wetlands	3.85	$40.17
Central Wetlands (w/ Bird Pond)	2A: Restoration of Existing Wetlands	5.03	$28.73
	2B: Expansion/Restoration of Existing Wetlands and Improvement of Additional Wetlands	10.69	$46.62
Central Wetlands (w/o Bird Pond)	*2A1: Restoration of Existing Wetlands*	*5.03*	*$37.74*
	2B1: Expansion/Restoration of Existing Wetlands and Improvement of Additional Wetlands	*10.69*	*$55.19*
Skip's Pond	3: Restoration of Existing Wetlands	1.05	$8.53
Polders	6: Management/Modification of Existing Polders/Basins	18.14	$14.19
Fringe Wetlands	7A: Restoration of Cove 1 (Wetland/Riparian Plantings)	29.9	$61.86
	7B: Restoration of Cove 2 (Wetland/Riparian Plantings)	6.6	$13.69
	7C: Restoration of Cove 3 (Wetland/Riparian Plantings)	3.81	$7.93
	7D: Combination of Coves 1 & 2	36.5	$75.51
	7E: Combination of Coves 1 & 3	33.71	$69.75
	7F: Combination of Coves 2 & 3	10.41	$21.56
	7G: Combination of Coves 1, 2 & 3	40.31	$83.4
Dam Forested Wetlands	9A: Restoration of Existing Wet Riparian Habitat	0.47	$23.58
	9B: Expansion/Restoration of Existing Wet Riparian Habitat and Improvement of Additional Riparian Habitat	0.83	$26.67
Downstream Wetlands	10: Creation of Wetlands Downstream of Mitchell Lake	13.6	$402.95

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 1,152 plans (including various scales), 37 were identified as cost-effective plans (including no action). The results are shown graphically in Figure 3-1and

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.

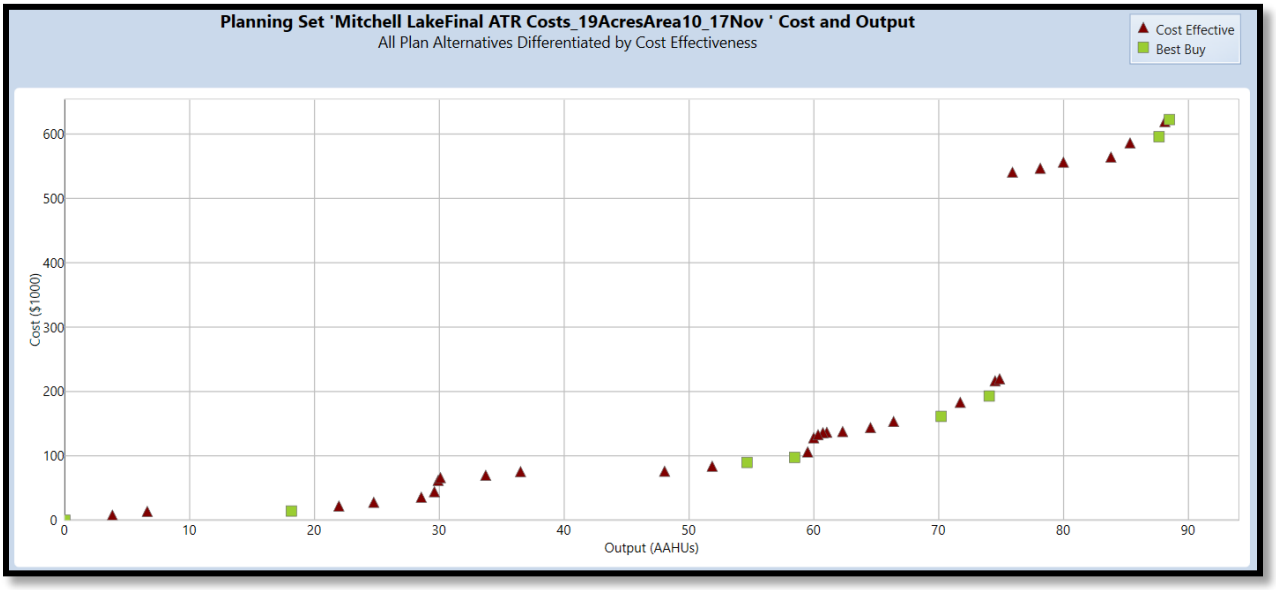


Figure 3-1. Cost Effective Results

Table 3-4. Cost Effective Plans

Cost Effective Plans	Output	Cost ($1000s)	Average Cost	Cost Effective Plans Cont'd	Output	Cost ($1000s)	Average Cost
No Action	0	0	0.00	S1P1F7D2	60.33	132.79	2.20
F3	3.81	7.93	2.08	CC1S1P1F4	60.72	135.97	2.24
F2	6.60	13.69	2.07	B1S1P1F7	61.03	136.55	2.24
P1	18.14	14.19	0.78	B2P1F7	62.30	137.76	2.21
P1F3	21.95	22.12	1.01	CC1S1P1F7	64.53	143.86	2.23
P1F2	24.74	27.88	1.13	CC2S1P1F4	66.38	153.42	2.31
P1F6	28.55	35.75	1.25	CC2S1P1F7	70.19	161.31	2.30
S1P1F6	29.60	44.28	1.50	B1C2S1P1F7	71.72	183.17	2.55
F1	29.90	61.86	2.07	B2C2S1P1F7	74.04	192.91	2.61
B1P1F6	30.08	66.18	2.20	B2C2S1P1F7D1	74.51	216.49	2.91
F5	33.71	69.75	2.07	B2C2S1P1F7D2	74.87	219.58	2.93
F4	36.50	75.51	2.07	B2P1F7Z1	75.90	540.71	7.12
P1F1	48.04	76.05	1.58	CC1S1P1F7Z1	78.13	546.81	7.00
P1F5	51.85	83.94	1.62	CC2S1P1F4Z1	79.98	556.37	6.96
P1F4	54.64	89.70	1.64	CC2S1P1F7Z1	83.79	564.26	6.73
P1F7	58.45	97.59	1.67	B1C2S1P1F7Z1	85.32	586.12	6.87
S1P1F7	59.50	106.12	1.78	B2C2S1P1F7Z1	87.64	595.86	6.80

B1P1F7	59.98	128.02	2.13	B2C2S1P1F7D1Z1	88.11	619.44	7.03

B1 =Bird Pond (Area 1, Scale 1)	F2 =Cove 2 (Area 7, Scale 2)
B2 =Bird Pond (Area 1, Scale 2)	F3 =Cove 3 (Area 7, Scale 3)
C1 =Central Wetland w/ Bird Pond (Area 2, Scale 1)	F4 =Coves 1 & 2 (Area 7, Scale 4)
C2 =Central Wetland w/ Bird Pond (Area 2, Scale 2)	F5 =Coves 1 & 3 (Area 7, Scale 5)
CC1 =Central Wetland w/o Bird Pond (Area 2, Scale 2)	F6 =Coves 2 & 3 (Area 7, Scale 6)
CC2 =Central Wetland w/o Bird Pond (Area 2, Scale 2)	F7 =Coves 1, 2, & 3 (Area 7, Scale 7)
S1 =Skip's Pond (Area 3)	D1 =Dam Forested Wetlands (Area 9, Scale 1)
P1 = Polders (Area 6)	D2 =Dam Forested Wetlands (Area 9, Scale 2)
F1 =Cove 1 (Area 7, Scale 1)	Z1 =Downstream Wetlands (Area 10)

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 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, nine were identified as "Best Buy" plans (including the no action plan). The results of the analysis are shown graphically in Figure 3-2.

The alternative best buy plans are:

Plan 1: No Action

Plan 2: Polders

Plan 3: Polders + Coves 1 & 2

Plan 4: Polders + Coves 1, 2 & 3

Plan 5: Polders + Coves 1, 2 & 3 + Central Wetlands (2B) + Skip's Pond

Plan 6: Polders + Coves 1, 2 & 3 + Central Wetlands (2B) + Skip's Pond + Bird Pond (1B)

Plan 7: Polders + Coves 1, 2 & 3 + Central Wetlands (2B) + Skip's Pond + Bird Pond (1B) + Downstream Wetlands

Plan 8: Polders + Coves 1, 2 & 3 + Central Wetlands (2B) + Skip's Pond + Bird Pond (1B) + Downstream Wetlands + Dam Forested Wetlands (9B)

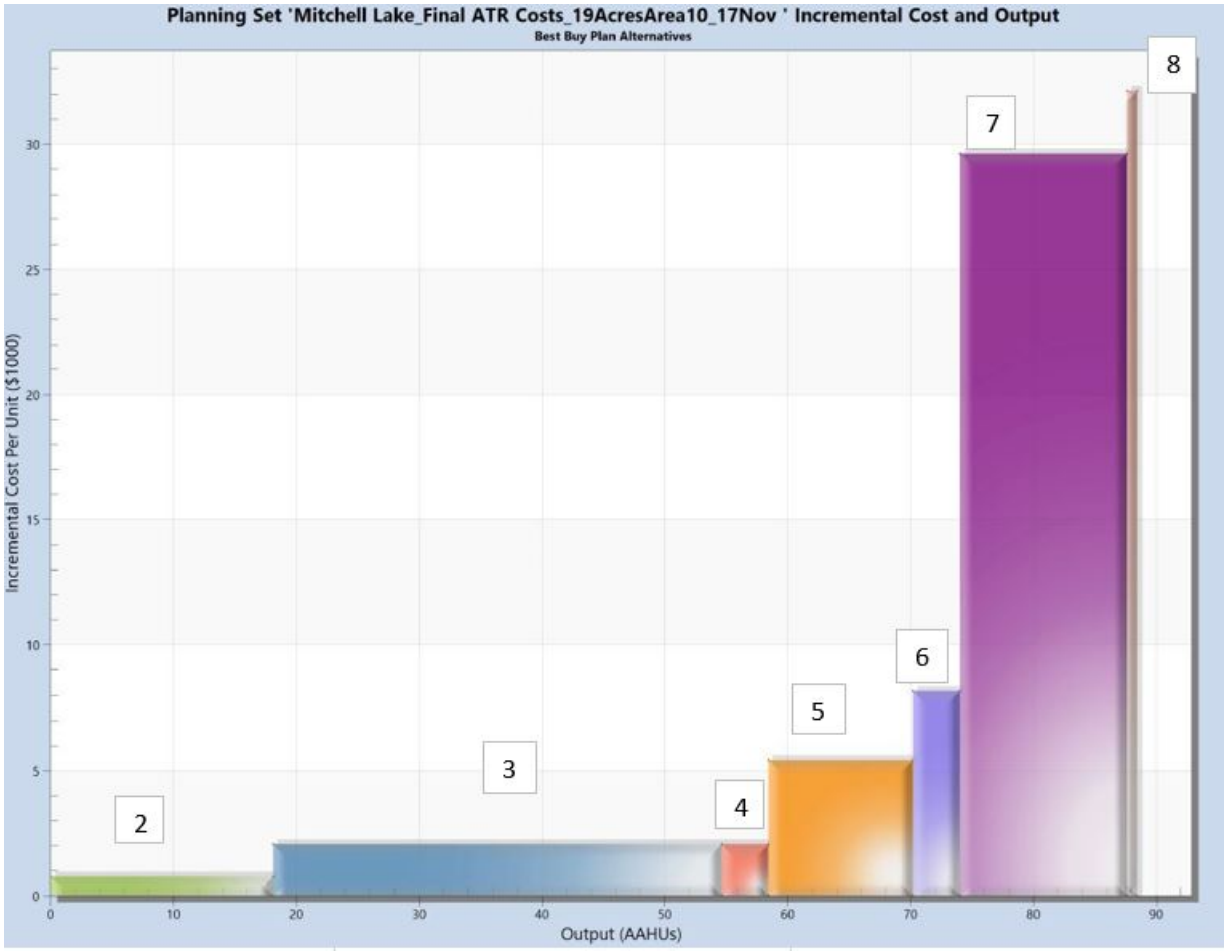
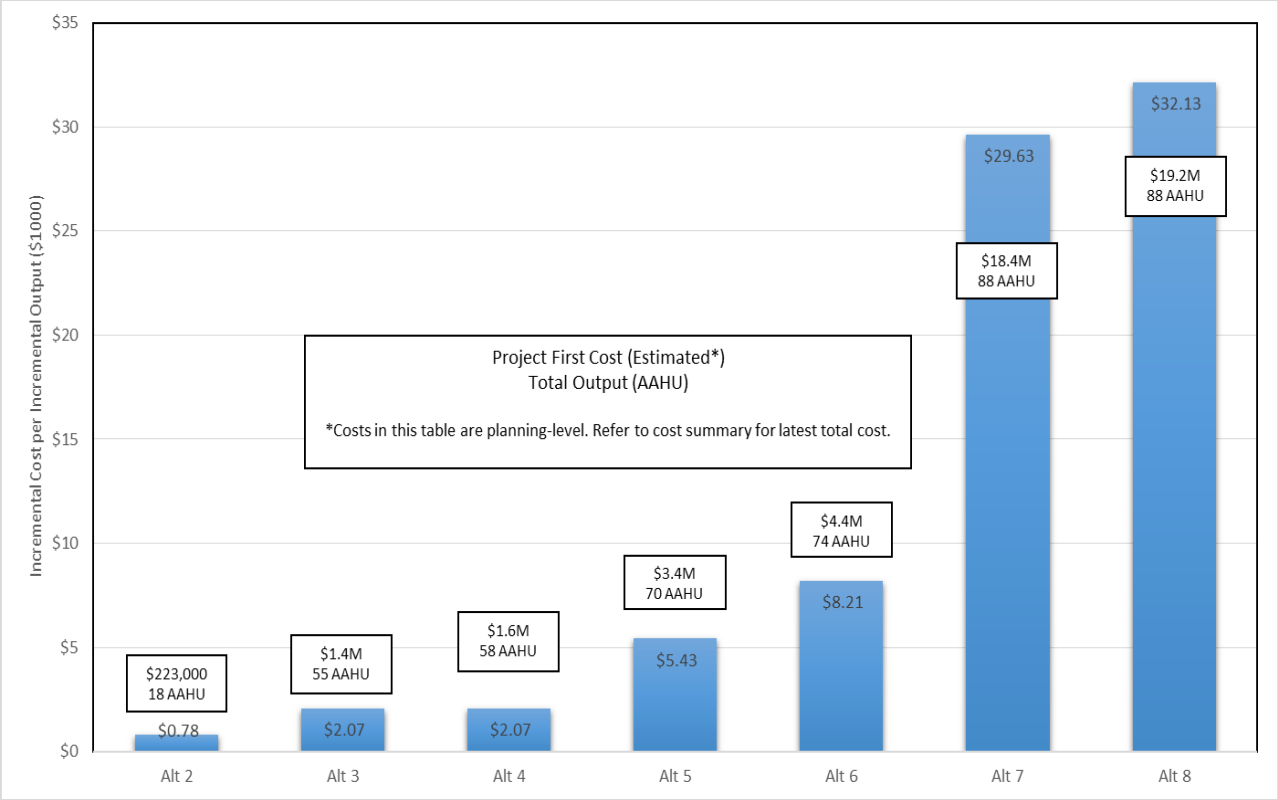


Figure 3-2. Incremental Cost Analysis Result

Table 3-5. Best Buy Plans

Plan	Output (AAHU)	Annual Cost ($1000)	Average Annual Cost ($1000/AAHU)	Incremental Cost ($1000)	Incremental Output (AAHU)	Incremental Cost per Output	Plan Construction Cost
1: No Action	0	0	-	-	-	-	-
2: Polders	18.140	14.190	0.782	14.190	18.140	0.782	$222,922
3: Polders + Coves 1 & 2	54.640	89.700	1.642	75.510	36.500	2.069	$1,430,962
4: Polders + Coves 1, 2 & 3	58.450	97.590	1.670	7.890	3.810	2.071	$1,557,381
5: Polders + Coves 1, 2 & 3 + Central Wetlands + Skip's Pond	70.190	161.310	2.298	63.720	11.740	5.428	$3,372,217
6: Polders + Coves 1, 2 & 3 + Central Wetlands + Skip's Pond + Bird Pond	74.040	192.910	2.605	31.600	3.850	8.208	$4,355,847
7: Polders + Coves 1, 2 & 3 + Central Wetlands + Bird Pond + Skip's Pond + Downstream Wetlands	87.640	595.860	6.799	402.950	13.600	29.629	$18,388,829
8: + Coves 1, 2 & 3 + Central Wetlands + Bird Pond + Skip's Pond + Downstream Wetlands + Dam Forested Wetlands	88.470	622.530	7.037	26.670	0.830	32.133	$19,244,926

Figure 3-3. Comparison of Final Array of Plans



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 Mitchell Lake 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, shorebirds, and waterfowl. 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 Mitchell Lake 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 Mitchell Lake 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 lake attracts. Therefore, migratory birds must expend additional, limited energy resource in search of food resources elsewhere. Therefore, Plan 1 is an ineffective Plan to improve habitat for the nationally significant migratory bird populations at Mitchell Lake.

4.2 Plan 2 (Polders)

Plan 2 entails the restoration of mud flats habitats that would have been interspersed throughout the historical wetland complex prior to the impoundment of Mitchell Lake. The Plan would result in the restoration of five mudflat cells within the existing polder complex comprising a total of 49.52 acres of mudflat habitat from Alternative 6 (Figure 4-1). Details of the ecological benefits of the mudflat restoration are provided in Chapter 6 of the Main Report.

Under the existing condition, the polders are managed for open water and provide essentially no foraging habitat for migrating shorebirds. Due to the larger size of the East and West Polders in comparison to the basins, berms will be installed to create more equal sized cells. This measure will allow better manageability of the water levels within this area, which will assist in waterbird, waterfowl, and shorebird management overall. Therefore, the creation of the mudflats would create a total of 18 AAHU for migratory shorebirds with an incremental cost per incremental output of $782. The Plan has a construction cost of $222,922 and an incremental cost of $14,190. Plan 2 encompasses 24.1% of the total area identified for restoration under this study. Because this Plan would provide critical habitat for migrating shorebirds, a nationally significant resource with population numbers that are in decline primarily due to habitat loss, implementation of polder restoration is worth the Federal and local investment.

Figure 4-1. Plan 2 Restoration Area

4.3 Plan 3 (Polders and Coves 1 & 2)

Plan 3 includes the restoration of the mud flats adds the restoration of 65.52 acres of emergent/submergent wetland habitat. The restoration of the fringe wetlands along the shoreline and shallows of the cove provides significant resting and foraging habitat for migrating waterbirds and waterfowl, along with providing minor riparian habitat. Details of the ecological benefits of the emergent/submergent wetland habitats are provided in Chapter 6 of the Main Report.

Plan 3 adds 37 AAHUs of emergent/submergent wetland habitat to the 18 AAHUs of mudflat habitat. Keeping the caveat identified above regarding combination of AAHUs from different habitat types quantified using different habitat models model in mind, Plan 3 would result in a total 55 AAHUs or 62% of the total potential AAHUs available for the study. The incremental cost per incremental output for Plan 3 is $2,069 with a construction cost of $1,430,962. Plan 3 would restore 67% of the total area identified for restoration under this study.

The addition of Coves 1 & 2 increases the number of ecological guilds and niches that would benefit from the Mitchell Lake restoration efforts. The creation of mudflat habitat specifically benefits shorebirds and the emergent/submergent wetlands benefit waterfowl and waterbirds. Cove 1 & 2 could potentially provide habitat for waterbirds (another group of birds experiencing significant declines in population sizes) and waterfowl (a nationally managed resource). Because Plan 3 adds habitat features that provide increased benefits to for additional bird guilds and is economically justified, the Plan is worth the Federal and local investment.

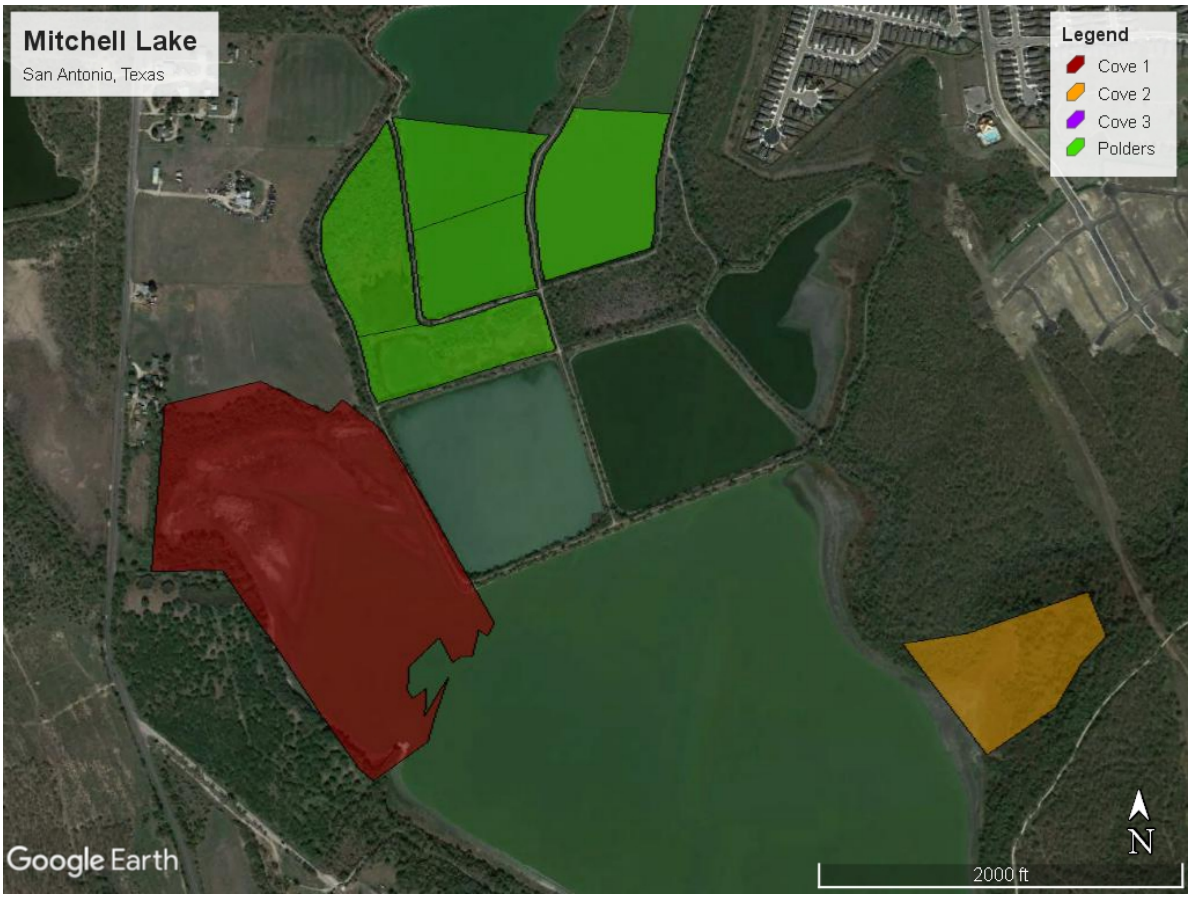


Figure 4-2. Plan 3 (Polders and Coves 1 & 2)

4.4 Plan 4 (Polders, Coves 1, 2, & 3)

Plan 4 adds the restoration of emergent and submergent wetlands in Cove 3 from Alternative 7F to those restoration features included in the previous Plan. Restoration would include 6.84 acres of restoration in Cove 3 located at the southwest end of the lake and 65.52 acres of restoration in the coves at the northeastern and western edges of the lake. The additional 6.84 acres of emergent/submergent wetland provided by Plan 4 would result in a total of 72.36 total acres of restoration in the coves of Mitchell Lake. Adding Cove 3 to this plan expands the geographic extent of emergent/submergent wetlands within the study area, creating additional habitat in an area that will provide better connectivity between Coves 1 & 2 and the polders.

Plan 4 would increase the area of emergent/submergent wetlands restored by an order of magnitude. The larger areal extent of Coves 1 and 2 result in exponentially longer habitat edge. The edge habitats provide significant habitat for birds that require shallower habitats for foraging and resting. The result of the larger restored area and longer edge habitat significantly increase waterbird and waterfowl habitat in Mitchell Lake. As previously mentioned, this habitat is highly valuable for nationally significant resources such as waterbirds and waterfowl. Each year, these birds migrate through the area and settle on Mitchell Lake. The inclusion of all of the coves to the restoration Plan would spread the bird population over a larger area and accommodate more birds that would otherwise have been forced to expend energy in search of additional habitat. The addition of Cove 3 creates “patch” habitat that is utilized by different species of waterfowl and waterbirds. Patch habitats are a component of the island biogeography concept. The island biogeography theory considers the benefits of habitat connectivity in relation to habitat patch sizes and distances between the habitat patches. The restoration of separate patches provides resiliency as natural stresses such as drought or flooding may adversely impact one patch more than another. These stressors are anticipated to increase over time as the effects of climate change manifest. Because of the value of these wetlands, the expenditure of the additional incremental cost per incremental output is worth the Federal and local investment.

Plan 4 adds 3 AAHUs of emergent/submergent wetland habitat to the previous 37 AAHUs of emergent/submergent wetlands and 18 AAHUs of mudflat. The 58 total AAHUs captured by this Plan can be broken down for each habitat type:

- 49.52 acres and 18 AAHUs of mudflat habitat
- 72.36 acres and 40 AAHUs of emergent/submergent wetland habitat

The incremental cost per incremental output for Plan 4 is $2,071 with a construction cost of $1,557,381. Plan 4 would restore 71% of the total area identified for restoration under this study. Because of the value of these wetlands, the expenditure of the additional incremental cost per incremental output is worth the Federal and local investment.

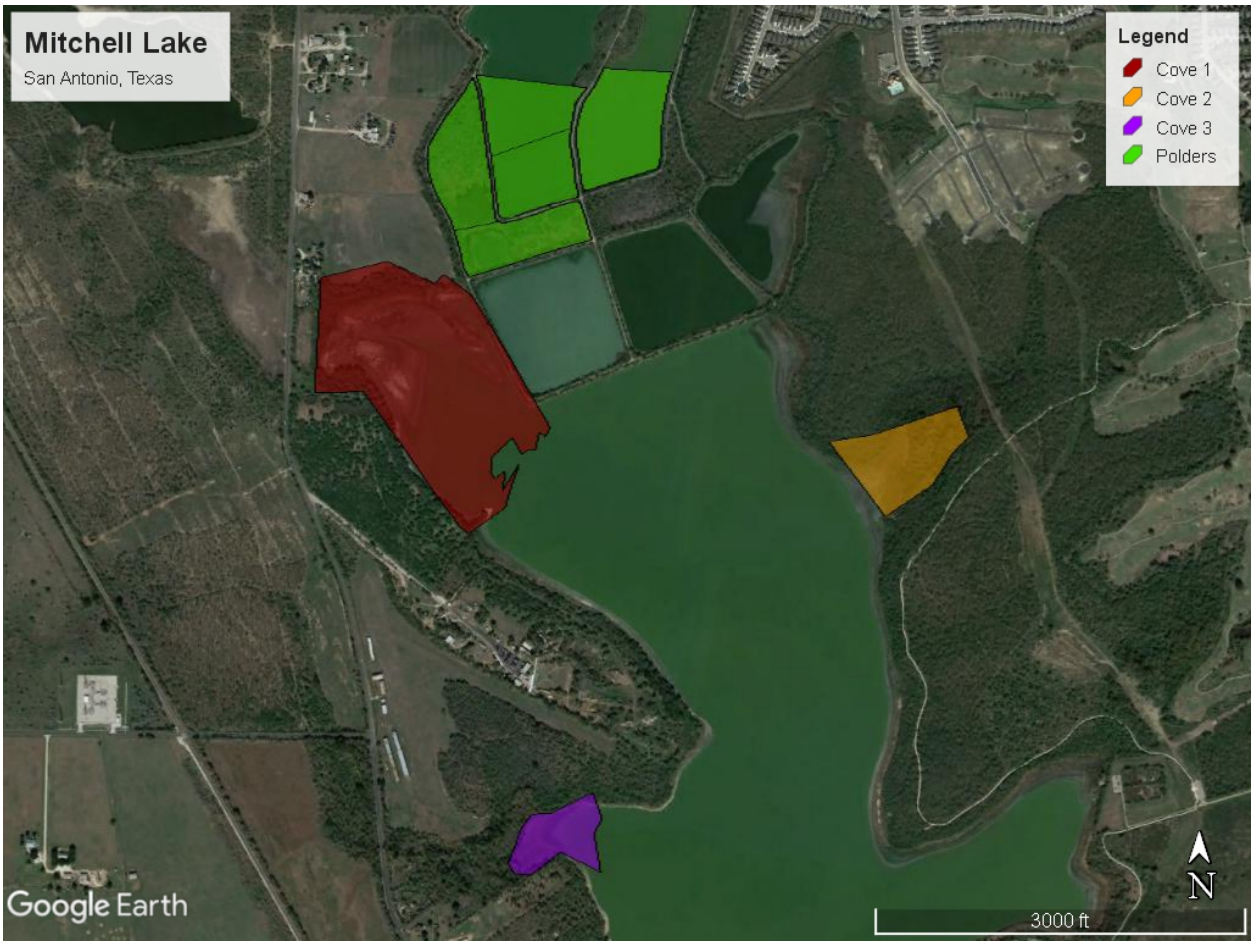


Figure 4-3. Plan 4 (Polders and Coves 1, 2, & 3)

4.5 Plan 5 (Polders; Coves 1, 2 & 3, Central Wetlands, and Skip's Pond)

Plan 5 adds restoration measures to improve the habitat quality of Central Wetlands from Alternative 2 and Skip's Pond from Alternative 3. The Central Wetlands is a low quality existing emergent wetland and Skip's Pond is an existing submergent/emergent wetland with areas of open water. The restoration would increase the topographic diversity of the Skip's Pond, create emergent vegetation on the margins of the pond, and control non-native, invasive species.

The Skip's Pond wetlands are significantly different than the cove wetlands. The cove wetlands border the deeper open water habitats of Mitchell Lake with the wetlands graduating from submergent to emergent vegetation towards the shoreline. The deeper wetland areas associated with the cove primarily attract diving ducks such as Canvasbacks (*Aythya valisineria*), Redheads (*A. americana*), and Greater and Lesser Scaup (*A. marila and A. affinis*).

The Skip's Pond wetlands provide smaller patches of shallower open water surrounded by more tussocks of emergent vegetation. These smaller wetlands provide high quality habitat for migrating dabbling ducks such as Mallard (*Anas platyrhynchos*), Northern Pintail (*Anas acuta*), Gadwall (*Mareca streptera*), and teal (*Spatula discors, Spatula cyanoptera, and Anas crecca*). Because the addition of the Skip's Pond wetlands provides habitat that has not been included in the previous Plans and that habitat provides resources for another distinct group/guild of birds; absorbing the increased incremental cost to incremental output ratio resulting from moving from is worth the Federal and local investment.

The Central Wetlands is a complex of emergent wetlands located immediately north of Skip's Pond. The existing wetlands are dominated by noxious species such as willow baccharis, palo verde, and cattails. The restoration measures would improve the plant diversity and expand the wetland complex.

Thus far, Plans 2 through 4 have included restoration areas that realize benefits in isolation, albeit with cumulative benefits across the spread of the study area. With the addition of the Central Wetlands, Plan 9 begins linking restoration areas from the previous Plans resulting in synergistic benefits to fish and wildlife habitat. Plan 5 also provides significant ancillary water quality benefits that are not captured or included in the plan formulation of the study.

One of the key components of the Central Wetland restoration is the pipeline from the polders to the northern end of the Central wetland complex. This pipeline provides the capability of managing the water levels of the wetlands, extracting low quality water from Mitchell Lake and releasing it into the Central Wetlands. Wetland habitats provide water quality benefits as the wetland vegetation captures nutrients as the water passes through them. The water exiting the wetlands has a lower nutrient load and is of a higher quality than the water entering them. Once the water is filtered through the Central Wetlands, the water flowing through Skip's Pond will further filter out the nutrients. Skip's Pond empties into a long linear wetland/drainage feature that borders the polders. This linear wetland continues along the northern and western boundary of the polders until it empties into Cove 1 of Mitchell Lake. Therefore, once leaving Skip's Pond, the water is "polished" further as it flows approximately 4,635 feet through the linear wetland and Cove 1 of Mitchell Lake.

Although the incremental cost per incremental output for restoring the Skip's Pond and the Central Wetlands is slightly higher than the incremental ratio of the previous plans, the Central Wetlands complex has a relatively flat topography and supports an extensive ecotone with transitional habitats between the wetland and upland prairie areas.

Because of the connectivity the Central Wetlands provide to Skip's Pond and Cove 1; the synergistic captured and uncaptured benefits attributed resulting from the connected system; and the connection of the existing transitional habitats to the Central Wetlands, the increased incremental cost to incremental output ratio resulting from moving from Plan 4 to Plan 5 and the increase in the first cost, Plan 5 is worth the Federal and local investment.

A total of 70 AAHUs are provided by Plan 5; the allocation of the AAHUs are provided below:

- 49.52 acres and 18 AAHUs of mudflat habitat
- 18.37 acres and 11 AAHUs of emergent wetland habitat
- 74.54 acres and 41 AAHUs of emergent/submergent wetland habitat

The incremental cost per incremental output for Plan 5 is $5,428 with a construction cost of $3,372,217. Plan 5 would restore 83% of the total area identified for restoration under this study.

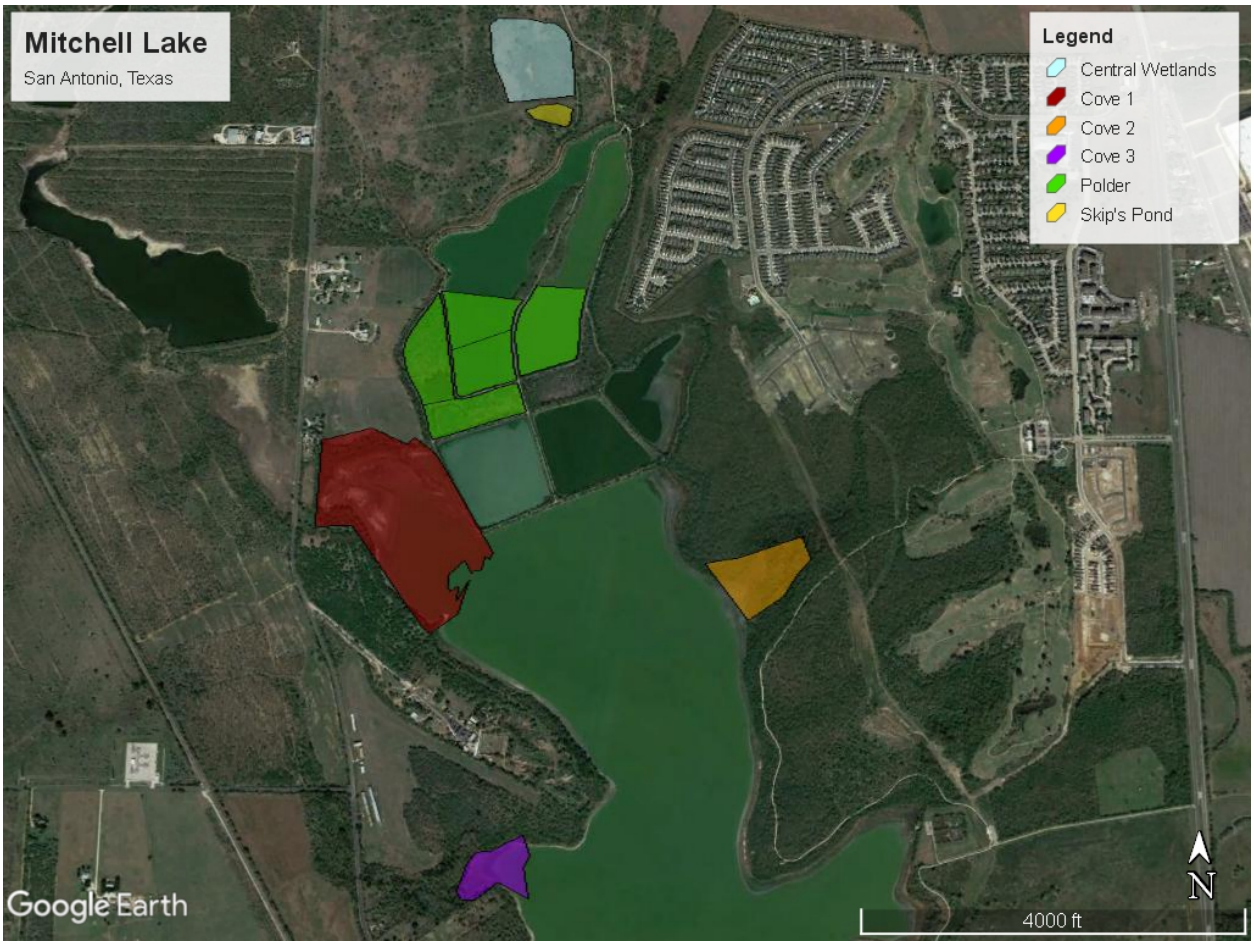


Figure 4-4. Plan 5 Restoration Areas

4.6 Plan 6 (Polders, Coves 1, 2, & 3, Central Wetlands, Skip's Pond, and Bird Pond Wetlands)

Plan 6 includes the restoration features included in Plan 5 and adds the restoration and expansion of the Bird Pond Wetland from Alternative 1B. The Bird Pond Wetlands are an existing wetland system located east of Bird Pond and upstream of the Central Wetlands. The existing wetlands are dominated by cattails with little herbaceous diversity. An indistinct drainage comprised of a swale of wetlands with intermittent sections of distinct channels connects the Bird Pond and Central Wetlands. Instead of placing the pipeline outfall structure at the north end of the Central Wetlands (Plan 5), the pipeline would be moved to the north end of the Bird Pond Wetland. The restoration measures would improve the plant diversity and expand the wetland complex. The Bird Pond Wetland restoration would add 6.42 acres of emergent wetlands and 4 AAHUs to the previous Plan.

Plan 6 increases the synergistic water quality benefits of the previous Plan by adding the nutrient filtering function of the Bird Pond Wetlands and approximately 591-foot channel to the Central Wetland/Skip's Pond /Cove 1 system.

The Bird Pond Wetlands provide the same core target habitat benefits as the Central Wetlands and provide the same uncaptured benefits as the Central Wetlands associated with the surrounding transitional habitats. However, the Bird Pond Wetlands are located adjacent to the

aquatic habitat of Bird Pond and the associated forested habitat that surrounds the pond. The proximity of the forested habitats to the Bird Pond Wetlands provide significant resources for specific neotropical migratory birds that utilize edge habitats along wetland/woodland boundaries such as the Common Yellowthroat (*Geothlypis trichas*), Yellow Warbler (*Setophaga petchia*), Swamp Sparrow (*Melospiza georgiana*), and Song Sparrow (*M. melodia*). The Bird Pond Wetland also provides optional foraging opportunities for pond dependent species utilizing the Bird Pond habitats such as egrets and herons.

A total of 74 AAHUs are provided by Plan 6; the allocation of the AAHUs are provided below:

- 49.52 acres and 18 AAHUs of mudflat habitat
- 74.54 acres and 41 AAHUs of emergent/submergent wetland habitat
- 24.79 acres and 15 AAHUs of emergent wetland habitat

The incremental cost per incremental output for Plan 6 is $8,208 with an estimated construction cost of $4,355,847. Plan 6 would restore 86% of the total areas identified for restoration under this study. Although the incremental cost per incremental output for restoring the Bird Pond Wetland is slightly higher than the incremental ratio of the Central Wetlands, the Bird Pond Wetland provides habitat for an additional bird guild and increasing the water quality treatment of the Mitchell Lake water flowing through the system. Because of the increased diversity of bird species benefiting from the restoration, the increased water quality function resulting from adding the Bird Pond Wetland to the Plan, and the relatively small increase in incremental cost to incremental output ratio and increase in first cost resulting from moving from Plan 5 to Plan 6, Plan 6 is worth the Federal and local investment.

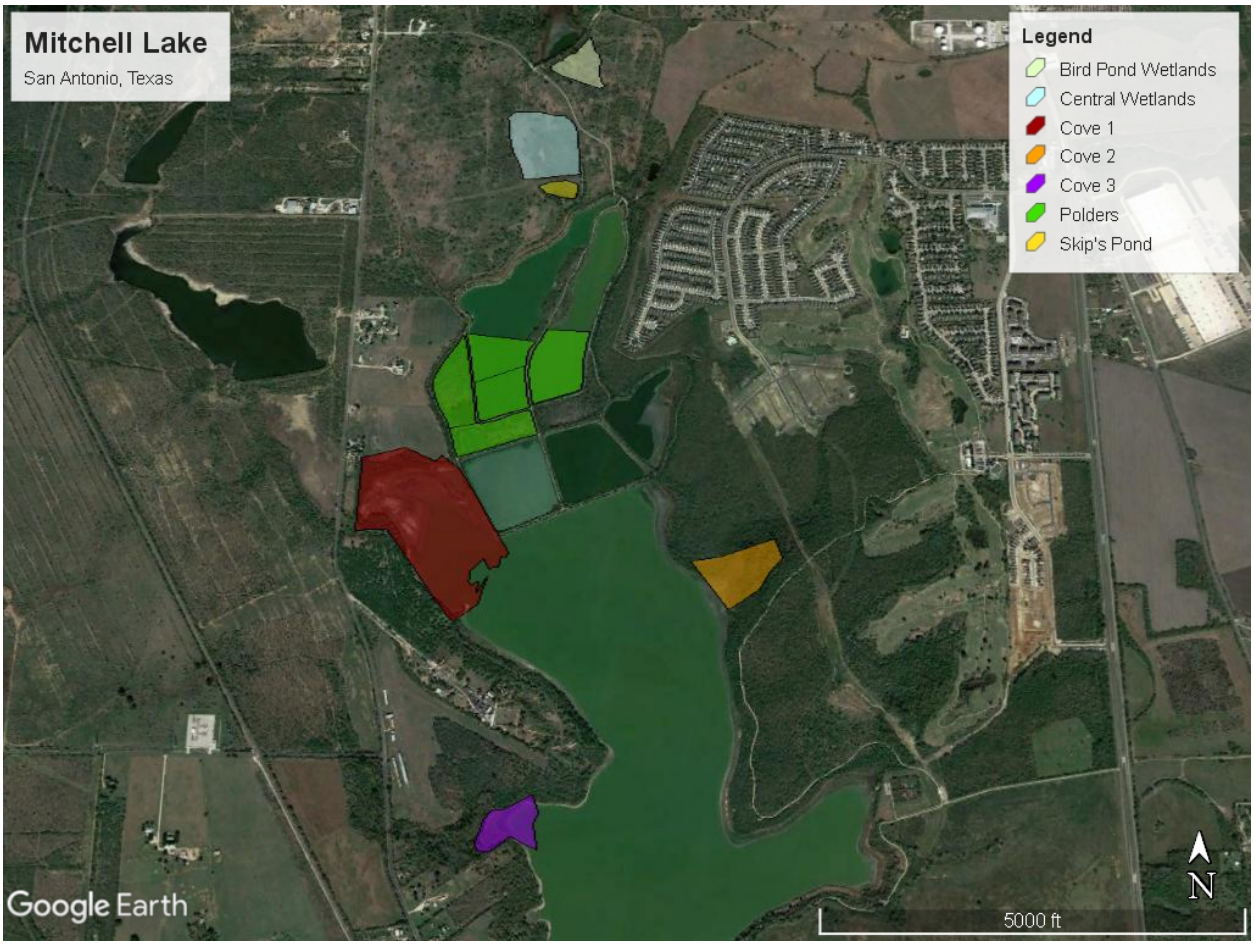


Figure 4-5. Plan 6 (Polders, Coves 1, 2, & 3, Central Wetlands, Skip's Pond, and Bird Pond Wetlands)

4.7 Plan 7 (Polders, Coves 1, 2, and 3, Central Wetlands, Skip's Pond, Bird Pond Wetlands, and Downstream Wetlands)

Plan 7 includes the mudflat and emergent/submergent restoration defined in Plan 6 and adds the restoration of 19 acres of emergent wetlands located downstream of the Mitchell Lake Dam from Alternative 10. The downstream emergent wetlands provide cover and foraging habitat for temperate and neotropical migrant songbirds and waterbirds. Neotropical migrant songbirds attracted to emergent wetlands include the Marsh Wren (*Cistothorus palustris*), Sedge Wren (*C. platensis*), Bobolink (*Dolichonyx oryzivorus*), rails, egrets, and herons. The population trends for neotropical migrant songbirds are also in decline.

Plan 7 adds 14 AAHUs of emergent wetland habitat to the 74 AAHUs of mudflat, emergent and submergent habitat. Because the mudflat and emergent wetlands are entirely different habitats and the habitat quality for each area was calculated using two different sets of habitat models, the AAHUs for each habitat are not directly comparable or additive. With that caveat, Plan 7 would provide a total of 88 AAHUs; this comprises 99% of the output of that captured by the largest Plan (Plan 8). The incremental cost per incremental output of Plan 7 is $29,629 with a construction cost of $18,388,829. Despite the benefits of creating the emergent wetlands in Area 10, the benefits are not worth the Federal investment given the steep increase in incremental cost per output as well as the substantial increase in total project cost.

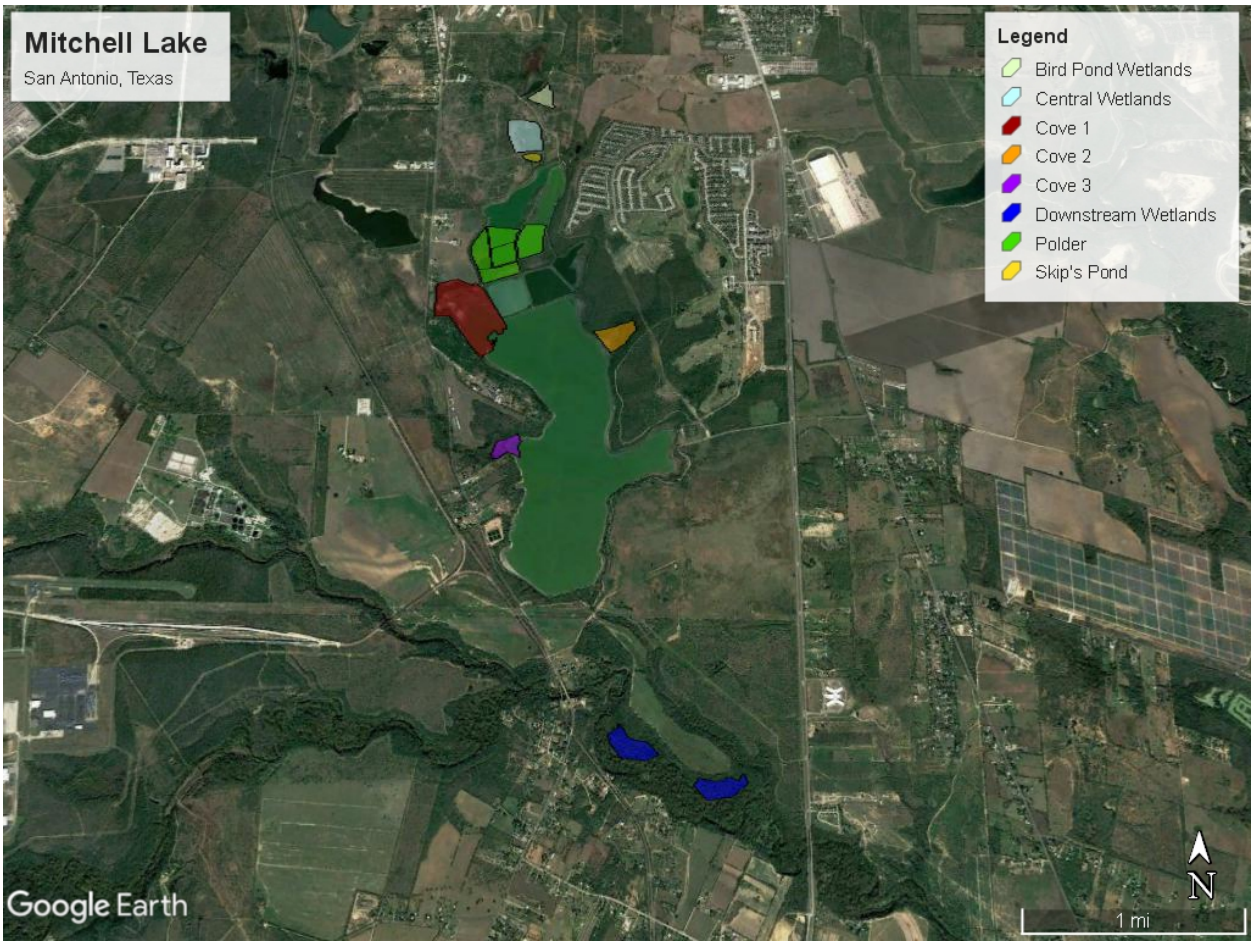


Figure 4-6. Plan 7 (Polders, Coves 1, 2, & 3, Central Wetlands, Skip's Pond, Bird Pond Wetlands, and the Downstream Wetlands)

4.8 Plan 8 (Polders, Coves 1, 2, and 3, Central Wetlands, Skip's Pond, Bird Pond Wetlands, Downstream Wetlands, and Dam Forested Wetlands)

Plan 8 includes the restoration features included in Plan 7 and adds the restoration of a forested wetland complex south of the Mitchell Lake Dam from Alternative 9B. Although the existing Dam Forested Wetlands have an extremely low plant species diversity, the structural diversity of the wetlands is appropriate for that system. The restoration strategy for the Dam Forested Wetlands would be to thin the dominant tree species and replant with a more diverse palette of native tree species to increase the diversity. The Dam Forested Wetland restoration would add 4.48 acres of forested wetlands and 1 AAHU to the previous Plan. The small increase in AAHUs is attributed to the fact that the habitat quality models key in on structural habitat features and not on species diversity.

A total of 89 AAHUs are provided by Plan 8; the allocation of the AAHUs are provided below:

- 49.52 acres and 18 AAHUs of mudflat habitat
- 74.54 acres and 41 AAHUs of emergent/submergent wetland habitat
- 43.79 acres and 29 AAHUs of emergent wetland habitat
- 4.48 acres and 1 AAHU of forested wetland habitat

The incremental cost per incremental output for Plan 8 is $32,133 with a construction cost of $19,244,926. Plan 8 would restore all areas identified for restoration under this study.

Plan 8 would introduce a fourth habitat type into the proposed restoration Plans – forested wetlands. Forested wetlands provide for additional guilds of Neotropical migrant songbirds including the Barred Owl (*Strix varia*), Northern Parula (*Setophaga americana*), Vermilion Flycatcher (*Pyrocephalus rubinus*), Louisiana Waterthrush (*Parkesia motacilla*), and Prothonotary Warbler (*Protonotaria citrea*). The forested wetlands also provide for species of reptiles, amphibians, and mammals that are not found in the grassland and savannah wetlands associated with the previous Plans. In spite of the ecological value that the addition of the Dam Forested Wetlands provide for the restoration plan, the high incremental cost per incremental output is significantly higher than the rest of the Plans combined. Therefore, the expenditure of Federal and local funds to implement Plan 8 is not justified.

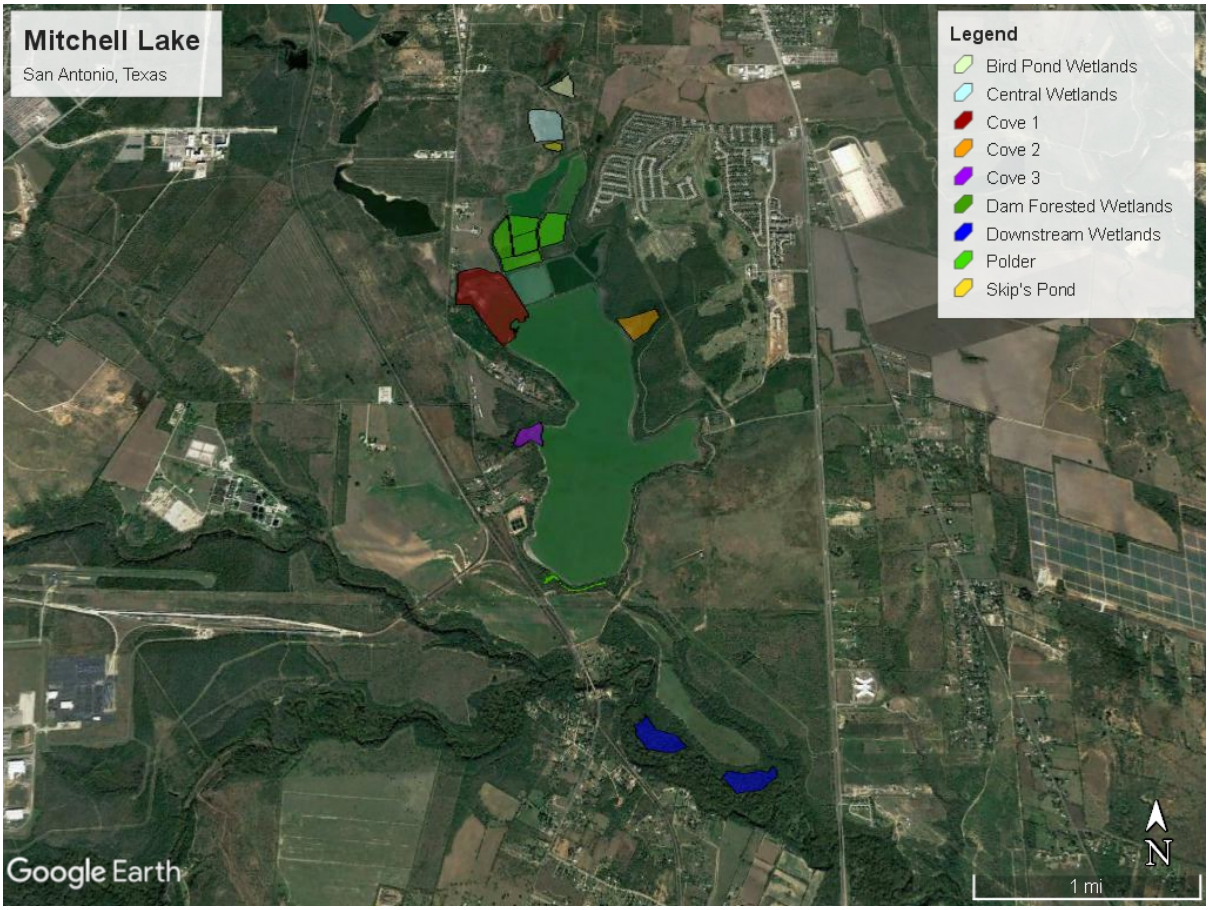


Figure 4-7. Plan 8 Restoration Areas

5 National Ecosystem Restoration Plan

Migratory birds are the primary resource of national significance identified within the study area. Based on historical descriptions, the large wetland complex that occupied the study area prior to the impoundment of Mitchell Lake would have acted as extremely valuable stopover habitat for migrating birds. The recreation of the emergent, submergent, and forested wetlands along with the associated mudflat and prairie habitats are critical to improving vital migratory habitat for migratory birds and help stem the systemic decline in population sizes for these species.

Plan 6 is the recommended National Ecosystem Restoration (NER) plan. This Plan provides:

- Three distinct habitat types (emergent wetlands, submergent/emergent wetlands, and mudflats) out of the four targeted habitat types;
- Resilient habitat for migratory birds;
- The creation of a complex of wetlands that can be managed to improve water quality as an ancillary benefit;
- The restoration of 86% of the proposed restoration areas;
- An incremental cost per incremental output of $8,208;
- An approximate first cost of $8.1 million.

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.

Risk 2: Habitat quality metrics include estimates of canopy cover, species diversity, and other environmental factors that would optimally be measured in April/May. The Mitchell Lake habitat was assessed in March. As such habitat quality may have been under- or overestimated

- Likelihood: High
- Consequence Rating: Low
- Risk Management: Based on field surveys, this risk was realized. To mitigate, future conditions were adjusted to reflect later (peak) season conditions based on professional judgment/concurrence with the interagency field team.

Risk 3: If the SAWS treatment wetlands are not constructed, the cost of supplying water to the Downstream Wetlands would increase as a separate water source would be required.

- Likelihood: Low
- Consequence Rating: High
- Risk Management: SAWS is mandated by the EPA to treat water quality coming out of Mitchell Lake. SAWS is studying the efficacy and design optimization of a treatment wetland as a solution to that requirement. The probability of the construction of the treatment wetlands prior to the appropriation of funds for the restoration study is high, so no risk management options will be employed at this time.

7 Recreation

There are several recreation opportunities that can be incorporated alongside the ecosystem restoration project surrounding Mitchell Lake. The Mitchell Lake Audubon Center has recreation features in place currently, including picnic areas, walking (and road) trails, and bird blinds. Discussions with the non-Federal sponsor and Mitchell Lake Audubon Center staff led to the development of additional recreation features and potential locations for these features. The additional recreation features proposed are similar to those existing near Bird Pond, with the [potential] addition of two boardwalks for bird viewing. The additions to the existing recreation are compatible with the ecosystem restoration project and would enhance the experience for visitors of Mitchell Lake by providing ease of access to the ecosystem restoration areas, while also providing additional educational and wildlife viewing opportunities.

Plans to enhance the recreation experience include: Additional trails, trailheads located at the beginning of the natural trails, several picnic tables placed throughout the study area near points of interest, two lookout decks, and bird blinds located throughout the study.

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
- would not exist without 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 Mitchell Lake 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, and interest in expanding opportunities for picnics (etc.)
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 discovered through the Master Plan research align with the type of recreation opportunities that will be created via the Mitchell Lake Ecosystem Restoration and Recreation projects, including increased trails and access to nature for all.

7.1.1 Expected Annual Visits

Expected annual visits to the proposed recreation is based on current visitation numbers provided by the Mitchell Lake Audubon society. The Audubon society reported an annual visitation number of 10,000 visitors as of 2020. The population of Bexar County and the City of San Antonio has been steadily increasing in recent years, and that trend is expected to continue through at least the first half of the period of analysis (2025 to 2050), as shown in Table 7-1. For purposes of estimating recreation benefits, the 10,000 visits per annum estimate will be used. Though it is likely that visitation will increase as population increases, using the conservative (i.e., current) visitation estimate to calculate the benefit-cost ratio (BCR) ensures the justification of the recreation features in a no-visitation-growth scenario.

Table 7-1. Bexar County Population Estimate

2019	2025	2035	2050
2,053,260	2,297,072	2,706,907	3,353,060

7.1.2 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 (UDV) method. The UDV method was selected for estimating recreation benefits for the Mitchell Lake 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. Though the visitation number was held constant between FWOPC and FWPC, the proposed recreation features will enhance the recreation experience of visitors to the project area. The difference between the FWOPC points and the FWPC points was converted to a dollar value, as described below, and the dollar value was multiplied by the number of visitors expected annually to determine the annual benefit of the proposed recreation features.

Table 7-2 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. The FWOPC and FWPC point value assignments are noted in Table 7-2, below. The FWOPC was assigned 29 points; the FWPC

was assigned 53 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. Rationale for the point values assigned is described below.

1. Recreation Experience – The Mitchell Lake recreation enhancement project would enhance the bird watching opportunities based on proximity to restoration areas and ease of viewing. Though ~1.2 miles of walking trails exist in the future with-project condition, the surrounding areas are wooded, causing obstruction of views for birders. The addition of trails to restoration areas would allow for clear views of unique species of birds (neo-tropical migrants, shorebirds, waterfowl, and waterbirds) that use the restoration areas compared to the wooded areas.
2. Availability of Opportunity – The availability of opportunity is based on the opportunity to view species that are rare to the area, such as shorebirds. This is considered the highest quality recreation activity available at Mitchell Lake for the recreation analysis in this report. The availability of this activity does not change in the future-with project condition. According to the San Antonio Audubon Society, there is at least one area with opportunity to view shorebirds within 30 minutes from Mitchell Lake and one within an hour from Mitchell Lake.
3. Carrying Capacity – The Mitchell Lake recreation carrying capacity point values are estimated to improve with the additional recreation implementation. In addition to increasing total capacity of the walking trails, the new trails proposed in the upper wetlands create a safer environment for pedestrians. Current access to the upper wetlands is limited to 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.
4. Accessibility – Accessibility is sufficient in the without project condition. The with-project condition creates greater accessibility within the site in the with-project condition; therefore, the points within the “judgment factor” range were increased in the FWPC.
5. Environmental Quality – In the without-project condition, there is an abundance of invasive species and presence of a monoculture in the areas surrounding Mitchell Lake. In the with-project condition, recreation areas are positioned around the restoration areas with improved habitat quality that will include a more diverse, aesthetically pleasing habitat quality as compared to the FWOPC.

Table 7-2. Recreation Point Value Assignments

Criteria	Judgment Factors				
1. Recreation Experience *FWOPC Points: 10* *FWPC Points: 14*	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: 11* *FWPC Points:* 14	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* 11	Good access, high standard road to site; good access within site *15-18*

5. Environmental Quality *FWOPC Points: 2* *FWPC Points: 12*	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 $5.93 (interpolated). The conversion of recreation points to dollar values, as prescribed by EGM 21-02, is shown in Table 7-3.

Table 7-3. Recreation Points to Dollars Conversion

Point Values	General Recreation Values
0	$4.27
10	$5.07
20	$5.61
30	$6.41
40	$8.01
50	$9.08
60	$9.88
70	$10.41
80	$11.48
90	$12.28

7.2 Recreation BCR

To calculate the BCR for the recreation features, the recreation first cost, $481,311 (including 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 $17,075. Using the annual recreation benefit of $59,300, the BCR is 3.5 to 1, as displayed in Table 7-4.

Table 7-4. Recreation Benefit-Cost Ratio

Construction First Cost (Recreation)	$327,000
PED and CM (Recreation)	$154,311
Annual Interest Rate	2.50%
Period of Analysis (years)	50
Construction Period (months)	6
Annual Recreation Benefits	$59,300
Recreation AAEQ Cost	$17,075
Recreation BCR	3.5
Note: Based on FY 2021 price level and interest rate	

8 Economic Summary

The economic cost summary of the NER Plan (Plan 6) and associated recreation is displayed in Table 8-1. The table displays project first cost, interest during construction based on a 12-month construction period, and average annual equivalent (AAEQ) costs. Project first cost was refined after plan selection; therefore, the first cost listed in this table will differ from the costs used in CE/ICA analysis.

AAEQ OMRR&R is annualized over the 50-year period of analysis and includes estimated maintenance of plantings for years 1 through 10 and operations and maintenance of engineering structures for years 1 through 50.

Table 8-1. Economic Cost Summary

Economic Cost Summary	
Project First Cost	$8,149,000
Fish & Wildlife Facilities	$4,715,000
Recreation Construction Cost	$327,000
Lands and Damages	$525,000
PED	$1,542,000
Construction Management	$1,040,000
Interest During Construction	$101,446
Total Investment (Economic Cost)	$8,250,446
AAEQ Total Investment	$290,895
AAEQ OMRR&R*	$37,155
Total AAEQ Cost	$328,050
Note: Based on FY 2021 price level and 2.5% discount rate; OMRR&R annualized over 50-year period of analysis; See O&M section for breakdown of costs by year	

9 *References

1994. "Executive Order No. 12898, 59 FR 7629."

USACE. 2011. "Corps of Engineers Civil Works Cost Definitions and Applicability." Memorandum, Director of Civil Works, Dated 27 Aug 2011.

USACE. 2017. Economic Guidance Memorandum, 18-01, Federal Interest Rates for Corps of Engineers Projects for Fiscal Year 2018. Washington, D.C.: U.S. Army Corps of Engineers.

USACE. 2000. "Planning Guidance Notebook, ER 1105-2-100."