Mitchell Lake, San Antonio, Texas

Final Integrated Detailed Project Report and Environmental Assessment, Bexar County

June 2021

FINAL

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Fort Worth District

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DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, FORT WORTH DISTRICT
P. O. BOX 17300
FORT WORTH, TEXAS 76102

Mitchell Lake, San Antonio, Texas Integrated Detailed Project Report and Environmental Assessment, Bexar County

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STUDY DESCRIPTION

Mitchell Lake, Texas began as a single-purpose, ecosystem restoration, general investigation feasibility study but was converted to a Continuing Authorities Program Section 206 Aquatic Ecosystem Restoration study. The study officially started with the signing of the Feasibility Cost Share Agreement between the US Army Corps of Engineers and the San Antonio Water System on 27 September 2018. A combination Charette and Alternatives Milestone Meeting was successfully conducted on 16 January 2019. The Tentatively Selected Plan was determined at the successful milestone meeting held 25 October 2019. The Tentatively Selected Plan was confirmed as the Recommended Plan at the Agency Decision Milestone Meeting on 23 April 2020. After this meeting, the Vertical Team decided that the most appropriate path to implementation would be to change the authority from General Investigations to the Continuing Authorities Program due to the relatively low cost. Therefore, this decision document is a Detailed Project Report and Integrated Environmental Assessment.

STUDY AUTHORITY

Resolution of the Committee on Transportation and Infrastructure, US House of Representatives, House Resolution Docket No. 2547, dated 11 March 1998.

> *"Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That, the Secretary of the Army is requested to review the report of the Chief of Engineers on the Guadalupe and San Antonio Rivers, Texas, published as House Document 344, 83rd Congress, 2nd Session and other pertinent reports, with a view to determining whether any modifications of the recommendations contained therein are advisable at the present time, with particular reference to providing improvements in the interest of flood control, environmental restoration and protection, water quality, water supply and allied purposes on the Guadalupe and San Antonio Rivers in Texas."*

PURPOSE AND NEED

This is an interim, or partial, response to the study authority. Broadly, the problem is the loss of both habitat structure and function of the aquatic and riparian habitats of Mitchell Lake. Although the lake no longer serves a wastewater function, the degradation from that function is still evident. The waters of Mitchell Lake are highly eutrophic causing unstable dissolved oxygen and pH levels and therefore the current conditions no longer support the biodiversity of the historic wetland vegetation community or other aquatic life.

LOCATION

The study area is in south San Antonio, Texas in Bexar County (Figure 1). It is just north of the confluence of the Medina River and Leon Creek (both tributaries of the San Antonio River). The area is a natural drainage between the Balcones Fault zone to the north and the Luling fault zone to the south. The watershed draining to Mitchell Lake consists of 9.76 square miles. The total drainage area downstream of Mitchell Lake Dam (excluding the drainage area of the lake) that contributes runoff to Cottonmouth Creek (and ultimately to the Medina River) is 0.80 square miles.

SPONSOR

The San Antonio Water System, San Antonio, Texas

PROBLEMS AND OPPORTUNITIES

Changes in and around, Mitchell Lake have caused the historic tule (tall emergent wetland vegetation) wetland system to degrade resulting in hyper-eutrophic waters, reductions in habitat quality and quantity and reductions in wildlife diversity.

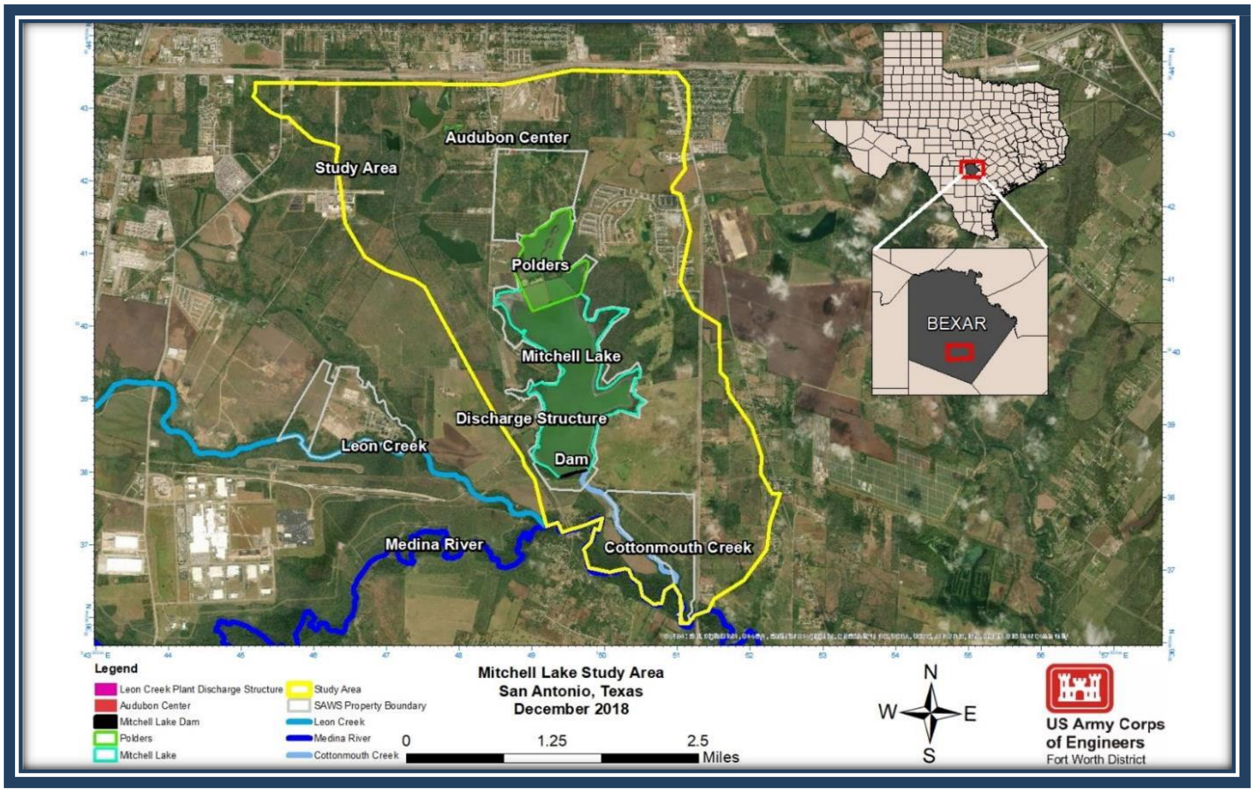

Figure 1 - Location of Mitchell Lake, Bexar County, Texas

Problems:

1. There is loss of fish and wildlife habitat quality and diversity, particularly for migratory birds.
2. There is little aquatic connectivity between the upstream and downstream habitats. Nutrient loads will continue to increase.
3. There are invasive species on site that out-compete native flora. These invasive species will continue to spread.
4. There are extreme daily variations in pH and O_2 levels leading to hypereutrophic conditions.

Opportunities exist to:

1. reconnect the upstream and downstream hydrologies
2. improve water quality through ecosystem restoration

3. provide additional recreation and ecotourism benefits to the community

SPECIFIC PLANNING OBJECTIVES

1. increase the areal extent and quality of fish and wildlife habitat in the study area for the 50-year period of analysis
2. increase the floral and faunal species diversity and richness in the study area for the 50-year period of analysis

CONSTRAINTS

Institutional Constraints:

1. Avoid increasing flood risks
2. Plans must be consistent with existing Federal, State and Local laws.
3. Ecosystem restoration may not principally result in treating, or otherwise abating, pollution, or other compliance responsibilities of the NFS.
    a. The Non-Federal Sponsor is under an Administrative Order by the Environmental Protection Agency to improve water quality of Mitchell Lake water prior to entering the Medina River.

Specific Planning Constraints:

1. avoid mobilization of pollutants that would exceed Environmental Protection Agency water quality criteria limits
2. avoid currently developed areas

PLANS

Ecosystem Restoration management measures were brainstormed by the full Project Delivery Team – Non-Federal Sponsor, US Army Corps of Engineers and stakeholders. Each management measure was then judged as to whether it was a Water Quality Only, a combination Water Quality + Ecosystem Restoration, or Ecosystem Restoration Only measure. Those measures deemed to be Water Quality Only measures were removed from further consideration.

At the same time, the study area was broken into 10 distinct areas based upon attributes like hydrology, soils and existing vegetation. Three areas were removed from further plan formulation based upon differing criteria.

For each of the seven areas remaining, the final array of management measures was combined into individual alternatives. Each of these alternatives could be a standalone plan or combined with other alternatives to form a suite of Plans.

In addition, several scales of most alternatives were developed for each area in order to achieve differing levels of captured and uncaptured benefits (Table 1 and Table 2).

Table 1 - Average Annual Habitat Benefits by Alternative

Project Area	Alternative	FWOP AAHU	FWP AAHU	Annual Benefits AAHU	FWP Acres
Area 1: Bird Pond Wetlands	1A: Restoration of Existing Wetlands	0.86	2.39	1.53	3.17
	1B: Expansion/Restoration of Existing Wetlands and Restoration of Additional Wetlands	0.86	4.71	3.85	6.42
Area 2: Central Wetland	2A: Restoration of Existing Wetlands	2.85	7.88	5.03	10.46
	2A1: Restoration of Existing Wetlands w/out Area 1	2.85	7.88	5.03	10.46
	2B: Expansion/Restoration of Existing Wetlands and Restoration of Additional Wetlands	2.85	13.54	10.69	18.37
	2B1: Expansion/Restoration of Existing Wetlands and Restoration of Additional Wetlands w/out Area 1	2.85	13.54	10.69	18.37
Area 3: Skip's Pond	3: Restoration of Existing Wetlands	0.59	1.64	1.05	2.18
Area 6: Polders	6: Management/Modification of Existing Polders/Basins	30.21	48.35	18.14	49.52
Area 7: 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
Area 9: 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	1.25	2.08	0.83	4.48

Project Area	Alternative	FWOP AAHU	FWP AAHU	Annual Benefits AAHU	FWP Acres
	Restoration of Additional Riparian Habitat				
Area 10: Downstream Wetlands	10: Creation of Wetlands Downstream of Mitchell Lake	0.0	13.6	13.6	19

Table 2 - Average Annual Benefits and Costs by Alternative

Project Area	Alternatives	Annual Benefits AAHU	Annual Cost ($1,000) October 2020 Prices
Area 1: Bird Pond Wetlands	1A: Restoration of Existing Wetlands	1.53	$30.43
	1B: Expansion/Restoration of Existing Wetlands and Creation of Additional Wetlands	3.85	$40.17
Area 2: Central Wetland	2A: Restoration of Existing Wetlands w/Area 1	5.03	$28.73
	2A1: Restoration of Existing Wetlands w/out Area 1	5.03	$46.62
	2B: Expansion/Restoration of Existing Wetlands and Creation of Additional Wetlands w/Area 1	10.69	$37.74
	2B1: Expansion/Restoration of Existing Wetlands and Creation of Additional Wetlands w/out Area 1	10.69	$55.19
Area 3: Skip's Pond	3: Restoration of Existing Wetlands	1.05	$8.53
Area 6: Polders	6: Management/Modification of Existing Polders/Basins	18.14	$14.19
Area 7: Fringe Wetlands	7A: Restoration of Cove 1 (Wetland/Riparian Plantings)	29.90	$61.86
	7B: Restoration of Cove 2 (Wetland/Riparian Plantings)	6.60	$13.69
	7C: Restoration of Cove 3 (Wetland/Riparian Plantings)	3.81	$7.93
	7D: Combination of Coves 1 & 2	36.50	$75.51

Project Area	Alternatives	Annual Benefits AAHU	Annual Cost ($1,000) October 2020 Prices
	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
Area 9: Dam Forested Wetlands	9A: Restoration of Existing Wet Riparian Habitat	0.47	$23.58
	9B: Expansion/Restoration of Existing Wet Riparian Habitat and Creation of Additional Riparian Habitat	0.83	$26.67
Area 10: Downstream Wetlands	10: Creation of Wetlands Downstream of Mitchell Lake	13.60	$402.95

COST EFFECTIVENESS–INCREMENTAL COST ANALYSIS

Environmental restoration benefits (increase in with-project Average Annual Habitat Units) and annual costs (expressed in thousands of dollars) were entered into the Institute for Water Resources Planning Suite, resulting in 1,152 plans. CE/ICA analyses were based on preliminary cost estimates that were subsequently refined for the Recommended Plan.

COST EFFECTIVE AND BEST BUY PLANS

Of the 1,152 Plans (including various scales), 37 were identified as cost-effective plans, including the No Action Plan. Of the Cost-Effective plans, 8 were also Best Buy plans, including the No Action Plan (Figure 2 and Figure 3).

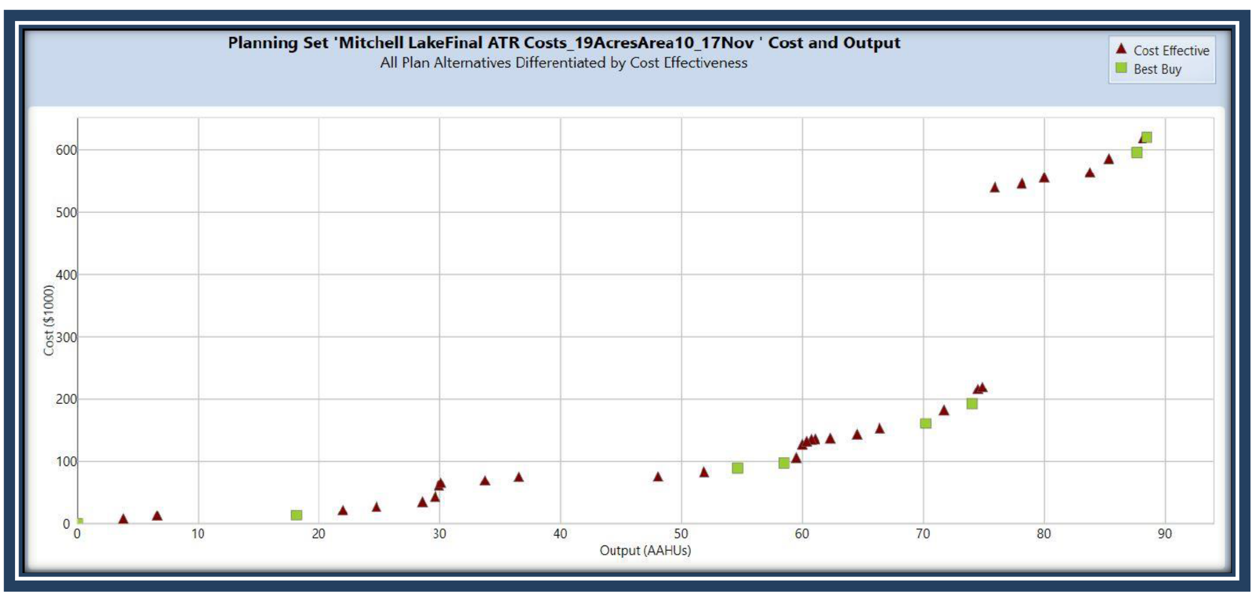

Figure 2 - Cost Effective [red triangles] and Best Buy Plans [green squares]

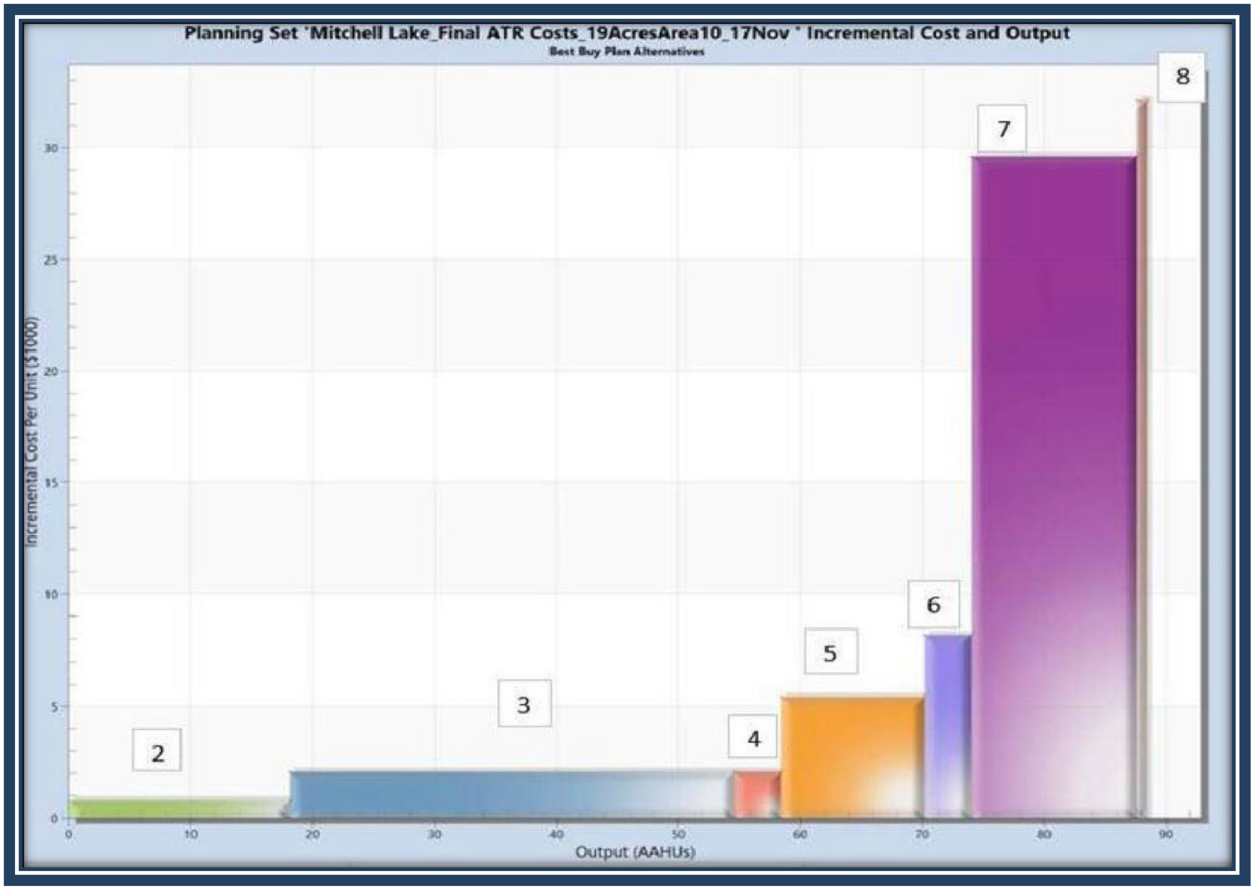

Figure 3 - Bar Chart comparing Best Buy Plans Benefits vs. Costs for Implementation

RECOMMENDED PLAN

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

Plan 6 (Figure 91) 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 project first cost of $8.1 million. Plan 6 would restore 86% of the total area 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.

Analyses indicate that Plan 6 is the National Ecosystem Restoration Plan and Recommended Plan. It is the plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective.

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 improve 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 improve 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 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

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.

Recreation features include:

- additional trails from Bird Pond to Skip's Pond – ~2 miles
- boardwalks at Polders
- trailheads near new Bird Pond
- trailhead near Skip's Pond
- bird Blinds near Polders and Northern Chain of improved wetlands

Table 3 - Recreation Benefit-Cost Ratio ($1,000s)

Estimated First Cost	$327
Annual Interest Rate	2.5%
Period of Analysis	50 years
Construction Period	6 months
Annual Recreation Benefits	$59
Recreation AAEQ Cost	$17
Recreation BCR	3.5:1

Cost Estimate

Table 4 - Project First Costs Allocation (rounded)

FEATURE	FEDERAL	NON-FEDERAL	TOTAL
Ecosystem Restoration (65/35)			
01 Lands and Damages	$0	$525	$525
06 Fish and Wildlife Facilities	$4,715	$0	$4,715
30 Engineering & Design	$1,542	$0	$1,542
31 Construction Management	$1,040	$0	$1,040
Unadjusted ER	$7,297	$525	$7,822
Adjustment for 65/35	**($2,213)**	**$2,213**	
Subtotal for ER	**$5,084**	**$2,738**	**$7,822**
Recreation (50/50)			
14 Recreation Facilities	$164	$163	$327
Project First Costs	**$5,248**	**$2,901**	**$8,149**
October 2020 Price Levels ($1,000s)			

NON-FEDERAL SPONSOR SUPPORT

The San Antonio Water System presented their support for the Tentatively Selected Plan during the Tentatively Selected Plan Milestone on 25 September 2019. They stated:

- The proposed project has the potential to provide substantial ecological benefits for the Mitchell Lake habitat.
- We anticipate the proposed plan will receive positive support during the public review process.
- There are exciting things happening in the Mitchell Lake area.

SAWS has since indicated that they are "willing and able to participate as the Sponsor for the Mitchell Lake Aquatic Ecosystem Restoration, in partnership with the U.S. Army Corps of Engineers (USACE), to cooperatively design and construct" Recommended Plan 6 per their Letter of Intent dated 11 June 2021.

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1 General Information

The San Antonio Water System (SAWS), of San Antonio, Texas, sent a letter of intent to the US Army Corps of Engineers (USACE) Fort Worth District's (SWF) District Engineer in April of 2018. The letter contained their desire to initiate a study partnership to address ecosystem restoration and water resource opportunities at Mitchell Lake. A Feasibility Cost Share Agreement (FCSA) was signed between the USACE, the SWF and SAWS on September 27, 2018.

Mitchell Lake, Texas began as a single-purpose, ecosystem restoration, general investigation feasibility study but was converted to a Continuing Authorities Program Section 206 Aquatic Ecosystem Restoration study. The study officially started with the signing of the Feasibility Cost Share Agreement between the US Army Corps of Engineers and the San Antonio Water System on 05 September 2018. A combination Charette and Alternatives Milestone Meeting was successfully conducted on 16 January 2019. The Tentatively Selected Plan was determined at the successful milestone meeting held 25 October 2019. The Tentatively Selected Plan was confirmed as the Recommended Plan at the Agency Decision Milestone Meeting on 23 April 2020. After the ADM, the Vertical Team determined that the most appropriate path to implementation would be to change the authority from General Investigations to the Continuing Authorities Program due to the relatively low cost. Therefore, this decision document is a Detailed Project Report and Integrated Environmental Assessment.

1.1 Original Study Authority

The Mitchell Lake DPR-EA was originally conducted as an interim, or partial, response under the Guadalupe and San Antonio Rivers and Tributaries, Texas, resolution adopted by the Committee on Transportation and Infrastructure, United States (US) House of Representatives, in House Resolution Docket #2547 dated 11 March 1998, which reads in part:

> *"Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That, the Secretary of the Army is requested to review the report of the Chief of Engineers on the Guadalupe and San Antonio Rivers, Texas, published as House Document 344, 83rd Congress, 2nd Session and other pertinent reports, with a view to determining whether any modifications to the recommendations contained therein area advisable at the present time, with particular reference to providing improvements in the interest of flood control, environmental restoration and protection, water quality, water supply and allied purposes on the Guadalupe and San Antonio Rivers in Texas".*

1.1.1 Additional Study Guidelines

The guidance for this feasibility study was also issued in a memorandum dated 20 June 2001, Subject: Guadalupe and San Antonio River Basins, Texas Section 905(b) Analysis, signed by the Chief for Planning and Policy Division, Directorate of Civil Works, HQ USACE.

1.2 Final Study Authority

The Mitchell Lake DPR-EA was completed under the authority provided to the Chief of Engineers by Section 206 of the Water Resources Development Act of 1996, as amended.

1.3 Study Purpose and Need

The purpose of this feasibility study is to evaluate Federal interest in Plans (including the No Action Plan) for ecosystem restoration at Mitchell Lake, San Antonio, Texas. Per Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook, as amended, the USACE incorporated ecosystem restoration as a project purpose, within the Civil Works program, in response to the increasing National emphasis on environmental restoration and preservation. Historically, the USACE involvement in environmental issues focused on compliance with National Environmental Policy Act (NEPA) requirements related to flood protection, navigation and other project purposes. The USACE ecosystem restoration purpose is to be carried out in addition to activities related to NEPA compliance. Ecosystem restoration features are to be considered as single purpose projects, or as a part of multiple purpose projects, along with navigation, flood protection and other purposes, wherever those restoration features improve the value and function of the ecosystem. Ecosystem restoration projects are to be formulated in a systems context to improve the potential for long-term survival of aquatic, wetland and terrestrial complexes as self-regulating, functioning systems. Like other project purposes, the value of ecosystem restoration outputs is required to equal, or to exceed, their cost.

Broadly, the problem is the loss of both habitat structure and function of the aquatic and riparian habitats of Mitchell Lake. Mitchell Lake has been a workhorse of both the wildlife and human communities since before the time of the first European explorers in the area, providing a wide range of ecological goods and services, not the least of which was sustenance for humans, livestock and wildlife. The area was first described as a tule (tall emergent wetland vegetation) that teemed with varied species of flora and fauna. Wetlands are often defined as areas where the frequent and prolonged presence of water at or near the soil surface drives the natural system including the type of soils (i.e. hydric soils) that form, the plants that grow and the fish and/or wildlife that use the habitat.

Extensive use of Mitchell Lake as a 20th century wastewater facility, beginning with the construction of the dam in 1901, has created current conditions that no longer support the diversity of aquatic species and wildlife described by the 19th century naturalists. Where there once existed an ecologically rich freshwater emergent wetland, there is now a larger open water site surrounded by savannah, forested vegetation and invasive riparian species.

Although the lake no longer serves a wastewater function, the degradation from that function is still evident. The waters of Mitchell Lake are highly eutrophic causing unstable dissolved oxygen (DO) and pH levels and therefore the current conditions no longer support the biodiversity of the historic wetland vegetation community or other aquatic life. Despite degraded conditions and ecological losses, the high-quality opportunity of the ecosystem is evident as the area provides habitat to over 338 migratory bird species – 30 species on the Audubon Watch List; and 129 species considered to be directly threatened by habitat loss and climate change.

1.4 Federal Interest

Federal interest in water resources development is established by law. Within the larger Federal interest in water resource development, the USACE is authorized to carry out projects in seven mission areas: navigation, flood damage reduction, ecosystem restoration, hurricane and storm damage reduction, water supply, hydroelectric power generation and recreation. Ecosystem restoration projects improve ecosystem structure and function.

National Significance: The North American Central Flyway passes through 10 other US states before funneling 80-90% of the migratory population to the state of Texas and ultimately through south Central Texas. The San Antonio region and subsequently Mitchell Lake, is situated at the intersection of three ecoregions allowing for a large biodiversity of habitats, which provide the requisite migratory needs of these high species numbers. Evidence of the importance of the intersection of these ecoregions is the presence of the Mitchell Lake emergent wetland complex. This type of wetland complex is unique to the region, the outputs it provides are therefore unique to the region and the region serves a national function to the Central Flyway.

Federally listed threatened and endangered (T&E) species known to utilize Mitchell Lake are Red Knot (*Calidris canutus*) and Piping Plover (*Charadrius melodus*). For more information, see Main Report, Chapter 2, Resource Significance and Appendix C – Environmental Resources, Chapter 2, Resource Significance.

1.5 Study Area

Partial History of the State of Texas

Recorded history for what would eventually become the State of Texas began with the Spanish conquistadors and their attending priests in the early 16th century. Prior to that, the area was the home for an unknown number of tribes. At various times, this area would be claimed by various entities: native tribes, Spain, France, Mexico, the Republic of Texas and then the United States (US) of America in the mid-19th Century (Figure 4).

Throughout the 19th and early 20th centuries, the Texas economy depended upon four major industries: Cattle, Cotton, Lumber and Petroleum. Texas politicians sold off large parcels of public lands in order to fund higher education. Subsequent polities allowed individuals to buy large parcels of land creating huge cattle spreads. Cotton was grown mainly in the fertile lands of east Texas along the Louisiana border, often after the forests had been clear-cut for logging.

Texas is probably best known for its petroleum production. In 1901, oil was discovered at Spindletop Hill in Beaumont, Texas. Thus, began the Texas Oil Boom, sometimes known as the Gusher Age. Eventually the US surpassed the Russian Empire as the world’s top producer of petroleum, in large part due to Texas oil. Most oil production takes place in southeast Texas, but reserves have been found across Texas and up into Oklahoma.

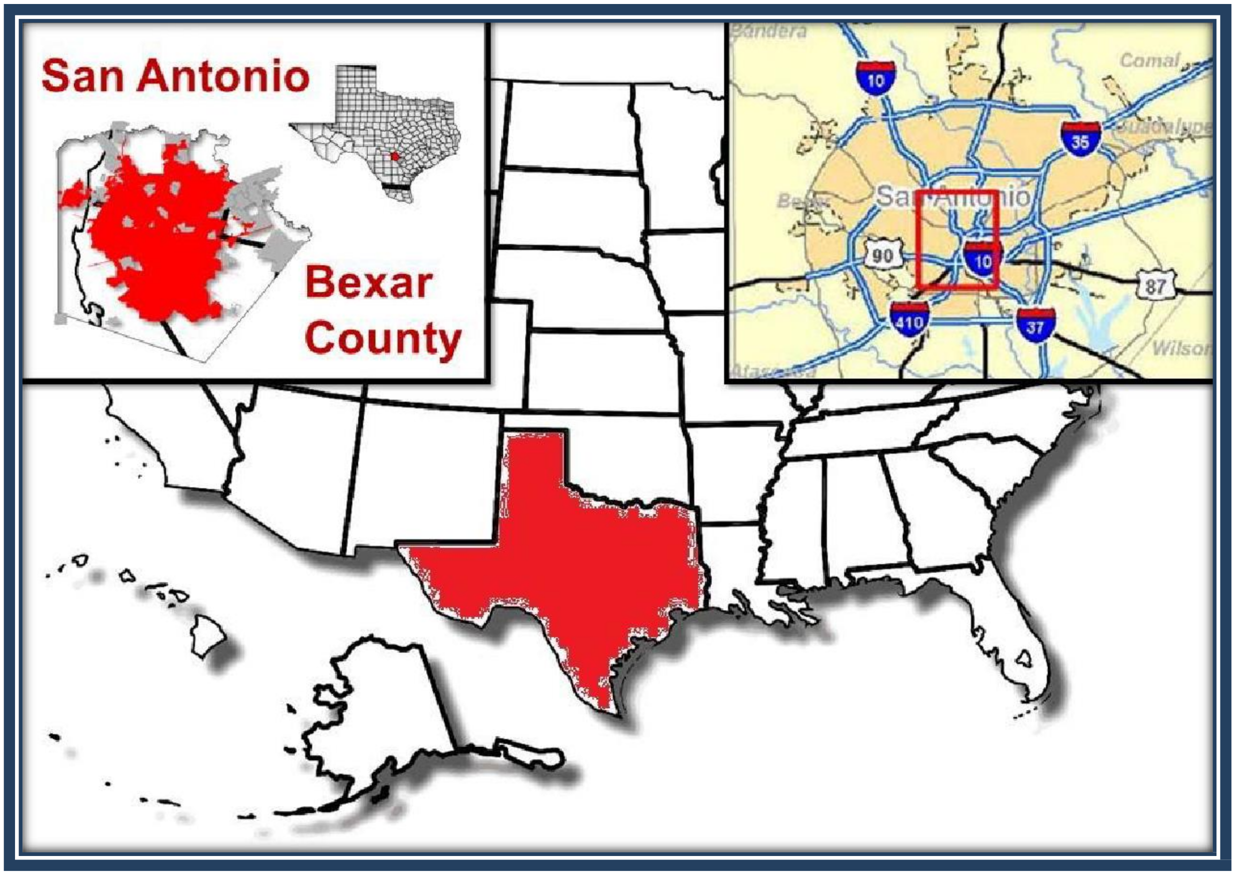

Figure 4 - Location of the State of Texas, United States of America and of the City of San Antonio

Partial History of Bexar County

Bexar County (pronounced BAY-er, or bear), Texas was founded in 1836 and once contained the disputed western area of the Republic of Texas, which stretched from what is now east Texas, through western New Mexico and north to Wyoming. The county was named for San Antonio de Bexar and was one of 23 Mexican administrative areas of Texas at the start of the Mexican – American war. The Villa de San Fernando de Bexar was the first civilian government established in Mexico's Texas Province. This Villa eventually became the City of San Antonio, Texas (Figure 4).

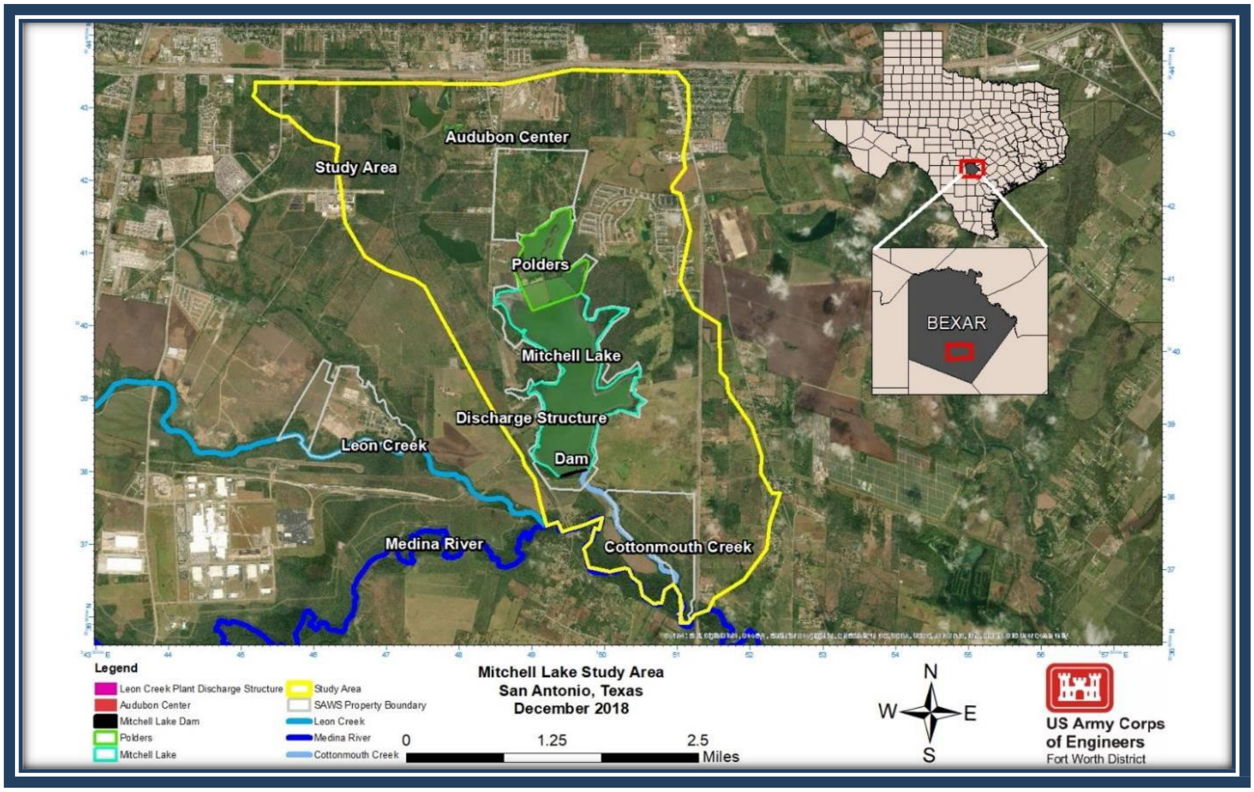

Figure 5 - Map showing location of Study Area and Bexar County, Texas (Yellow – study area)

City of San Antonio, Texas

San Antonio, Texas is located in Bexar, County (Figure 4 and Figure 6). It is the seventh most populous municipality in the US and the second most populous in the State of Texas, surpassed only by Houston. It was founded as a Spanish mission and colonial outpost in 1718 by the Spanish Empire.

Mitchell Lake Area History

At the time of the Spaniards, until after the American Civil War, the area that is now known as Mitchell Lake was an area of open water, marshes, wetland grasses and forest patches. In 1839, Asa Mitchell purchased ~14,000 acres of public land from the newly created Republic of Texas, this included Mitchell Lake.

Dr. Rudolph Menger, a City native born in 1851, described the area as ”Tule [swamp weed] jungles” man-high and covered the three miles long lake from one end to the other”. He stated that “one could wade with his long boots, nearly any part of the interior spaces,” and that ”millions of ducks and chattering water hens” afford fine sport for San Antonio hunters and other sportsmen.” (1913, Menger) Another description comes from naturalist H.P. Attwater, who said in 1884 that the area of Mitchell Lake was ”a big muddy water hole which could be waded in dry seasons.”

After the Civil War, San Antonio grew rapidly from ~12,000 people in 1870, to ~53,000 in 1900. By the end of the 19th century, San Antonio had sewer lines that extended over 25 miles to 500 acres called the Stinson Field and still needed more. In response, an open-air ditch was dug from the Stinson Field to Mitchell Lake and the Mitchell Lake dam was constructed. This ditch, the San Antonio Canal, was 4.5’ wide x 2.5’ deep. Another ditch, which eventually became Cottonmouth Creek, was dug from the dam to the Medina River. The dam was ~10’ high x 500’ long, with a top crest width of 14’.

Figure 6 – Location of Mitchell Lake as surrounded by San Antonio, Bexar County, Texas

In 1925, San Antonio began construction of the Rilling Road Treatment Plant and completed construction in 1930 in order to serve a population of ~231,000 people. Sewage from San Antonio no longer flowed directly into Mitchell Lake. However, the effluent from the treatment plant was still used by the local irrigation district and flowed into the lake. In 1932, San Antonio took over the surface property rights to the lake’s outfall, with an easement to use Mitchell Lake.

During periods of high precipitation, untreated sewage from the treatment plant entered the lake.

After World War II, the population increased and San Antonio expanded its political limits. In 1956, a study recommended the construction of a sewage treatment plant on Leon Creek. Instead, San Antonio added to the Rilling Road Treatment Plan in 1956, 1958 and again in 1962.

In 1963, San Antonio purchased part of Mitchell Lake and in 1965, the Leon Creek Treatment Plant was built. In addition, in 1970, the Salado Creek Treatment Plan was opened. With these two new treatment plants, Mitchell Lake discharge was mostly eliminated.

The 62nd Texas State Legislature passed a House resolution, with Senate concurrence and created the Texas Water Quality Board (TWQB). The TWQB was directed to work with the Texas Water Development Board (TWDB), Bexar County, San Antonio, the San Antonio River Authority (SARA), the Texas Parks and Wildlife Department (TPWD) and the Texas State Health Department to clean the water of Mitchell Lake. The group was also directed to convert Mitchell Lake into a public recreation lake, or to some other "beneficial use as they may find practical." Mitchell Lake could no longer be used as a sewage disposal area.

On January 10, 1973, the San Antonio Audubon Society sent a letter to the mayor of San Antonio recommending that Mitchell Lake be designated as a wildlife refuge for waterfowl. The San Antonio City Council approved City Ordnance 41789 on February 8, 1973 designating Mitchell Lake a refuge for shore birds and waterfowl and approved the purchase of the lands north of Mitchell Lake. The lake and adjacent properties were now wholly owned by San Antonio.

Because San Antonio could not put sludge into Mitchell Lake, the north end of the lake was diked off to create digesting basins (polders). This area then received activated sludge from the Rilling Road Treatment Plant from 1973 until 1987. The activated sludge was moved from polder to polder by way of pumps in clockwise circulation. This sludge was then used for irrigation on grazing lands until 1987 then stopped after complaints of adverse smell. San Antonio also constructed Bird Pond, Skip's Pond and Edward's Tank north of Mitchell Lake. Bird Pond held excess sludge, Skip's Pond caught runoff from Bird Pond and Edward's Pond appeared to stay wet from groundwater seepage.

Mitchell Lake Today

Mitchell Lake is a 600-acre impoundment managed and owned by SAWS. The earthen dam is currently classified by the Texas Council on Environmental Quality (TCEQ) as an intermediate size, low hazard dam. The lake has a normal storage capacity of 2,640-acre-feet and a maximum storage capacity of 5,000 acre-feet.

Mitchell Lake Dam is an earth- and rock-fill embankment (Figure 7) with a crest length of ~3,200' and a maximum height of 10'. The normal water level elevation is 520.4'.

SAWS does not perform discharges from the lake into Cottonmouth Creek, which flows into the Medina River. The only flows that come from the lake are a result of large precipitation events.

Figure 7 - Mitchell Lake Dam facing west

Figure 8 - Lakeside view of primary spillway

Figure 9 - Aerial view of primary spillway on east side of Mitchell Lake

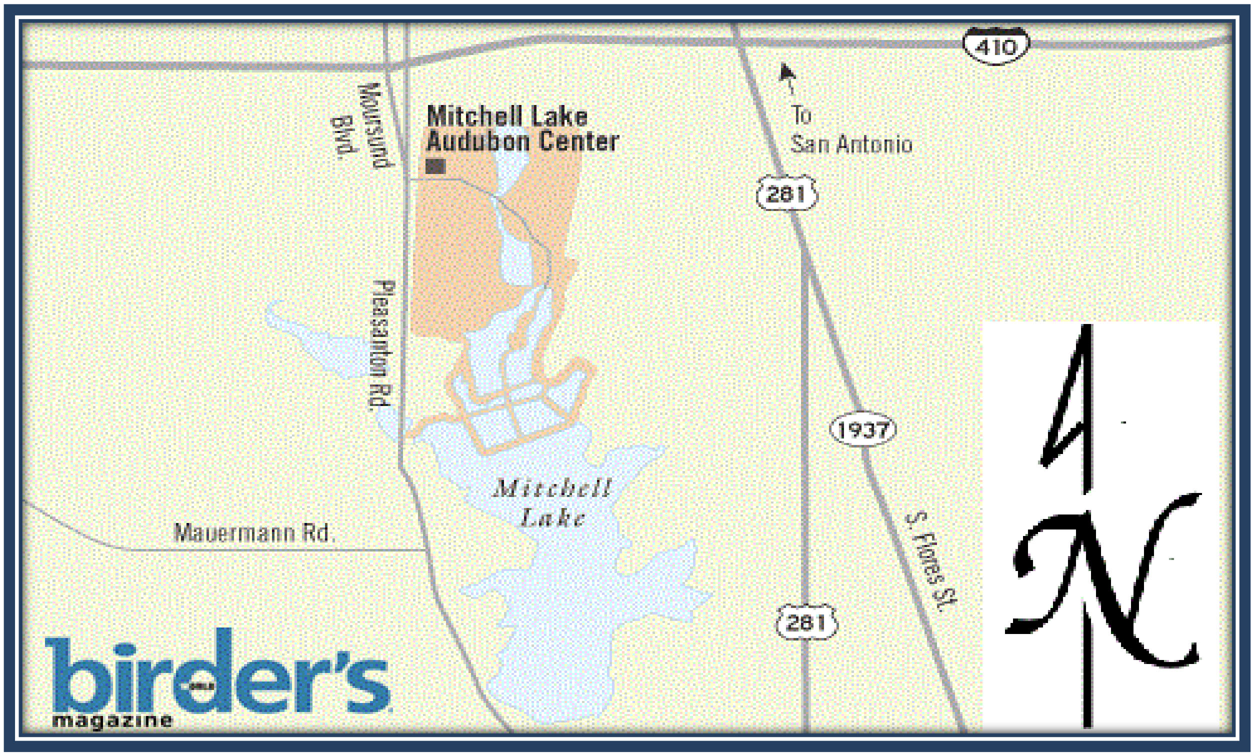

Figure 10 - Map showing Audubon Center in relation to Mitchell Lake

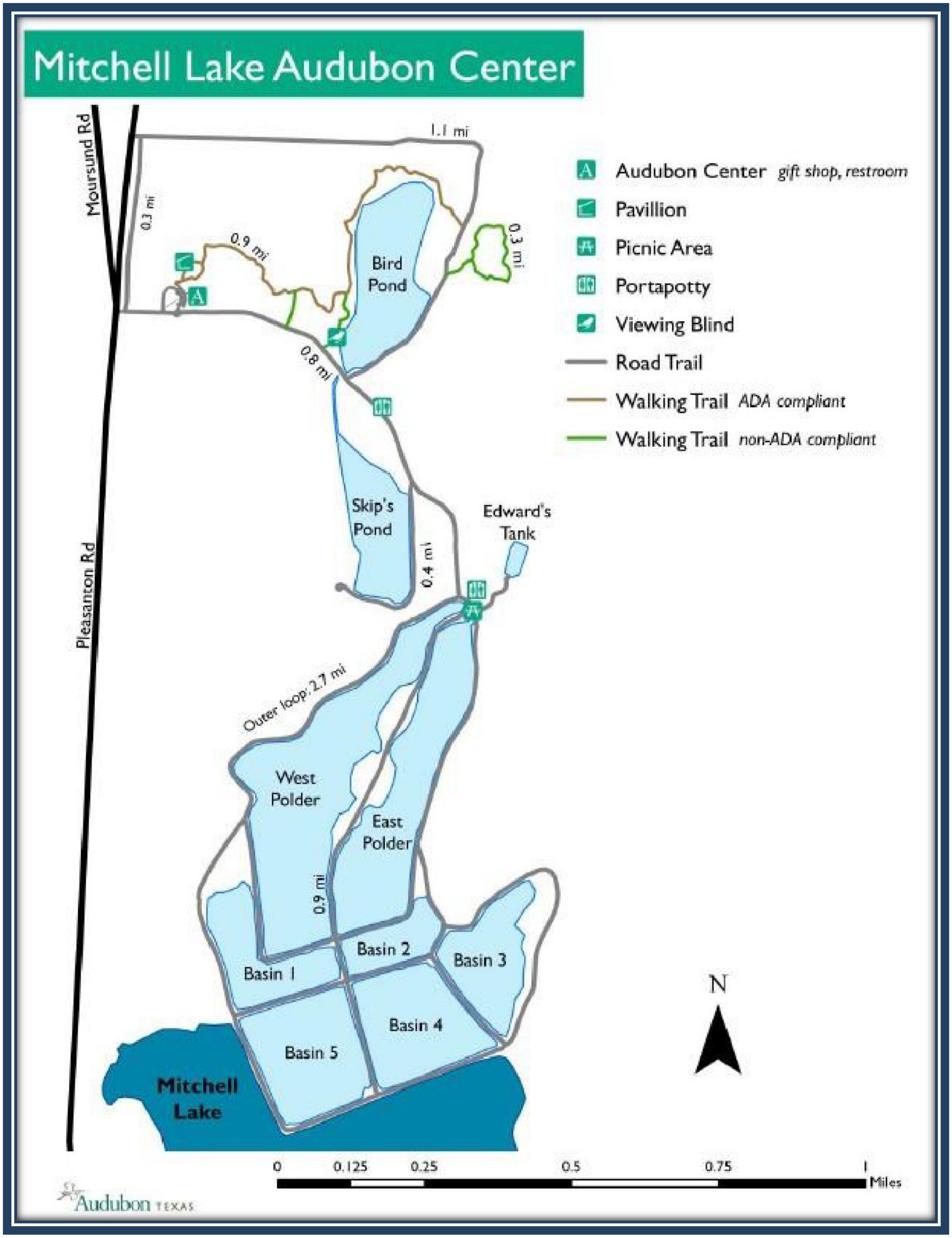

Figure 11 - Another map showing Audubon Center in relation to Mitchell Lake

Since 2004, the lake and surrounding uplands and wetlands have been leased to the Audubon Society for management and operation as a public use and education facility (Figure 10 and Figure 11).

There is significant development activity near Mitchell Lake, including San Antonio's Police Academy, Mission Del Lago residential area and the Texas A&M University System San Antonio campus. Mission Del Lago includes an 18-hole public golf course to the east of Mitchell Lake.

The watershed draining to Mitchell Lake consists of 9.76 square miles. Downstream of Mitchell Lake, along the southeast side of the lake, is a 250' long stone and mortar outfall channel. The outfall channel discharges into Cottonmouth Creek, which extends ~7,000' downstream and into the Medina River, a tributary of the San Antonio River. The total drainage area downstream of Mitchell Lake Dam (excluding the drainage area of the lake) that contributes runoff to Cottonmouth Creek (and ultimately to the Medina River) is 0.80 square miles.

1.5.1 Non-Federal Sponsor

San Antonio Water System, San Antonio, Texas

In 1992, SAWS was established as "a single utility responsible for water, wastewater, stormwater and reuse…SAWS was created through the consolidation of three predecessor agencies: the San Antonio Water Board (the previous city-owned water supply utility); San Antonio Wastewater Department (a department of San Antonio government responsible for sewage collection and treatment); and the Alamo Water Conservation and Reuse District (an independent city agency created to develop a system for reuse of San Antonio's treated wastewater).

"In the consolidation, SAWS was also assigned the responsibility for complying with federal permit requirements for treatment of San Antonio's stormwater runoff. In addition, the water resources planning staff of San Antonio Planning Department was realigned to the new agency to give it a complete package of related functions.

"An important component of SAWS' planning role is the responsibility to protect the purity of the city's water supply coming from the Edwards Aquifer, including enforcing certain city ordinances related to subdivision development."[1]

NON-FEDERAL SPONSOR SUPPORT

The San Antonio Water System presented their support for the Tentatively Selected Plan during the Tentatively Selected Plan Milestone on 25 September 2019. They stated:

- The proposed project has the potential to provide substantial ecological benefits for the Mitchell Lake habitat.
- We anticipate the proposed plan will receive positive support during the public review process.
- There are exciting things happening in the Mitchell Lake area.

SAWS has since indicated that they are "willing and able to participate as the Sponsor for the Mitchell Lake Aquatic Ecosystem Restoration, in partnership with the U.S. Army Corps of

[1] https://www.saws.org/about-saws/history-chronology/

Engineers (USACE), to cooperatively design and construct" Recommended Plan 6 per their Letter of Intent dated 11 June 2021.

1.5.2 Congressional Representatives

Representatives to Congress from the Study Area / Project Area are:

1. Senator – John Cornyn
2. Senator – Ted Cruz
3. Representative 23rd District – Tony Gonzales

1.6 Prior Reports and Existing Water Projects

1.6.1 Prior Reports

1991. CH2M Hill. *Mitchell Lake Constructed Wetlands Feasibility Study*.

"Special Condition 19 of the Texas Water Commission's discharge permit for the Rilling Road Wastewater Treatment Plant (WWTP) required development of a reclamation plan for the polders and related facilities. A previous evaluation of reclamation alternatives conducted by the Mitchell Lake Recovery Advisory Subcommittee identified excavation of the remnant sludge in the basins, capping of the-sludge material with clean fill and creation of a permanent wetland system. Sludge excavation and capping would have negative impacts on bird habitat and they would cost considerably more than wetland creation.

"This report outlines a reclamation plan for the Mitchell Lake polders and decant basins. The proposed modification to the polder and decant basins satisfies TWC's requirement to provide a closure plan that allows for natural decomposition of waste sludge and minimizes odor problems. The proposed constructed wetland system will provide an appropriate response to required mandates for the cleanup and restoration of the area. In addition, the wetland system will provide ancillary benefits of improved wildlife habitat and aesthetics, creation of additional wetland areas and educational and recreational opportunities."

1997. Simpson Group. *Wetlands Feasibility Study*.

"In July 1996, Simpson Group completed a Feasibility Study Report for the utilization of water stored in Mitchell Lake as source water destined for SAWS Central-East Reuse Project. In that report, one option proposed that the existing Polder Complex could be used as a wetland to generate high quality water that would be suitable for non-potable use without further treatment. SAWS subsequently directed Simpson Group to further explore the wetland treatment option utilizing the existing Mitchell Lake polder complex area as a means of improving the quality of the Mitchell Lake system. This report contains the findings and recommendations for meeting the goals specified by SAWS.

"The recommended project envisions that LCWRC [Leon Creek Water Recycling Center] effluent be transported to the existing Basin No.5 pumping station… a force line will transport water to Bird Pond which will also be planted with wetland vegetation… A strip of Mitchell Lake along the southern polder complex dike will be planted with wetland vegetation… Water levels in the wetlands will be regulated by adjustable mechanical weirs… dike top elevations be lowered from an elevation of 530’ to about 525’ above (NAVD88)…”

2000. SAWS. *Mitchell Lake Master Implementation Plan*.

“The purpose of the Mitchell Lake Master Implementation Plan is to implement the goals established by SAWS Board of Trustees through the creation of a world-class wildlife refuge and a significant environmental experience for all ratepayers.

“The [Wetland Feasibility Study] WFS included several key recommendations that are summarized as follows:

- Relocation of influent water pipeline from west side of lake to polder area.
- Improvements to polder complex to include level and flow controls, improvements to berms and addition of wetland plantings.
- Re-establishment of upland ponds to include Bird and Skip’s Ponds.
- Development of below lake wetlands (BLW) for the purpose of water treatment, discharge permit compliance and habitat improvement.”

2006. US Army Corps of Engineers. *Olmos Creek Section 206 Aquatic Ecosystem Restoration Project, Bexar County, Texas*.

“Description of Action. The USACE has developed a Planning Design Report and integrated Environmental Assessment (EA) to assess the potential impacts to the environment that may result from the implementation of the Section 206 Aquatic Ecosystem Restoration Project on Olmos Creek, San Antonio, Bexar County, Texas. The recommended alternative would include the restoration of ~73 acres of riparian bottomland hardwood forest adjacent to Olmos Creek. Approximately six acres of aquatic habitat within Olmos Creek would be restored and improved by reducing erosion and increasing stream shade providing better habitat for a variety of freshwater species. Additionally, the recommended alternative would restore over 17 acres of riparian grassland by planting native grasses. Riparian grassland restoration would provide additional benefits to the study area by increasing habitat and species diversity and improving aquatic habitat conditions.”

2014. ARCADIS. *Hydrologic and Hydraulic Analysis – Mitchell Lake Dam, Cottonmouth Creek, Bexar County, Texas.*

“SAWS retained ARCADIS US, Inc. (ARCADIS) to conduct a hydrologic and hydraulic study of Mitchell Lake Dam located in southern Bexar County within San Antonio. The purpose of this study is to evaluate the capacity of the existing primary and emergency spillways in accordance with Texas Commission on Environmental Quality (TCEQ) recommendations. This analysis also evaluates the discharges released from the lake to Cottonmouth Creek and the impact of current conditions on US Highway 281, located approximately 1.3 miles downstream of the dam.

CONCLUSION:

“The results of this hydrologic and hydraulic analysis indicate that the existing spillway at Mitchell Lake Dam is adequate to pass 28% of the Probably Maximum Flood, as required by TCEQ. Multiple HEC-HMS and HEC-RAS model runs were evaluated to determine the adequacy of the spillway. The dam is predicted to overtop during a storm of approximately 40% of the PMF. Based on TCEQ requirements for existing conditions, no modifications to the dam are necessary at this time. Future conditions and breach analyses are not included as part of this study.

“For maintenance purposes, SAWS should note that the primary spillway gates at elevation 520.73’ (NAVD88) could become engaged once the watershed receives 2” of rain in a 24-hour period. The emergency spillway at elevation 527’ (NAVD88) could overtop with 11” of rain and the remainder of the dam at elevation 528’ (NAVD88) could overtop after 12” of rain.”

2014. The USACE. *Westside Creek Ecosystem Restoration, San Antonio, Texas*.

“The purpose of the San Antonio Channel Improvement Project (SACIP) General Re-evaluation Report (GRR) and Environmental Assessment (EA), Westside Creeks (WSC), Ecosystem Restoration, San Antonio, Texas, is to identify ecosystem restoration measures to restore the riverine ecosystem within the WSC that is severely degraded due to the construction and continuing maintenance of the authorized and constructed SACIP and identify recreation opportunities that are compatible with the ecosystem restoration objectives. The GRR and integrated EA describe the characteristics of the existing and future without-project (FWOP) conditions, water related resource problems and opportunities, planning objectives and constraints, formulation, evaluation and comparison of alternatives and identifies a recommended plan.

”The recommended plan is the combined National Ecosystem Restoration (NER)/National Economic Development (NED) plan. The NER plan, Alternative 6, would restore 67% of the lower trophic organism carrying capacity possible for the WSC riverine system and provide 114% improvement in habitat quality over the no action alternative for 11 miles along the WSC. At maturity (75 years), the NER plan would provide 222 acres of mixed riparian meadow and riparian woody vegetation. The 6.5-mile pilot channel network would incorporate 146 pool-riffle-run sections and 143 off-channel slack water areas in the existing SACIP right of way contributing to the restoration of aquatic habitat. The implementation of the NER plan would provide a total migratory bird diversity benefit of 101 average annual avian community units, which represents 82% of the diversity benefits available in the system, at a first cost (October 2013 prices) of approximately $61.3 million. The NED plan for recreation would provide 44,600 linear feet of concrete walk, jog and bike trails. In addition to trails, other components include shade structures (6), interpretive/directional signage (50), benches (15), water fountains (15), picnic tables with pads (23) and trash receptacles (23). The first cost for recreational facilities is approximately $6.2 million. First cost of the combined NER/NED plan is estimated at $67.5 million in October 2013 prices.”

1.6.2 Existing Water Projects

Eagleland Section 1135, San Antonio, Texas - The Eagleland project is in San Antonio along the portion of the SACIP from the Alamo Street dam downstream to the Lone Star Boulevard Bridge. Clearing of the floodway and channel re-alignment for the SACIP destroyed much of the high-quality riparian habitat. This project incorporated ecosystem restoration and recreation purposes into the existing Flood Risk Management project while maintaining the existing FRM performance. The Eagleland project restored approximately one mile of the San Antonio River, relocating the base flow channel to meander primarily along the outside of the existing bends.

Olmos Creek Section 206, Bexar County, Texas – The purpose of this feasibility study was to identify areas of ecosystem degradation, evaluate measures to restore important ecological resources and recommend a plan for implementation, if one could be found that was technically feasible, environmentally acceptable and supported by the non-Federal partner. The goal of the recommended restoration alternative was to restore aquatic habitat and the associated riparian community to benefit the variety of resident and migratory wildlife that utilize the study area.

Olmos Creek is located near the central portion of Bexar County, Texas, approximately five miles north of San Antonio's central business district. The study area was located on lands owned by the City of San Antonio and the City of Alamo Heights within the Olmos Basin Reservoir. The study area comprised of grassland, remnant bottomland forests and in-stream aquatic habitat, lies within the Olmos Creek watershed and was found to be suitable for ecosystem restoration.

The recommended alternative consisted of the restoration of ~73 acres of bottomland hardwood habitat, 17 acres of native riparian grasslands and six acres of in-stream aquatic habitat.

SACIP – Mission Reach – The SACIP was originally authorized under the Section 203 of the Flood Control Act of 1954 as part of a comprehensive plan for flood protection on the Guadalupe and San Antonio Rivers. The project was subsequently modified in Section 103 of the Water Resources Development Act (WRDA) of 1976 and again in Section 335 of the WRDA of 2000 to include ecosystem restoration and recreation as authorized project purposes. The SACIP-GRR was initiated at the request of the SARA. A cost sharing agreement for the feasibility study was executed in November 2001.

The Mission Reach begins near Lone Star Boulevard and extends downstream to just south of Interstate Highway-410. The pilot channel has been highly altered over the years due to erosion and implementation of erosion control measures. To maintain the flood carrying capacity of the SACIP, vegetation is regularly mowed to a height of 6" or less. With rare exception, there are no trees or shrubs within the floodway channel. A large portion of the pilot channel is lined with large blocks of concrete riprap. Due to the mowing regime and the riprap lining the channel, no semblance of a functioning riparian zone exists for the entire length of the Mission Reach.

The study area totaled 483 acres in size including 355 acres within the existing SACIP and 128 outside of the SACIP. Of this acreage, 69.23 acres was aquatic, 394.21 acres was riparian and 19.56 as other (concrete, non-vegetated, etc.). The future without-project Average Annual Habitat Unit (AAHU) totaled 55.4 (26.7 aquatic and 27.8 riparian).

The recommended plan provided 113.40 total acres of total aquatic habitat and 320.14 total acres of riparian habitat. Another 49.46 acres was categorized as other (vegetated pilot channel, non-vegetated surfaces). The aquatic habitat produced 77.25 total AAHUs and the riparian habitat produced 103.72 total AAHUs. These represented an increase over the existing condition of 44.17 acres of aquatic habitat and 50.56 annual habitat units (HU); and a decrease in riparian acres of 74.07 acres, but an increase in annual HUs of 75.89. The NER plan was also the recommended plan.

1.7 Planning Process

The USACE plan formulation process, as specified in ER 1105-2-100 Planning Guidance Notebook, was used to develop measures for problem solving and identifying opportunities and ultimately to develop an array of comprehensive Plans from which a plan is recommended for implementation.

This section presents the rationale for the development of a Tentatively Selected Plan (TSP). It describes the USACE iterative six-step planning process used to develop, evaluate and compare the array of management measures and preliminary Plans that have been considered. The six steps used in the Plan formulation process include:

1. **Identifying Problems and Opportunities:** The specific problems and opportunities to be addressed in the study are identified and the causes of the problems are discussed and documented. Planning goals are set, objectives are established and constraints are identified.
2. **Inventorying and Forecasting Resources:** Existing and FWOP (No Action) conditions are identified, analyzed and forecast for a 50-year period of analysis. The existing condition resources, problems and opportunities critical to plan formulation, impact assessment and evaluation are characterized and documented.
3. **Formulating Plans:** Plans are formulated that address the Planning objectives. An initial set of Plans are developed and evaluated at a preliminary level of detail and are subsequently screened into a more final array of Plans. Each plan is evaluated for its costs, potential effects and benefits and is compared with the No Action Plan for the 50-year period of analysis.
4. **Evaluating Plans:** Plans are evaluated for their potential to meet specified objectives and constraints and for effectiveness, efficiency, completeness and acceptability. The impacts of Plans are evaluated using the system of accounts framework NED, Environmental Quality, Regional Economic Development and Other Social Effects specified in the USACE' Principles and Guidelines and ER 1105-2-100 (Economic and Environmental Guidelines for Water and Related Land Resources Implementation Studies, U.S. Water Resources Counsel, March 10, 1983).
5. **Comparing Plans:** Plans are compared with one another and with the No Action Plan (FWOP). Results of analyses are presented (e.g., benefits and costs, potential environmental effects, trade-offs, risks and uncertainties) to prioritize and rank Plans.
6. **Selecting the Recommended Plan:** A plan is selected for recommendation and related responsibilities and cost allocations are identified for project approval and implementation.

1.7.1 Problems and Opportunities

Water resources projects are planned and implemented to solve problems, meet challenges and seize opportunities. In the Planning setting, a problem can be thought of as an undesirable condition, such as those expressed by the public in the Main Report, Chapter 8, Public Scoping. An opportunity offers a chance for progress or improvement of the situation. The identification of problems and opportunities gives focus to the Planning effort and aids in the development of planning objectives. Problems and opportunities can also be viewed as local and regional resource conditions that could be modified in response to expressed public concerns. This section identifies the problems and opportunities in the study area based on the assessment of existing and expected FWOP conditions.

The objective of the USACE with respect to ecosystem restoration is to restore degraded ecosystem structure, function and dynamic processes to a less degraded, more natural condition. Restored ecosystems should mimic, as closely as possible, conditions, which would occur in the area in the absence of human changes to the landscape and hydrology. Indicators of success would include the presence of a large variety of native plants and animals, the ability of the area to sustain larger numbers of certain indicator species or more biologically desirable species and the ability of the restored area to continue to function and produce the desired outputs with a minimum of continuing human intervention. Those restoration opportunities that are associated with wetlands, riparian and other floodplain and aquatic systems are most appropriate for USACE involvement.

General Problem Statement: The structure and / or function of the Mitchell Lake aquatic ecosystem is impaired through its operation as part of a sewage treatment facility. The quantity and quality of the wetland habitat no longer supports the historic level of organism diversity at all trophic levels. The degraded aquatic habitat within the study area fails to support the diversity of aquatic plants and macro invertebrates that form the foundation of wetland biotic ecosystems.

Specific Problem and Opportunity Statements

Changes in and around, Mitchell Lake (Chapter 1, Study Area, Mitchell Lake History) have caused the historic tule (tall emergent wetland vegetation) wetland system to degrade resulting in hyper-eutrophic waters, reductions in habitat quality and quantity and reductions in wildlife diversity.

Problems:

1. There is loss of fish and wildlife habitat quality and diversity, particularly for migratory birds.
2. There is little aquatic connectivity between the upstream and downstream habitats. Nutrient loads will continue to increase.
3. There are invasive species on site that out-compete native flora. These invasive species will continue to spread.
4. There are extreme daily variations in pH and O_2 levels leading to hypereutrophic conditions.

Opportunities exist to:

1. reconnect the upstream and downstream hydrologies.
2. improve water quality through ecosystem restoration.
3. provide additional recreation and ecotourism benefits to the community

1.7.2 Planning Objectives and Constraints

An objective is a statement of the intended purposes of the planning process; it is a statement of what a Plan should try to achieve. More specific than goals, a set of objectives effectively constitutes the mission statement of the Federal/non-Federal planning partnership.

Our planning partnerships exist in a world of scarcity where it is not possible to do everything. Our choices are constrained by several factors. Planning is no exception. An essential element of any planning study is the set of constraints confronting the planners. A constraint is a restriction that limits the extent of the planning process. Constraints, like objectives, are unique to each planning study.

Federal Goal

The 1983 Principles and Guidelines (P&G) states that the Federal objective of water and related land resources project planning is to contribute to NED consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders (EO) and other Federal planning requirements. Water and related land resources project plans shall be formulated to alleviate problems and take advantage of opportunities in ways that contribute to this objective.

The P&G use of the term objective should be distinguished from study planning objectives, which are more specific in terms of expected or desired outputs. The P&G's objective (Federal objective) may be considered more of a National goal.

The NER Plan

For ecosystem restoration projects, a plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, shall be selected. The selected plan must be shown to be cost effective and justified to achieve the desired level of output. This plan shall be identified as the NER Plan.

Specific Study Planning Objectives for the Mitchell Lake

1. Increase the areal extent and quality of fish and wildlife habitat in the study area for the 50-year Period of analysis
2. Increase the floral and faunal species diversity and richness in the study area for the 50-year Period of analysis

Specific Planning and Institutional Constraints

Institutional Constraints:

1. Avoid increasing flood risks
2. Plans must be consistent will existing Federal, State and Local laws.
3. Ecosystem restoration may not principally result in treating, or otherwise abating pollution, or other compliance responsibilities of the NFS.
    a. The NFS is under an Administrative Order (AO) by the EPA to improve water quality of Mitchell Lake water prior to it entering the Medina River.

Specific Planning Constraints:

1. avoid mobilization of pollutants that would exceed EPA water quality criteria limits
2. avoid currently developed areas

1.7.3 Key Planning Assumptions

1. The NFS will have to perform real estate actions prior to project implementation.
    - Some measures and Plans, require the NFS to acquire a Deed with Surface [rights] Waiver. Some measures and plans require the NFS to acquire a Deed with Surface Rights Waiver from existing mineral rights holders.
    - Measures and Plans, will not require existing gas or oil wells to be acquired and capped by the non-federal sponsor.
    - Some measures and Plans, require the NFS to acquire lands downstream of the dam.

- Some measures and Plans, may require a waterline / culvert to cross the natural gas pipeline.
- No measures, or Plans, will require real estate actions involving the existing natural gas pipeline easement.

2. The non-federal sponsor will construct bulrush water polishing wetlands along Cottonmouth Creek sufficient to address responsibilities under their EPA water quality AO.
3. TCEQ will allow the NFS to modify their Water Rights to allow water from Mitchell Lake to be used for this project, if needed.
4. Engineer Research and Development Center (ERDC) will be able to develop a plant community that will flourish in the existing lake sediment and water quality conditions.
5. The NFS may discontinue Operations and Maintenance of Non-Structural / Non-Mechanical elements of any implemented NER project after 10 years
6. The existing pump, located at the southwest corner for the polders, will not be sufficient to pump water to the Bird Pond Wetland without significant modifications to the pump.
7. Possible future climate changes will have no effect on Plan success.

1.7.4 Key Uncertainties and Their Risks

1. The City of San Antonio does not currently own the mineral rights for the Bird Pond Wetlands, Central Wetlands and Skip's Pond areas.
    a. Risk – Medium. NFS doesn't own subsurface mineral rights within the NER project footprint.
        i. Mitigation – USACE has recommended and informed the NFS that they will be required to restrict the surface rights from the mineral rights holder for the project identified lands by restricting the mineral owner's use of the surface and subordinating the mineral estate for SAWs to have the right to flood the project lands to proceed forward with the project as the footprint exists at this time (Appendix F – Real Estate).
    b. Risk – Medium. Real estate costs necessary for project implementation may make the Recommended Plan uncompetitive against other congressionally authorized ecosystem restoration projects.
        i. Mitigation – Formulate to the extent possible to avoid non-NFS properties.
    c. The risk is addressed through real estate requirements per USACE policies and guidance during feasibility and to be addressed again during design and implementation. No change to risk significance.
2. A natural gas pipeline easement runs across the Mitchell Lake property north and west of the project area.
    a. Risk – Low. Pipeline and easement is within the project footprint.
        i. Mitigation – North Easement Crossing is a shallow open-air ditch.
        ii. Mitigation – West Easement Crossing will not interfere with the pipeline or ease of access for operations and maintenance.

   b. This risk was addressed through plan formulation and project design. Risk in now non-existent.

3. Downstream wetlands along Cottonmouth Creek are contingent upon a water supply from the treatment wetlands proposed by SAWS.

   a. Risk – Medium. Should the non-federal sponsor not construct water treatment wetlands to address their EPA needs, a new water source would be required.

      i. Mitigation – NFS will acquire lands downstream of the dam.

      ii. Mitigation – 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.

   b. This risk was addressed through plan formulation. Risk is now non-existent.

4. There is little uncertainty regarding the need for additional water rights for Plan success.

   a. Risk – None.

      i. Mitigation – All of the water required to maintain the Mitchell Lake water level of 518.5' (NAVD88) or 1,936-acre feet / year, is obtained from the Leon Creek Wastewater Treatment Plant. Per the NFS, "Historically, the volume allocated for Mitchell Lake has been 3,583 af/yr. This was the volume that modeling in the 1990s suggested would be needed to maintain lake levels in a very dry year."

   b. This risk was addressed through hydrologic and climate modeling. Risk is now non-existent.

5. Restoration of fringe / cove wetlands may not be successful.

   a. Risk – Low. Mitchell Lake sediments may be too impaired to support emergent and aquatic vegetation.

      i. Mitigation – Work with specialists at the ERDC to formulate plant communities appropriate to site conditions, including water and sediment quality.

   b. This risk was addressed to the practical extent possible through coordination with the experts at ERDC. Risk remains low post-implementation.

6. It is impossible to positively determine whether the NFS will continue to maintain non-structural / non-mechanical elements of the TSP past the 10-year requirement.

   a. Risk – Medium.

      i. Mitigation – Encourage the NFS to enter into agreements with local NGOs and other interested parties, to operate and maintain these elements should they be unable.

   b. This risk was addressed to the practical extent possible through communications with the NFS. Under current guidance, this risk will remain post-implementation for all ecosystem restoration projects.

7. Existing pumps are not sufficient to move enough water through the system for ecosystem restoration sustainability.
    a. Risk – None.
        i. Mitigation – Project costs include new pumps, pipeline, culverts and water control structures to move water through the project area.
    b. This risk was address through plan formulation and engineering expertise.
8. Construction projects pose a potential contamination risk from petroleum or chemical spills.
    a. Risk – Low.
        i. Mitigation – Contractors would be required to prepare and follow a site-specific Spill Prevention Plan during construction, which would include use of BMPs such as proper storage, handling and emergency preparedness, reducing the risk of such contamination.
    b. This risk is present in all implementation activities that require the use of heavy equipment.
9. There is little uncertainty that possible changes to local climate will negatively affect Plan success.
    a. Risk – None.
        i. Mitigation – None required. Per WRDA 2016 Section 1161, the NFS is not required to maintain non-structural / non-mechanical ecosystem restoration measures 10 years after ecological success has been determined.
    b. Risk – Low. Climate modeling Scenario 1 – Hotter / Wetter
        i. Mitigation. None required. The proposed plant palette is comprised of native, site-specific species. Each will be locally obtained and have been chosen for their hardiness, drought tolerance and for poor water and soil conditions.
        ii. Mitigation. None required. Should the local nine sq.mi. watershed experience increases in precipitation, wetland species would fare better. The FWOP condition is that the NFS will maintain Mitchell Lake at 518.5' msl or 1,936-acre feet / year. When additional stormwater enters the system, water flows out of the uncontrolled spillway (Figure 8 and Figure 9) into Cottonmouth Creek and on into the Medina River.
    c. Risk – Low. Climate modeling Scenario 2 – Hotter / Drier
        i. Mitigation. None required. The proposed plant palette is comprised of native, site-specific species. Each will be locally obtained and have been chosen for their hardiness, drought tolerance and for poor water and soil conditions.
        ii. Mitigation. None required. Water for Mitchell Lake comes from stormwater runoff and the Leon Creek WWTP. The FWOP condition is that the NFS will maintain Mitchell Lake at 518.5' asml or 1,936-acre feet / year. Per the NFS, "Historically, the volume allocated for Mitchell Lake has been

3,583 af/yr. This was the volume that modeling in the 1990s suggested would be needed to maintain lake levels in a very dry year."

d. Risk – Low. Climate modeling Scenario 3 – Colder / Wetter

    i. Mitigation. None required. Scientific consensus anticipates global warming and not cooling.

    ii. Mitigation. None required. Should the local nine sq.mi. watershed experience increases in precipitation, wetland species would fare better. The FWOP condition is that the NFS will maintain Mitchell Lake at 518.5' asml or 1,936-acre feet / year. When additional stormwater enters the system, water flows out of the uncontrolled spillway (Figure 8 and Figure 9) into Cottonmouth Creek and on into the Medina River.

e. Risk – Low. Climate modeling Scenario 4 – Colder / Drier

    i. Mitigation. None required. Scientific consensus anticipates global warming and not cooling.

    ii. Mitigation. None required. Water for Mitchell Lake comes from stormwater runoff and the Leon Creek WWTP. The FWOP condition is that the NFS will maintain Mitchell Lake at 518.5' asml or 1,936-acre feet / year. Per the NFS, "Historically, the volume allocated for Mitchell Lake has been 3,583 af/yr. This was the volume that modeling in the 1990s suggested would be needed to maintain lake levels in a very dry year."

f. This risk is present in all USACE proposed activities. For this project, the risk is low due to guaranteed amounts was water from the wastewater treatment plant in cases of drought. In cases of high precipitation, any waster that raises the lake above 518.5' leaves the system. Temperatures can't be mitigated for.

10. 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.

    a. Risk - Low.

        i. Mitigation. 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.

    b. This risk was reduced to the extent practicable through plan formulation and environmental technical expertise of the PDT. Since no models are ever 100% accurate, this risk will always remain.

11. 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.

a. Risk - Medium.

    i. Mitigation: 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.

b. This risk was addressed. See Appendix C.

2 Existing Conditions

Existing conditions are defined as those conditions that would exist within the study area, at the time of the study. The term baseline is also often used to refer to the existing conditions at the time of a measurement, observation, or calculation and may be used occasionally throughout this report.

A quantitative and qualitative description of resources within the study area is characterized, for both existing and future conditions. The second step of plan formulation and the starting point in any the USACE analysis, is to develop an accurate picture of the existing conditions (Chapter 2) and FWOP conditions (Chapter 3).

The resources discussed in Step 2 and again as part of the FWP condition (Chapter 6), are:

1. Hydrology and Hydraulic Engineering.
2. Economics.
3. Environmental Resources.
4. Cultural Resources.
5. Environmental Engineering, including Hazardous, Toxic and Radioactive Waste (HTRW).
6. Geology and the Structural Setting and
7. Socioeconomics.

2.1 Hydrology, Hydraulics and Sedimentation

2.1.1 Watershed

Mitchell Lake is in the Medina River watershed, which is a major tributary of the San Antonio River Basin. The Mitchell Lake drainage area (above Mitchell Lake Dam) is 9.76 square miles. The topography in the watershed around Mitchell Lake is generally flat with slopes less than one% but with more relief on the north side of the watershed with slopes between one% and four%. Most of the watershed is open space with a mix of grass and small trees. The primary developments in the area are San Antonio's Police Academy, Mission Del Lago and the Texas A&M University San Antonio campus. There are also low-density residential and commercial developments along Pleasanton Road between Loop 410 and the dam. A series of small lakes exist between Loop 410 and the dam - these small lakes include Canvasback, Little Canvasback, Timber and Teacup Lakes. In addition, Bird Pond and several smaller ponds are located along the tributaries north of the lake (Appendix A – Hydrology, Hydraulics and Climate, Chapter 1).

2.1.2 Climate

2.1.2.1 General Data

San Antonio is located in the south-central portion of Texas on the Balcones escarpment. Northwest of the city, the terrain slopes upward to the Edwards Plateau and to the southeast it slopes downward to the Gulf Coastal Plains. Soils are blackland clay and silty loam on the Plains and thin limestone soils on the Edwards Plateau. With its location on the northwest edge of the Gulf Coastal Plain, San Antonio experiences a modified subtropical climate. During the summer the climate becomes more tropical like with prevailing south and southeast winds. The moderating effects of the Gulf of Mexico prevent extremely high temperatures. Summers are usually long and hot with daily maximum temperatures above 90ºF more than 80% of the time. In many years, summer conditions continue into September and sometimes to October. The average monthly temperatures range from the 50sºF in winter to 80sºF in summer. The historic recorded high and low temperatures occurred 6 September 2000 (111ºF) and 21 January 1949 (0º F) (Appendix A – Hydrology, Hydraulics and Climate, Chapter 1).

2.1.2.2 Precipitation

San Antonio is situated between a semi-arid area to the west and a much wetter and more humid area to the east, allowing for large variations in monthly and annual precipitation amounts. The average long-term annual precipitation for San Antonio is around 29", although, it may range from as low as 10 to near 50" from one year to another. Precipitation extremes vary from 10.11" in 1917 to 52.28" in 1973. Most precipitation occurs in May, June, September and October. During some of these events, rain has exceeded 5" in several hours and caused flash flooding. The net lake evaporation rates range from 0.08" per day in January to 0.29" per day in August. Monthly and yearly precipitation totals from 2000 to 2019 are shown in Table 5. Yearly precipitation totals from 1934 – 2018 are shown in Figure 12 (Appendix A – Hydrology, Hydraulics and Climate, Chapter 1).

Table 5 - Monthly and Yearly Precipitation 2000 - 2019

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2000	1.40	2.20	0.91	1.22	3.59	7.61	0.34	0.16	2.65	5.62	8.58	1.57	35.85
2001	2.85	0.70	2.77	2.29	2.48	3.39	0.50	7.83	4.05	2.06	4.37	3.43	36.72
2002	0.37	0.42	1.19	3.82	2.26	1.48	16.92	0.54	7.02	7.64	2.08	2.53	46.27
2003	0.99	2.15	0.77	0.17	0.12	2.90	8.12	1.65	9.21	1.94	0.32	0.11	28.45
2004	2.31	1.73	2.35	5.02	1.80	9.47	0.61	1.10	1.92	9.47	9.46	0.08	45.32
2005	2.18	2.42	2.00	0.01	2.97	0.81	2.10	1.22	1.39	1.14	0.20	0.10	16.54
2006	0.35	0.62	1.36	1.40	3.80	1.63	1.41	0.03	4.11	3.44	0.75	2.44	21.34
2007	4.33	0.08	7.24	4.61	3.35	6.47	11.76	6.77	1.09	0.75	0.40	0.40	47.25
2008	0.42	0.20	1.82	0.83	0.66	0.01	3.86	4.98	0.46	0.26	0.01	0.25	13.76
2009	0.27	0.65	2.51	2.05	1.57	0.45	0.48	0.45	6.35	11.90	2.09	1.92	30.69
2010	4.45	4.38	2.09	3.57	4.48	4.24	3.68	0.07	9.37	0.17	0.26	0.63	37.39

2011	2.66	0.49	0.01	0.03	0.84	1.58	0.96	0.15	2.93	3.28	1.81	2.84	17.58
2012	3.99	5.63	3.24	0.04	9.84	0.11	3.79	2.41	7.31	2.40	0.27	0.37	39.40
2013	2.83	0.10	0.95	2.77	13.19	2.02	0.73	0.85	3.70	2.81	1.50	0.55	32.00
2014	0.23	0.42	1.06	0.68	4.97	5.38	3.25	0.08	1.77	1.91	7.21	1.24	28.20
2015	3.67	0.53	2.97	7.54	8.57	6.42	0.07	0.29	2.32	7.78	2.58	1.48	44.22
2016	1.38	1.55	3.56	6.19	9.14	2.39	0.33	4.91	6.30	0.16	1.79	6.22	43.92
2017	2.72	3.61	2.09	2.89	1.76	0.40	0.16	5.87	2.80	0.46	0.53	4.04	27.33
2018	0.28	1.91	4.02	0.36	0.97	0.71	4.87	0.62	16.86	6.47	1.78	2.35	41.20
2019	1.63	0.47	0.46	3.47	3.30	5.51	0.14	0.31	1.45	4.02	0.74	0.52	22.02

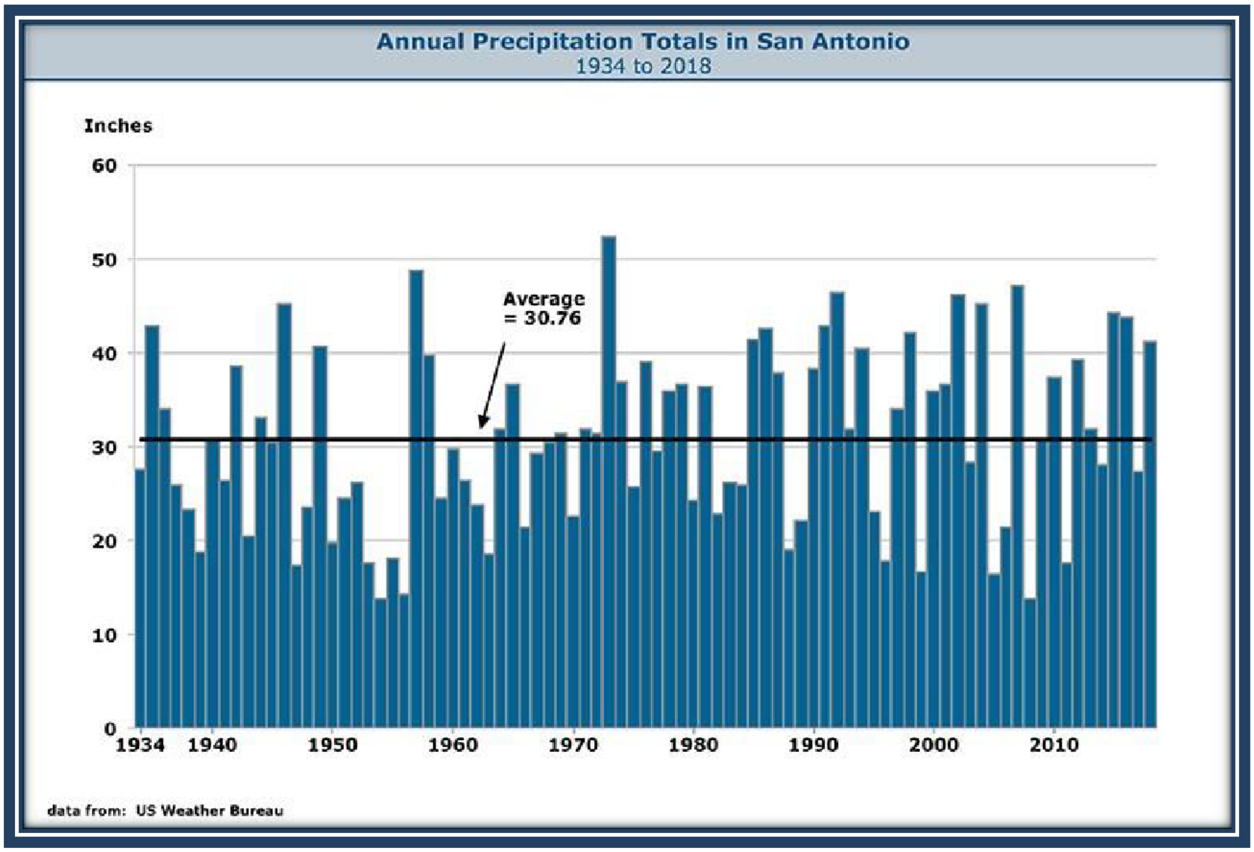

Figure 12 - 1934 through 2018 Precipitation Totals for San Antonio, Texas

2.1.3 Precipitation Analysis

The Natural Resources Conservation Service (NRCS) Curve Number Method, formerly the Soil Conservation Service (SCS) Curve Number Method, was used to determine rainfall losses. The NRCS Curve Number Method requires input parameters such as subbasin area, curve numbers (CNs), hydrograph type, design storm rainfall depth, basin lag times and channel routing parameters. "The SCS Type III rainfall distribution was selected as the rainfall distribution curve for this project. Twenty-four-hour rainfall depths for the 2-, 5-, 10-, 25-, 50-, 100- and 500- year storm events were obtained from the City of San Antonio's Unified Development Code" and are listed in Table 6. The table shows the Mitchell Lake computed peak inflows and peak water surface elevations for the range of flood events.

NOAA Atlas 14 Volume 11 provides precipitation frequency estimates for durations of 5-minute through 60-day at average recurrence intervals of 1-year through 1,000-year for the State of Texas. NOAA Atlas 14 is the product of a study used to analyze historical rainfall data in order to update statistical hypothetical rainfall events in Texas. This precipitation data was published on 27 September 2018, after the ARCADIS study was completed. Comparisons between the Atlas 14 precipitation data and existing data for the San Antonio area show very minor differences which would not result in meaningful changes to peak flood flows.

Table 7 shows the computed peak inflows and corresponding peak water surface elevations based on model results. ARCADIS validated the computed peak flows by comparing the values to published Bexar County Flood Insurance Study flows for nearby Polecat Creek, which is of similar drainage area size. The flows compared favorably with the effective published flows. Pertinent information on Polecat Creek was not available in the ARCADIS report. No calibration information was presented in the report.

Table 6 - 24-Hour Rainfall Depths

Annual Exceedance Probability	Rainfall Depth (inches)
0.50 (2-year)	3.96
0.20 (5-year)	5.00
0.10 (10-year)	6.00
0.04 (25-year)	7.50
0.02 (50-year)	9.00
0.01 (100-year)	10.00
0.002 (500-year)	13.70

Table 7 - Mitchell Lake Peak Inflows and Water Surface Elevations (NAVD88)

Annual Exceedance Probability	Peak Inflow (cfs)	Peak Water Surface Elevation (feet)
0.50 (2-year)	1,798	522.2
0.20 (5-year)	2,697	522.6
0.10 (10-year)	3,643	523.1
0.04 (25-year)	5,181	524.0
0.02 (50-year)	6,775	525.0
0.01 (100-year)	7,863	525.6
0.002 (500-year)	12,703	527.4

2.1.4 Hydrology

The Mitchell Lake drainage area consists of different types of land use. Figure 13 shows the watershed sub-basins as defined in the HEC-HMS model.

ARCADIS developed an existing conditions hydrologic model of the Mitchell Lake watershed (Appendix A – Hydrology, Hydraulics and Climate, Chapter 2). The following is from their 2014 report:

"The US Army Corps of Engineers (USACE) Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) version 3.5 was used to develop to generate runoff hydrographs and peak inflows for the 2-, 5-, 10-, 25-, 50-, 100- and 500-year storm events. The Natural Resources Conservation Service (NRCS) Curve Number Method (CNM), formerly the Soil Conservation Service CNM, was used to determine rainfall losses. The NRCS CNM requires input parameters such as sub-basin area, curve numbers (CNs), hydrograph type, design storm rainfall depth, basin lag times and channel routing parameters. Digital soil maps obtained from NRCS were used to determine the hydrologic soil groups within the Mitchell Lake watershed. Available aerial photography, field reconnaissance of the study area and guidance presented in SCS Technical Release 55 were used to select CNs representative of the land uses and hydrologic soil groups identified within the watershed and ultimately to develop composite CNs for each modeled subarea. The SCS Type III rainfall distribution was selected as the rainfall distribution curve for this project. Twenty-four-hour rainfall depths for the 2-, 5-, 10-, 25-, 50-, 100- and 500- year storm events were obtained from San Antonio's Unified Development Code."

Mitchell Lake has a normal storage capacity of 2,640 acre-feet and a maximum storage capacity of 5,000 acre-feet (ARCADIS US Inc., 2014). The Mitchell Lake dam captures stormwater runoff from the watershed to create the Mitchell Lake reservoir (Table 8).

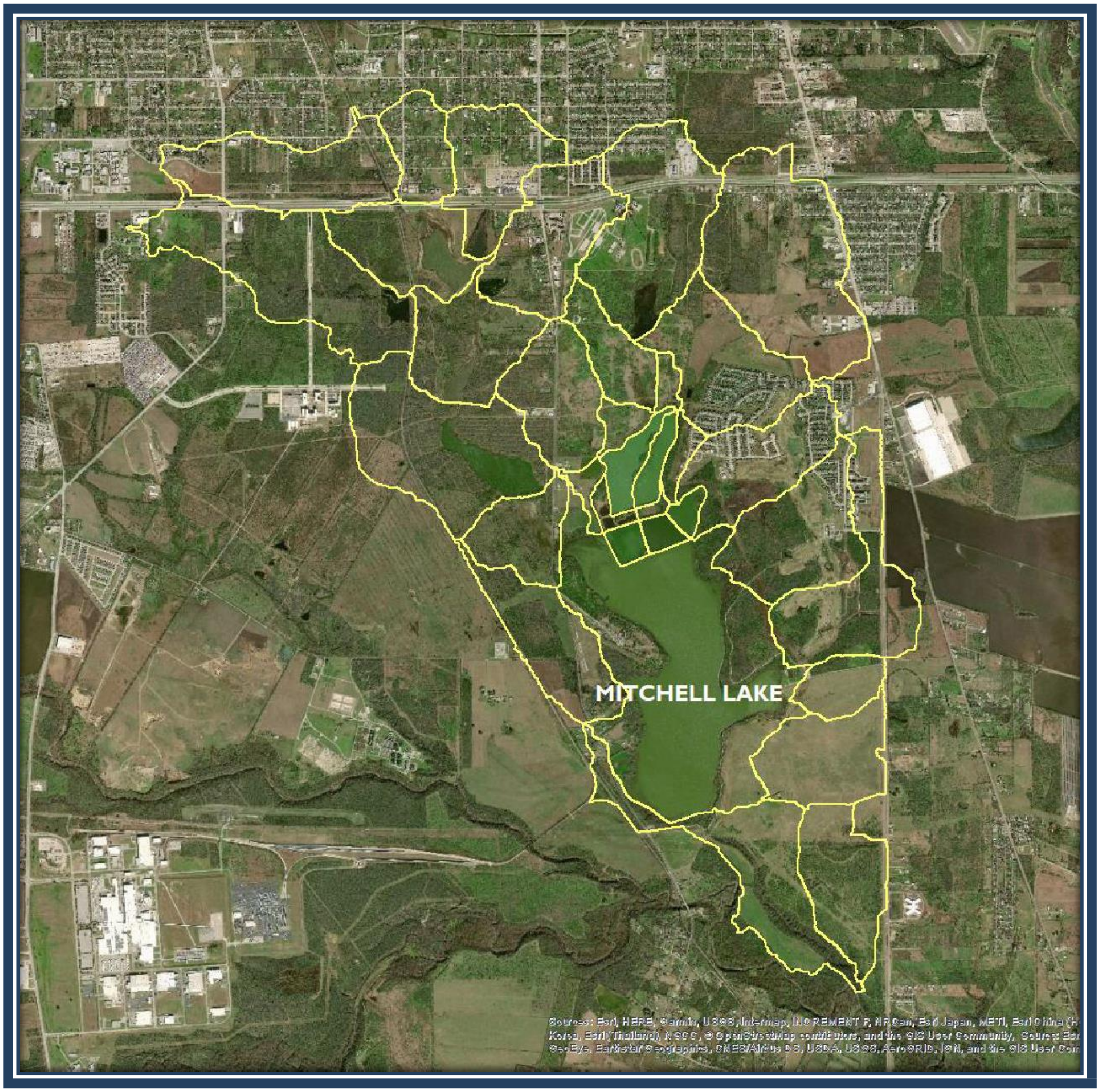

Figure 13 - Mitchell Lake Study Area Sub-Basins Used in the HEC-HMS Model

Table 8 - Peak Water Surface Elevations and Peak Inflows to Mitchell Lake (ARCADIS US Inc., 2014)

Storm Event	Peak Inflows (cubic feet / second or cfs)	Peak Water Surface Elevation in Mitchell Lake (NAVD88)(feet)
2-year	1,798	522.2
5-year	2,697	522.6
10-year	3,643	523.1
25-year	5,181	524.0
50-year	6,775	525.0
100-year	7,863	525.6
500-year	12,703	527.4
6-hour PMP	35,132	529.2
12-hour PMP	36,021	529.4
24-hour PMP	26,877	529.0
48-hour PMP	16,102	528.4
72-hour PMP	11,606	528.2
28% 12-hour PMP	6,673	526.0
40% 12-hour PMP	11,620	527.5

Outflows from the Leon Creek Wastewater Treatment Plan (Figure 14, Figure 15 and Figure 16) are used to offset evaporation in Mitchell Lake to maintain lake levels. No outflows from Mitchell Lake occur under normal operating conditions. SAWS has a contractual agreement with the Audubon Society to provide water for existing mudflats (polders) at the north end of the lake. These pumps are operated intermittently on an as-needed basis - the Audubon Society notifies SAWS when the polders water levels are getting low and the polders are filled accordingly. SAWS recently signed a 10-year contract extension with the Audubon Society to provide water.

2.1.4.1 Leon Creek Wastewater Treatment Plant

Information regarding the Leon Creek WRC, as supplied by SAWS, is as follows:

“The following charts show annual, monthly and daily volumes to Mitchell Lake. Demand is highly variable, but peak annual demand has been about 3,200 acre-feet in very dry years. When discharges are occurring, they tend to be 5-10 mgd but can sometimes be higher. Historically, the volume allocated for Mitchell Lake has been 3,583 acre-feet/year. This was the volume that modeling in the 1990s suggested would be needed to maintain lake levels in a very dry year. In practice that number turned out to be about right. But in the future, we will be maintaining a lower normal operating elevation of 518.5. Our recent modeling suggested the annual demand in that case would be 1,968 af for a flow to our constructed wetlands of 2 mgd and 2,682 acre-feet for a flow of 7 mgd. So that is the range of demand we expect in the future.”

Note that Mitchell Lake has been lowered to elevation 518.5' in the summer of 2020 (Appendix A – Hydrology, Hydraulics and Climate, Chapter 5).

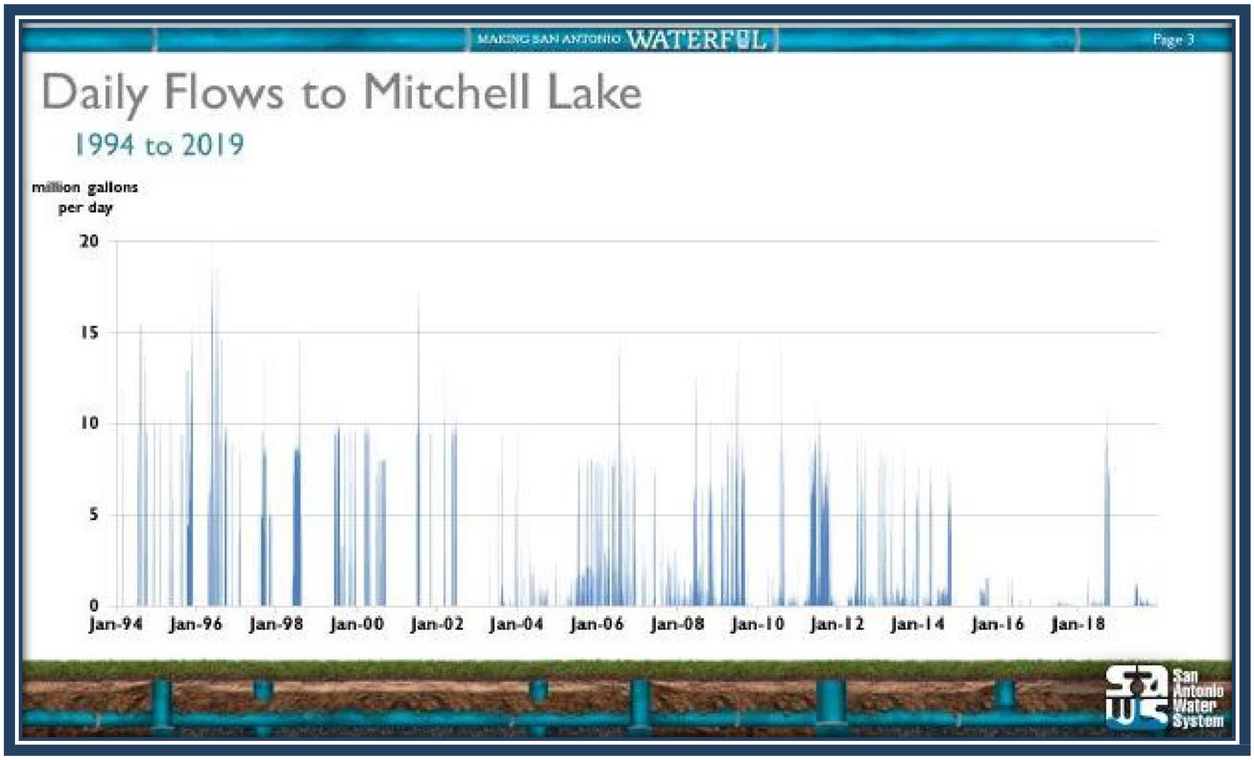

Figure 14 - Leon Creek WRC Daily Flows to Mitchell Lake

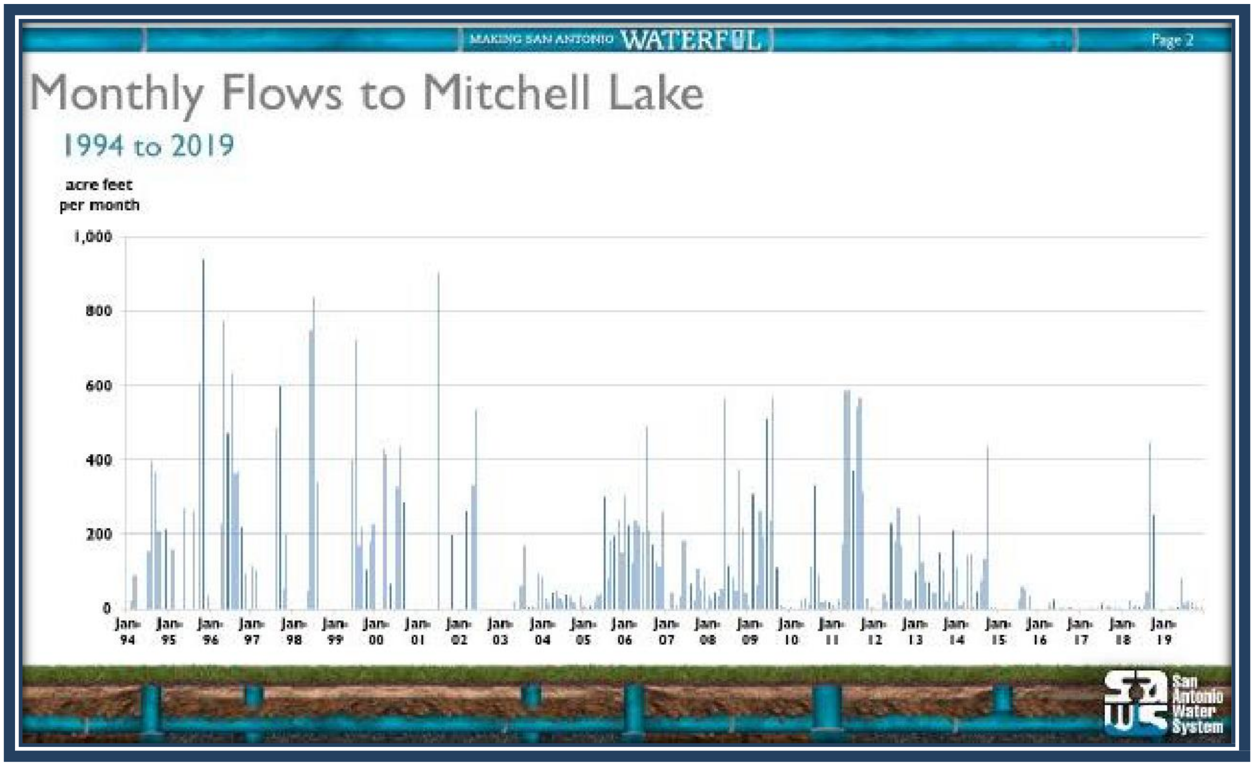

Figure 15 - Leon Creek WRC Monthly Flows to Mitchell Lake

Figure 16 - Leon Creek WRC Annual Flows to Mitchell Lake

2.1.5 Hydraulic Conditions

2.1.5.1 Mitchell Lake

Mitchell Lake has a surface area covering ~600 acres with an average water depth of less than eight feet (Figure 6). It is in southern Bexar County (Figure 5) and was purchased by San Antonio in 1901. It is currently operated and managed by SAWS. Mitchell Lake Dam was constructed in 1901 by the San Antonio Irrigation Company. In the 1970's, an eighty-seven-acre polder complex was constructed at the northern end of the lake to accept waste activated sludge from the Rilling Road WWTP. This practice continued until 1987, when the Dos Rios WWTP started operations. The upper complex currently consists of five decant basins (constructed in the 1980s) designated one through five and two polders (East and West). The polder complex area is protected by dikes and does not receive stormwater runoff (Appendix A – Hydrology, Hydraulics and Climate, Chapter 2).

The Polders complex has two pumping stations at the southern end of Basins 5 and 4 to allow for water circulation flows (Figure 11). Three pumps at the southwest corner of Basin 5 allow water to be pumped from the Mitchell Lake to the Polders complex. The water is pumped into Basin 5 then flows into Basin 1, which then flows into the West Polder. From there water will circulate to the East Polder, then to Basin 3 and finally into Basin 4. There is a single pump at the pump station on the southeast corner of Basin 4 allows for the water to be discharged back into Mitchell Lake (Appendix G – Civil Engineering, Existing Conditions).

2.1.5.2 The Dam and Spillway

Mitchell Lake Dam consists of an earthen embankment that varies from two feet to 10' in height and is ~3,200' long (Figure 17 and Table 9). Treated effluent (recycled water) is piped to the lake from the Leon Creek Water Recycling Center. Recycled lake water enters the polder complex from the main body of Mitchell Lake and is used to maintain polder water levels during dry periods (Appendix A – Hydrology, Hydraulics and Climate, Chapter 1).

The TCEQ has classified the dam failure rating as a "low" risk hazard. The TCEQ standards require dams with a hazard classification of "Low" be able to pass between 25 and 50% of the PMF without overtopping the respective dam. The TCEQ, in a letter to SAWS, recommended a 28% passage rate for the PMF. The USACE HEC-HMS was used to generate runoff hydrographs for the 2-, 5-, 10-, 25-, 50-, 100- and 500-year storm events to determine the resulting peak inflows and water surface elevation resulting from the associated storm events.

Figure 17 - Mitchell Lake Dam, Spillway and Plunge Pool

Table 9 - Mitchell Dam and Lake Pertinent Data[2]

Year Constructed	1901
Length	3,200’
Height	10’
Hazard Classification	Low
Drainage Area	9.76 square miles
Normal Water Level Elevation	520.4’ (NAVD88)
Normal Water Level Surface Area	670 acres
Normal Water Level Storage	2,640 acre-feet
Maximum Storage	5,000 acre-feet
Top of Dam Elevation	528’ (NAVD88)
Primary Service Spillway Crest	520.73’ (NAVD88)
Emergency Spillway Crest	527’ (NAVD88)
Top Width	15’

[2] 2014. ARCADIS. Hydrologic and Hydraulic Analysis – Mitchell Lake Dam, Cottonmouth Creek, Bexar County, Texas.

The primary concrete spillway located at the southeastern end of Mitchell Lake (Figure 8 and Figure 9) is ~55' wide and has eight 36" diameter gate valves (ARCADIS US, Inc. 2014). The valves are positioned at an elevation of 520.73' (NAVD88) and lead to an outfall comprised of a stone and mortar channel, which flows into Cottonmouth Creek. The gate valves are permanently open and are unable to be adjusted, essentially creating a weir structure. The uncontrolled flows over this weir structure for specific surface water elevations are provided in Table 10. There is a ninth gate, with a 36" reinforced concrete pipe, that discharges to an irrigation canal, which leads away from Cottonmouth Creek. An emergency spillway is located on the western side of the dam and is ~1,000' in length. Cottonmouth Creek then flows to the Medina River, a tributary of the San Antonio River, ~7,000' downstream of the spillway. Under the FWOP conditions, SAWS intends to retire the primary concrete spillway and build a new spillway structure; designs are unknown currently. SAWS does not allow lake levels to reach a level where the weir structure is activated. The only flows out of Mitchell Lake are those resulting from large storm events. The National Climatic Data Center storm event database reports 176 flash flood events in Bexar County between January 2009 and July 2019 (National Oceanic and Atmospheric Administration 2019).

Table 10 - Spillway Rating Curve (ARCADIS US Inc., 2014)

Elevation (NAVD88) (feet)	Gate Flow (cfs)	Weir Flow (cfs)	Flow Control
520.73	0	0	Gate
521	11	0	Gate
522	100	0	Gate
523	260	0	Gate
524	490	0	Gate
525	690	0	Gate
526	770	0	Gate
526.5	800	80	Gate
527	830	270	Gate
527.5	860	860	Gate/Weir
528	900	2,200	Weir
528.5	923	5,600	Weir
529	954	10,600	Weir

2.2 Environmental Resources – Affected Environment

In compliance with the NEPA, the Council on Environmental Quality (CEQ), 32 CFR 651 and 33 CFR 230 guidelines, the discussion of the affected environment (i.e., existing and FWOP conditions) focuses on those resource areas that are potentially subject to more-than-trivial impacts. In addition, the level of detail used in describing a resource is commensurate with the anticipated level of potential environmental impact.

For each resource area section, the resource is:

1. generally defined
2. given an appropriate project area
3. described for existing conditions

The project area for each resource is a geographic area within which the Proposed Action may exert some influence. The existing conditions discussion for each resource area presents the condition of the resource within each respective project area.

2.2.1 Resource Significance

In compliance with the CEQ NEPA regulations (40 CFR 1500.1(b), 1501.7(a)(2) and (3) and 1502.2(b)), as well as guidance for USACE ecosystem restoration projects, ER 1105-2-100 Section 2.3.m. *Significant Resources and Significant Effects*, require the identification of significant resources and attributes that are likely to be affected by one or more of the Plans. “Significant” is defined as “likely to have a material bearing on the decision-making process”. Resource significance is determined by the importance and non-monetary value of the resource based on institutional, public and technical recognition in the study area. Further description of Resource Significance is provided in Appendix C – Environmental Resources, Chapter 2. The criteria are defined as:

- **Institutional Recognition**: The importance of the resource or attribute is acknowledged in the laws, adopted plans and other policy statements of public agencies or private groups.
- **Public Recognition**: The resource or attribute is considered important by some segment of the public.
- **Technical Recognition**: The importance of the resource or attribute is based on scientific or technical knowledge or judgment of critical resource characteristics.

2.2.1.1 Institutional Recognition

Significance based on institutional recognition means that the importance of the environmental resource is acknowledged in the laws, adopted plans and other policy statements of public agencies or private groups. The institutional recognition of resource significance for the Mitchell Lake Study area is demonstrated by the following laws, policies, treaties, plans and cooperative agreements established for the conservation and protection of these environmental resources. Further support for the institutional recognition of resources in the Mitchell Lake Study area is documented in Appendix C – Environmental Resources, Chapter 2):

- Endangered Species Act (ESA) – Federally listed species that have the possibility of occurring in the study area are the golden-cheeked warbler (*Setophaga chrysoparia*), red knot (*Calidris canutus*), piping plover (*Charadrius melodus*) and whooping crane (*Grus americana*). However, their occurrences may be limited due to the lack of suitable habitat within the project area. The red knot and piping plover are shorebirds that may utilize Mitchell Lake during their migration as stopover habitat. It is anticipated that the ecosystem restoration proposed, such as mudflat habitat creation and invasive species management within this study area would greatly benefit these species and may possibly provide suitable core habitat over time.

- Texas State Threatened and Endangered Species – In 1973, the Texas legislature authorized the TPWD to establish a list of fish and wildlife that are endangered or threatened with statewide extinction. In 1988, the Texas legislature added the authority for the TPWD to establish a list of threatened and endangered plant species for the state. There are 25 Texas listed threatened and endangered species that can occur in Bexar County.
- Fish and Wildlife Coordination Act of 1958 (as amended) – This recognizes the contribution of wildlife resources to the nation. The US Fish and Wildlife Service (USFWS) and the TPWD have committed to dedicate time and resources in developing a set of measures toward the ultimate identification of a preferred plan that meets the USACE, the USFWS, the TPWD and the sponsor's objectives for restoration of aquatic habitat. Measures identified as part of the feasibility study will be considered by these agencies to have significant environmental outputs for fish and wildlife resources.
- Migratory Bird Treaty Act (MBTA) – The US has recognized the critical importance of this shared resource by ratifying international, bilateral conventions for the conservation of migratory birds. These migratory bird conventions impose substantive obligations on the US for the conservation of migratory birds and their habitats. Mitchell Lake is positioned on a natural migratory route and serves as a resting point for tens 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 able to provide services to over 338 migratory bird species.
- 2018 Farm Bill - This program is in direct correlation with the goals of the Mitchell Lake Aquatic Ecosystem Restoration Feasibility Study. The implementation of this program by NRCS shows the significance of wetlands within the U.S. and the importance of maintaining and restoring these habitats.
- EO 13112: Invasive Species – EO 13112 recognizes the significant contribution native species make to the well-being of the Nation's natural environment and directs Federal agencies to take preventive and responsive action to the threat of non-native species invasion and to provide restoration of native species and habitat conditions in ecosystems that have been invaded. This study addresses non-native invasive species by formulating plans to meet goals and objectives that will assist in the management and removal of these species.
- EO 13751: Invasive Species - This order amends EO 13112 and directs actions to continue coordinated Federal prevention and control efforts related to invasive species. This order maintains the National Invasive Species Council (Council) and the Invasive Species Advisory Committee; expands the membership of the Council; clarifies the operations of the Council; incorporates considerations of human and environmental health, climate change, technological innovation and other emerging priorities into Federal efforts to address invasive species; and strengthens coordinated, cost-efficient Federal action.
- EO 11990: Protection of Wetlands – EO 11990 directs Federal agencies to act in the conservation of wetlands. Any proposed aquatic ecosystem restoration would directly improve the circumstances for natural wetlands and increase benefits. The goal of this project is to improve the structure and function of the aquatic ecosystem at Mitchell Lake.
- WRDA of 1990 – This WRDA established an interim goal of no overall net loss of wetlands in the US and set a long-term goal to increase the quality wetlands, as defined

by acreage and function. Any proposed action for Mitchell Lake will improve and create acres of wetlands within the project area.

- EO 13186: Responsibilities of Federal Agencies to Protect Migratory Birds – ER 13186 directs Federal agencies to promote the conservation of migratory bird populations through restoring and augmenting habitat. Because the Mitchell Lake study area supports species of concern and their habitats, their institutional significance is recognized from a regional, national and international perspective.
- 1989 “No-Net Loss of Wetlands” Policy - The Mitchell Lake Aquatic Ecosystem Restoration Feasibility Study restores existing wetlands and improves upon degraded habitats. Impacts to wetlands were realized with the 1985 Farm Bill and the 1989 “No-Net Loss” Policy through the culmination of status and trends of wetland loss and combined Federal efforts to reduce wetland loss through restoration.
- Audubon Red List – In 2007, the Audubon Society and the American Bird Conservancy, published the Watchlist 2007. This List documented US bird species that were rapidly declining in numbers and/or had very small populations, or limited ranges and faced major conservation threats. A Yellow list was also published of bird species that were either declining or rare. Watchlist 2007 includes 15 Red-listed species and 48 Yellow-listed species that may be found in Bexar County.
- Partners in Flight (PIF) – PIF is a cooperative partnership between federal, state and local government agencies, philanthropic foundations, professional organizations, conservation groups, industry, academia and private individuals. To prioritize conservation needs, PIF assessed the conservation vulnerability for land bird species based on biological criteria such as population size, breeding distribution, non-breeding distribution, threats to breeding habitats, threats to non-breeding areas and population trends. There are 29 species in Bexar County on the PIF Watch Lists.
    - The Red Watch List – species with extremely high vulnerability due to small population and range, high threats and range wide declines has three species that correlate to Bexar County.
    - The “not declining” Yellow Watch List – species not declining but vulnerable due to small range or population and moderate threats has three species that correlate to Bexar County.
    - The “declining” Yellow Watch List – species with population declines and moderate to high threats has 23 species that correlate to Bexar County.
- Department of Defense (DoD) PIF – This PIF program consists of a cooperative network of natural resources personnel from military installations across the US. The DoD PIF works beyond installation boundaries to facilitate cooperative partnerships, determine the status of bird populations and prevent the listing of additional birds as threatened or endangered. There are 33 species on the DoD PIF Priority species occurring in Bexar County.
- North American Waterfowl Management Plan (NAWMP) - Established in 1986, the NAWMP is an international plan to reverse the downward trend in waterfowl populations. The goal of the plan is to protect, restore and augment wetland habitat and increase waterfowl population numbers. Ecosystem restoration of Mitchell Lake will directly affect North American Waterfowl Management. Any USACE plan would attract waterfowl and benefit those species by increasing the quality of forage found during their migration.

- North American Bird Conservation Initiative (NABCI) – The NABCI is a tri-national declaration of intent between the US, Canada and Mexico to strengthen cooperation on the conservation of North American birds throughout their ranges and habitats. The Mitchell Lake study area is located near the intersection of three Bird Conservation Regions: Oaks and Prairies, Edwards Plateau and Tamaulipan Brushlands
- North American Waterbird Conservation Plan (NAWCP) – The goal of the WCA is to sustain and restore waterbird populations and breeding, migratory and nonbreeding habitats in North America, Central America and the Caribbean. Increased quality of wetlands, mudflats and open water habitats at Mitchell Lake will attract waterbirds, supplement their food and their cover sources.
- Shorebird Conservation Plan – This plan is to protect and restore shorebird populations and their migratory, breeding and nonbreeding habitats. Mudflat habitat is of prime importance to shorebird conservation. The increase of mudflat habitat at Mitchell Lake will benefit shorebird populations within Bexar County and will have some positive effect on shorebirds nationwide.
- USFWS Birds of Conservation Concern (BCC) – The USFWS compiled a BCC list in 2008. The goal of the BCC is to identify the highest conservation priorities within the populations of migratory and non-migratory bird species. Forty-five species on the USFWS BCC list occur in Bexar County.

2.2.1.2 Public Recognition

Significance based on public recognition means that some segment of the public recognizes the importance of an environmental resource. Public recognition is evidenced by people engaged in activities that reflect an interest in or concern for a resource. Recognition of public significance for the Mitchell Lake study area can best be demonstrated by the actions of SAWS and National Audubon Society partnership.

The proposed Mitchell Lake 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 SARA and the Mitchell Lake Audubon Society facility (Figure 10 and Figure 11). The above entities have made commitments to improving habitat across the San Antonio River watershed, approximately two to five miles from Mitchell Lake. The following is a brief listing for some of the recent, current, ongoing and future projects for the San Antonio River watershed and Bexar County.

- Cibolo Creek, Leon Creek, Salado Creek, Olmos Creek, Eagleland, Mission Reach, WSC and River Road Studies: partnerships with the USACE to identify ecosystem restoration opportunities within the San Antonio River watershed
- On-going community input for the restoration of other water bodies in the San Antonio, TX area.
- December 2002, SAWS Board committed $1.5 million to improve roads and bridges in the Mitchell Lake study area to build a visitor’s center in partnership with the Mitchell Lake Wetlands Society, the San Antonio Audubon Society and the public.
- SAWS finalized a contract with the National Audubon Society to operate the Mitchell Lake Wildlife Refuge as a public use and education facility.

- A trail from the Mattox Park and the Mission Del Lago Golf Course, to the Pleasanton Road Trailhead encompasses the eastern boundary of Mitchell Lake. It is assumed that any ecosystem restoration project will attract additional recreationists based on birding and native vegetation viewing opportunities.

Several other public organizations around the country have immense interest in maintaining, restoring and creating wetlands and assisting waterfowl and shorebird persistence by managing appropriate habitat for essential nesting cover and other needs.

- Society of Wetland Scientists – purpose is to promote understanding, conservation, protection, restoration, science-based management and sustainability of wetlands.
- Wetlands International – a global not-for-profit organization dedicated to the conservation and restoration of wetlands.
- Delta Waterfowl – a leading conservation group that aims to produce ducks and secure the future of waterfowl hunting.
- Ducks Unlimited – conserves, restores and manages wetlands and associated habitats for North America's waterfowl.
- National Fish and Wildlife Foundation – works with both public and private sectors to protect and restore the nation's fish, wildlife, plants and habitats.
- Western Hemisphere Shorebird Reserve Network – conserves shorebirds and their habitats across the Americas through action at a network of key sites.

Further support for the public recognition of resources in the Mitchell Lake Study area is documented in Appendix C – Environmental Resources, Chapter 2.

2.2.1.3 Technical Recognition

Significance based on technical recognition requires identification of critical resource characteristics such as scarcity, representativeness, status and trends, connectivity, limiting habitat and biodiversity. Therefore, technical recognition of resources varies across geographic areas and spatial scale. The institutional section of this document provides evidence supporting the technical significance of the resources, specifically the scarcity, status and trends of the resources. Further support for the technical significance of resources in the Mitchell Lake Study area is documented in Appendix C – Environmental Resources, Chapter 2.

2.2.2 Geology, Topography and Soils (including Prime Farmlands)

The geology of an area includes outcrop materials and mineral deposits. The principal geologic factors influencing the stability of structures are soil stability, depth to outcrop and seismic properties. Topography describes the physical characteristics of the land such as slope, elevation and general surface features.

Elevation in the study area ranges from 484' (NAVD88) to 604' (NAVD88) with higher elevations in the northern portion of the study area and lower elevations in the southern portion. Therefore, the watershed drains south through the center of the study area and into Mitchell Lake before draining to the Medina River.

Geologic formations outcropping in the study area are Paleocene, Eocene and Pleistocene in age (Bureau of Economic Geology 1987). The formations within the study area include the

Wilcox and Midway Groups, Leona Formation and the Fluviatile Terrace Deposits. The Fluviatile Terrace Deposits surround the study area, while the Wilcox Group outcrops the northern and southern sections of the study area, which also includes the Mitchell Lake dam. The Midway Group lies directly below Mitchell Lake and the Leona Formation sits in the eastern section of the study area.

The Farmland Protection Policy Act (Public Law [PL] 97-98, Title XV, Subtitle I, Section 1539-1549 requires federal actions to minimize unnecessary and irreversible conversion of farmland to nonagricultural uses, specifically prime farmlands. The Act defines prime farmlands as "…land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oilseed and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides and labor and without intolerable soil erosion…" The act also exempts prime farmlands located within existing urban areas or areas that have been committed to urban development or water storage. The soils over much of the study area have been designated as prime farmland soils by the NRCS. However, because the Mitchell Lake study area is located within the city limits of San Antonio, the proposed project is exempt from the Farmland Protection Policy Act (FPPA) requirements. A list and map of the soil types within the study area of Mitchell Lake are shown in Table 11 and Figure 18.

Table 11. Soil Types Within the Mitchell Lake Study Area

Symbol	Name	Acres
CfB[3,4]	Miguel Fine Sandy Loam	731.2
CkC2	Miguel fine sandy loam, 2 to5% slopes, eroded	144.8
Fr[4]	Loire clay loam, 0 to 2% slopes, occasionally flooded	421.5
Gu	Gullied land-Sunev complex, 3 to 20% slopes	66.1
HgD	Rock outcrop-Olmos complex, 5 to 25% slopes	238.9
HkB[3]	Wilco loamy fine sand, 0 to 3% slopes	138.8
HkC[3]	Wilco loamy fine sand, 3 to 5% slopes	135.9
HnB[2]	Heiden clay, 1 to 3% slopes	127.5
HnC2	Heiden clay, 3 to 5% slopes, eroded	308.5
HsA[2]	Houston Black clay, 0 to 1% slopes	85.5
HsB[2]	Houston Black clay, 1 to 3% slopes	732.1
HtA[2]	Branyon clay, 0 to 1% slopes	164.7
HuB[2]	Houston Black gravelly clay, 1 to 3% slopes	349.5
HuC[2]	Houston Black gravelly clay, 3 to 5% slopes	190.2

Symbol	Name	Acres
Pt	Pits and Quarries, 1 to 90% slopes	19.1
SaB[2]	San Antonio clay loam, 1 to 3% slopes	244.6
SaC[2]	San Antonio clay loam, 3 to 5% slopes	279.2
Tf[4]	Tinn and Frio soils, 0 to 1% slopes, frequently flooded	337.9
VcA[1]	Sunev clay loam, 0 to 1% slopes	255.6
VcB[1]	Sunev clay loam, 1 to 3% slopes	258.9
W	Water	751.1
WbB	Floresville fine sandy loam, 1 to 3% slopes	124.9
WeC2	Floresville fine sandy loam, 1 to 5% slopes, eroded	360.9
WmA[2]	Willacy loam, 0 to 1% slopes	120.7
WmB[2]	Willacy loam, 1 to 3% slopes	70.0
Za	Zavala fine sandy loam, 0 to 2% slopes, occasionally flooded	19.2
Zg	Zavala and Gowen soils, 0 to 2% slopes, frequently flooded	46.4

[1]Soil of Statewide Importance
[2]Prime Farmland
[3]Prime Farmland if Irrigated
[4]Hydric Soil

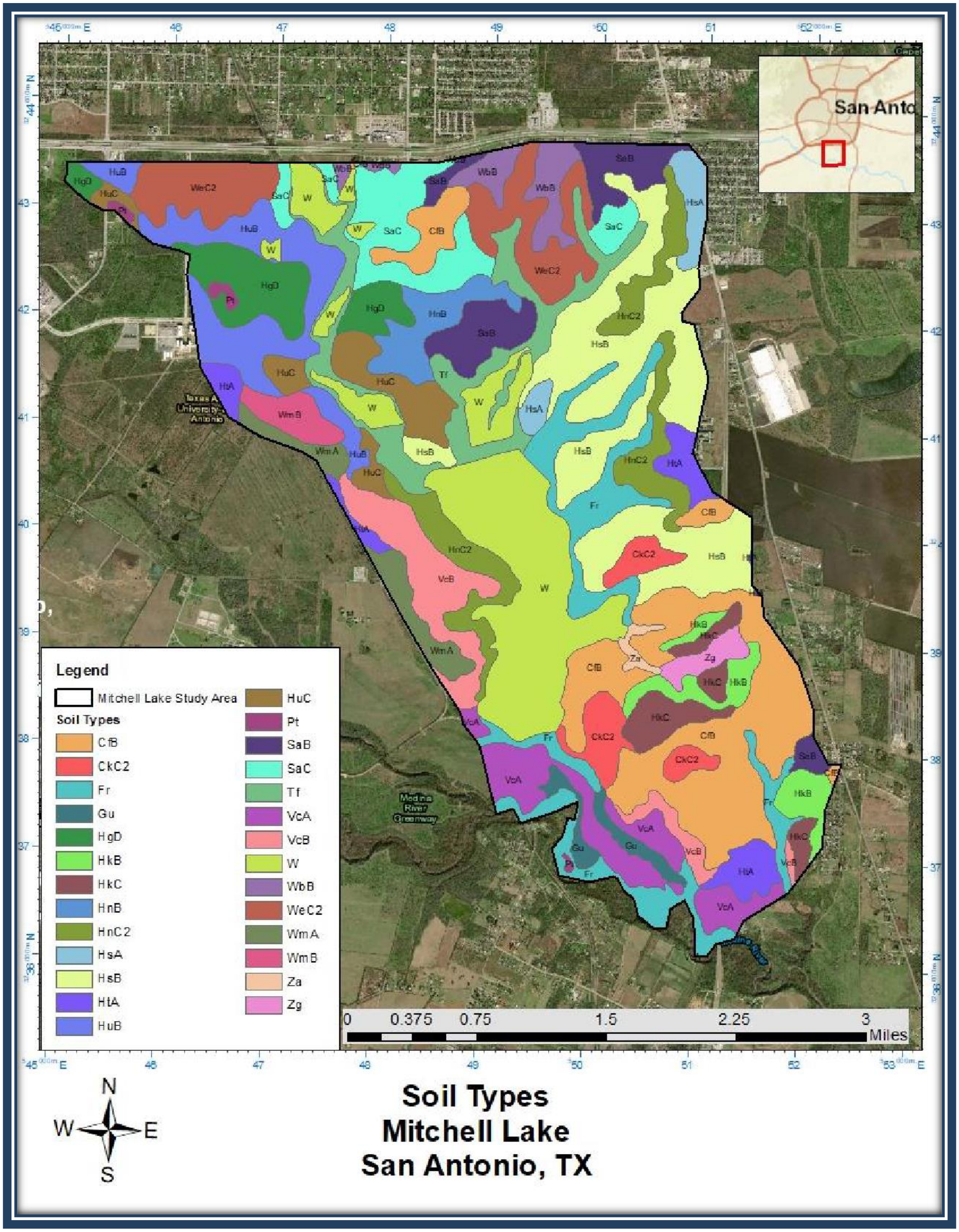

Figure 18. Mitchell Lake Soil Types (NRCS 2019)

For more information, see Appendix I - Geotechnical Engineering, Chapter 2.

2.2.3 Land Use

Bexar County includes three physiographic provinces: the Edwards Plateau, Blackland Prairie and Interior Coastal Plain. The Edwards Plateau is located to the northwest and Interior Coastal Plain encompasses the southeastern part of Bexar County. The Balcones Escarpment and Fault Zone makes up the dividing line between the Edwards Plateau and the Blackland Prairie (TWDB 2019). The Mitchell Lake study area is located exclusively within the Texas Blackland Prairie.

As described by Menger (1913), the historical landscape of the study area was centered on a "Tule" wetland complex dominated by bulrush species and surrounded by Blackland Prairie. These wetlands were inundated with the construction of the Mitchell Lake Dam and the conversion of the reservoir to wastewater treatment facility. The Blackland Prairie is characterized by deep, fertile black soils (TPWD 2019b). The Blackland Prairies supported a tallgrass prairie dominated by big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), Indiangrass (*Sorghastrum nutans*) and switchgrass (*Panicum virgatum*). Due to the fertile soils and proximity to the water from Mitchell Lake, much of the study area has been utilized for agricultural purposes.

2.2.4 Air Quality

The US Environmental Protection Agency (EPA) has the primary responsibility for regulating air quality nationwide. The Clean Air Act (42 USC. 7401 et seq.), as amended, requires the EPA to set National Ambient Air Quality Standards (NAAQS) for widespread pollutants from numerous and diverse sources considered harmful to public health and the environment. The Clean Air Act established two types of national air quality standards classified as either "primary" or "secondary". Primary standards set limits to protect public health, including the health of at-risk populations such as people with pre-existing heart or lung diseases (such as asthma), children and older adults. Secondary standards set limits to protect public welfare, including protection against visibility impairment, damage to animals, crops, vegetation and buildings.

EPA has set NAAQS for six principal pollutants, which are called "criteria" pollutants. These criteria pollutants include carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3) (Figure 19), particulate matter less than 10 microns (PM_{10}), particulate matter less than 2.5 microns ($PM_{2.5}$), sulfur dioxide (SO_2) and lead (Pb). If the concentration of one or more criteria pollutant in a geographic area is found to exceed the regulated "threshold" level for one or more of the NAAQS, the area may be classified as a non-attainment area. Areas with concentrations of criteria pollutants that are below the levels established by the NAAQS are considered either attainment or unclassifiable areas.

The study area is in Bexar County, which is currently in marginal nonattainment and has an attainment deadline of September 24, 2021. San Antonio is currently in non-attainment status as well.

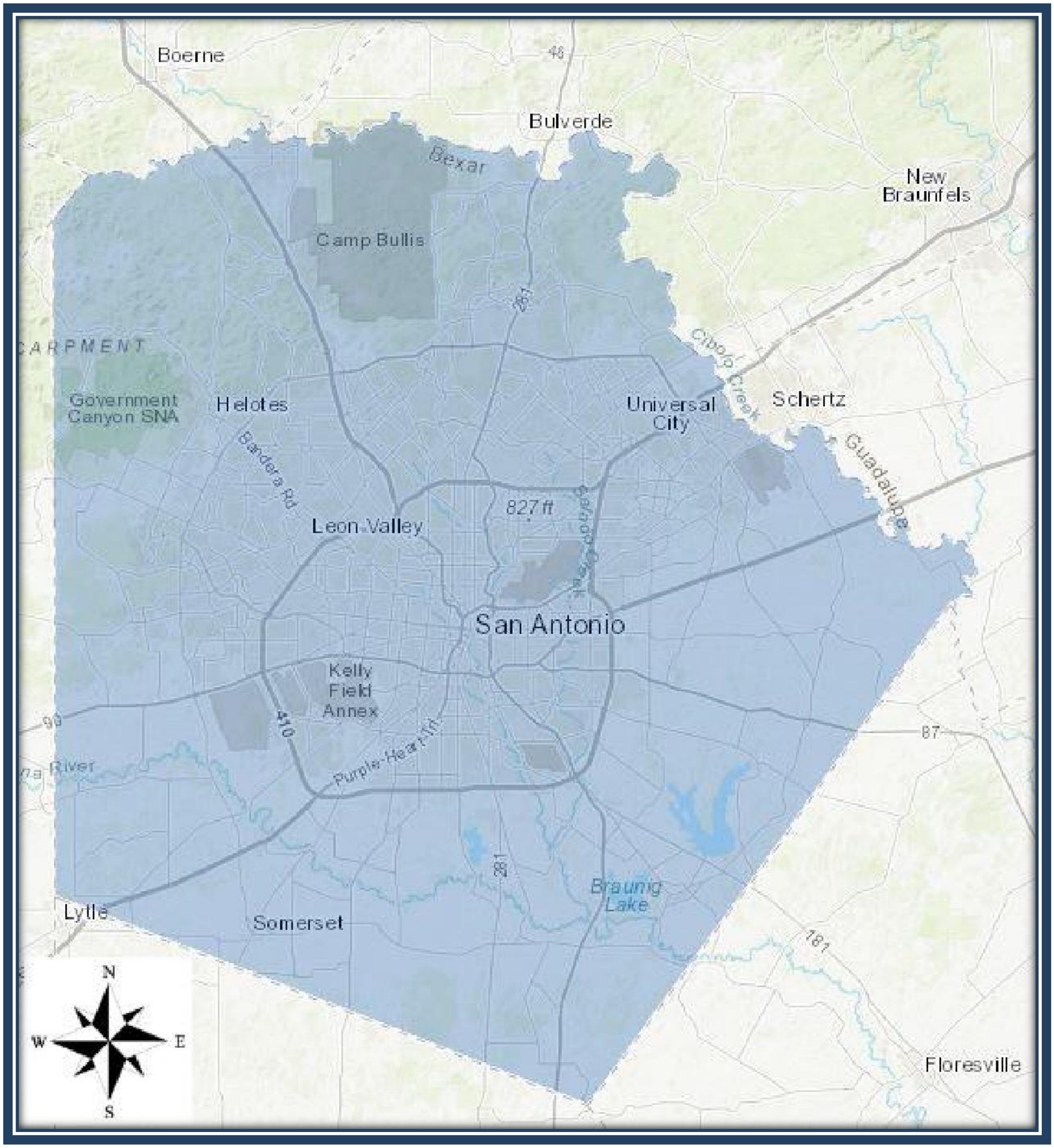

Figure 19 – NAAQS Non-Attainment Area State Level Maintenance Nonattainment Area: Ozone 8-hour 2015 for Bexar County, TX (EPA Air-Data Air Quality Monitors)

2.2.5 Noise

The study area is in a relatively rural area of San Antonio and access to the area controlled by fences around the perimeter. Existing noise sources within the study area are limited to the temporary operation of the pump station at the south end of the polders that is used to maintain water levels in the polders. Noise sources within the study area, but outside of the existing

Mitchell Lake property includes traffic on Pleasonton Road, US Highway 281 and I.H 410 and the driver training course and firing range at the police training academy north of Mitchell Lake.

A private airport, Horizon Airport-74r, is located west of Mitchell Lake; however, the airport facilities are in disrepair and it appears that the facility is no longer in use. A large Toyota Texas Manufacturing center is located approximately 3 miles southwest of Mitchell Lake. Audubon staff have reported infrequent noise pollution from any aircraft fly-over noise related to local airports and the Toyota Texas Manufacturing Center.

2.2.6 Transportation

Transportation refers to the movement of people, goods and / or equipment on a surface transportation network that can include many different types of facilities serving a variety of transportation modes, such as vehicular traffic, public transit and non-motorized travel (e.g., pedestrians and bicycles). The relative importance of various transportation modes is influenced by development patterns and the characteristics of transportation facilities. In general, urban areas tend to encourage greater use of public transit and / or non-motorized modes of transportation, especially if pedestrian, bicycle and transit facilities provide desired connections and are well operated and well maintained. More dispersed and rural areas tend to encourage greater use of passenger cars and other vehicles, particularly if extensive parking is provided and / or transit systems are unavailable.

Pleasanton Road, a two-lane road and US 281, a four-lane road, run parallel to Mitchell Lake. Pleasanton Road provides access to most recreation areas on the lake and has minimal traffic. Interstate 410, a four-lane road, is north of the lake.

A small, privately owned airport, Horizon 74R, is approximately nine miles south of San Antonio, TX and lies within the study area. As stated above, the airport appears to be non-operational.

2.2.7 Light

The study area is in a relatively rural area on the edge of the urbanized areas of San Antonio. Fugitive light from the urban areas can be seen from the study area. Existing fugitive light sources within the study area are associated with adjacent traffic, lighting around the Audubon Center facility (Figure 10 and Figure 11) and trailhead south of Mitchell Lake and from neighborhoods, businesses and industries adjacent to the lake.

2.2.8 Water Resources

Water resources include both surface water and groundwater resources; associated water quality; and floodplains. Surface water includes all lakes, ponds, rivers, streams, impoundments and wetlands within a defined area or watershed. Subsurface water, commonly referred to as groundwater, is typically found in certain areas known as aquifers. Aquifers are areas with high porosity rock where water can be stored within pore spaces. Water quality describes the chemical and physical composition of water as affected by natural conditions and human activities.

Mitchell Lake is located within the San Antonio River Basin. According to the SARA, there are ~4,180 square miles draining into the San Antonio River Basin. Major sub-watersheds located within the San Antonio River Basin are Cibolo Creek, Leon Creek, Medina River, Salado Creek and Upper San Antonio River (Figure 20)

Mitchell Lake is located within the Medina River Watershed. ~1,112 square miles drain into this watershed (SARA 2019). Most of the Medina River Watershed is characterized by undeveloped and rural land use and the hill country terrain of the Edwards Plateau. The immediate Mitchell Lake watershed is drained by Cottonmouth Creek, which empties into the Medina River.

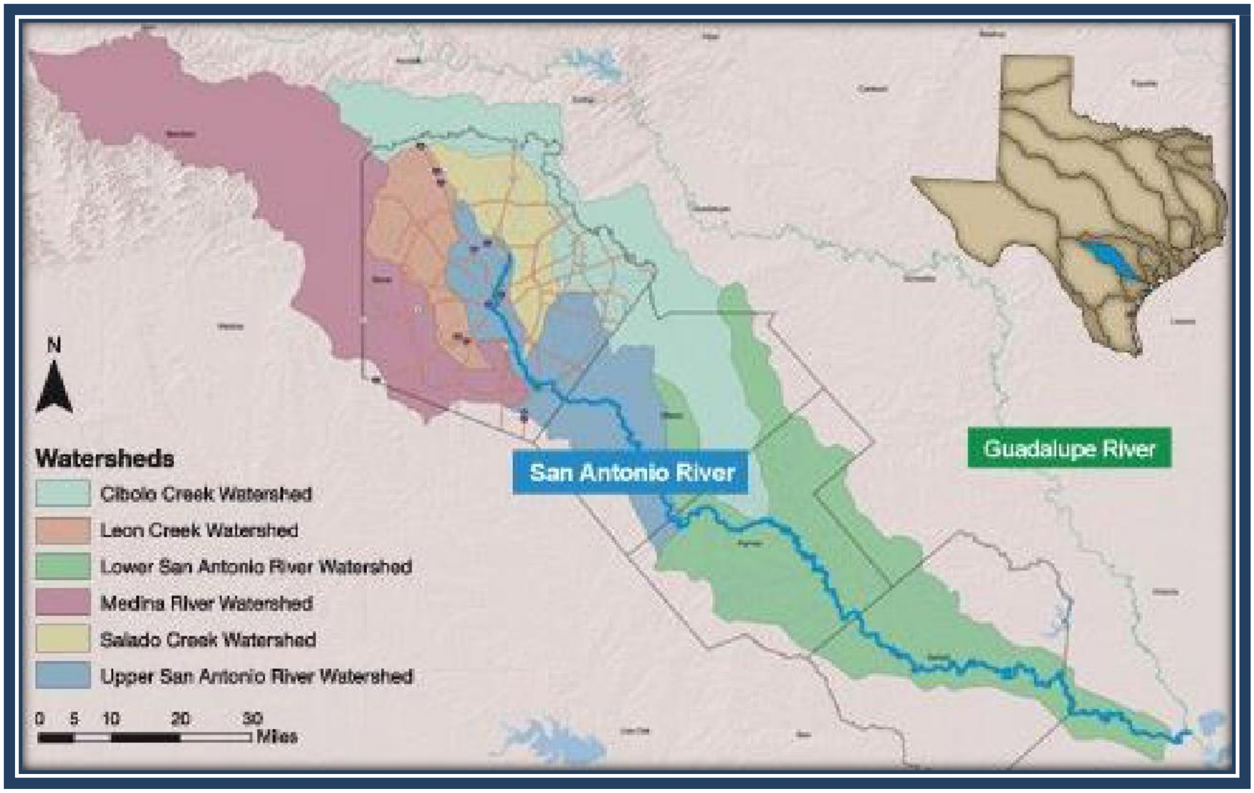

Figure 20 - San Antonio River Basin and Its Tributaries (SARA 2019)

2.2.8.1 Surface Water

Mitchell Lake has approximately 670 acres of surface water at an elevation of 520.4’ (NAVD88). The water surface elevation is maintained through surface water runoff in the upper basin and inputs from the Leon Creek Wastewater Recycling Center (WRC) west of the lake. Inputs from the WRC are used to offset the evaporation in Mitchell Lake to maintain aquatic habitats. Large storm events or prolonged wet periods result in releases through the water control structure associated with the Mitchell Lake Dam. For the FWOP condition, SAWS lowered the lake elevation from 520.4’ to 518.5’ (NAVD88) in the summer of 2020. Water is pumped from Mitchell Lake into the polders to maintain aquatic and avian habitats. The Audubon Society advises SAWS when water is needed and water levels may vary seasonally depending on habitat requirements. They cumulatively provide up to 159 acres of surface water.

Two ponds are located within the fenced portion of the Mitchell Lake study area: Bird Pond and Edward’s Tank, located north of Mitchell Lake and the polders (Figure 21). Bird Pond is an 11.8-acre reservoir created by the construction of a levee along an unnamed drainage. Edward’s Tank is a 0.75-acre pond located north of the polders. Based on the uniform, rectangular shape of the pond, it is assumed that the pond was excavated to provide water for livestock.

Figure 21. Bird Pond and Edward's Tank

Two additional ponds are located outside of the fenced portion of Mitchell Lake west of Pleasanton Road: Canvasback Lake and Ballasetal Lake. These two lakes are located along Cottonmouth Creek and flow into the northwest corner of Mitchell Lake. Cottonmouth Creek continues below the Mitchell Lake Dam until its confluence with the Medina River. Additional wetland areas were identified during USACE site visits. Wetlands adjacent to Bird Pond, known hereafter as the Bird Pond Wetlands, can be attributed to drainage and/or seepage from the levee southeast of Bird Pond. This wetland area is a monoculture of cattails (*Typha spp*.) and has the potential to provide high quality wildlife habitat if the area is adequately managed through invasive species management and low-quality vegetation removal.

Two other wetland areas north of Mitchell Lake are the “Central Wetlands” and Skip’s Pond. The wetlands are part of one larger wetland system but are separated by a petroleum pipeline right-of-way. The wetlands are connected to Bird Pond through an approximately 30’ wide drainage channel, which come from a water control structure on the southern end of Bird Pond. Water in the Central Wetlands and Skip’s Pond has collected in these areas due to an approximately 5’ elevation difference on the eastern and western edges of the wetland boundaries. Directly south of Skip’s Pond are inoperable water control structures. The water that drains from Skip’s Pond follows a small canal on the northwestern to western edge of the polders. This drainage eventually leads into the northwesternmost cove.

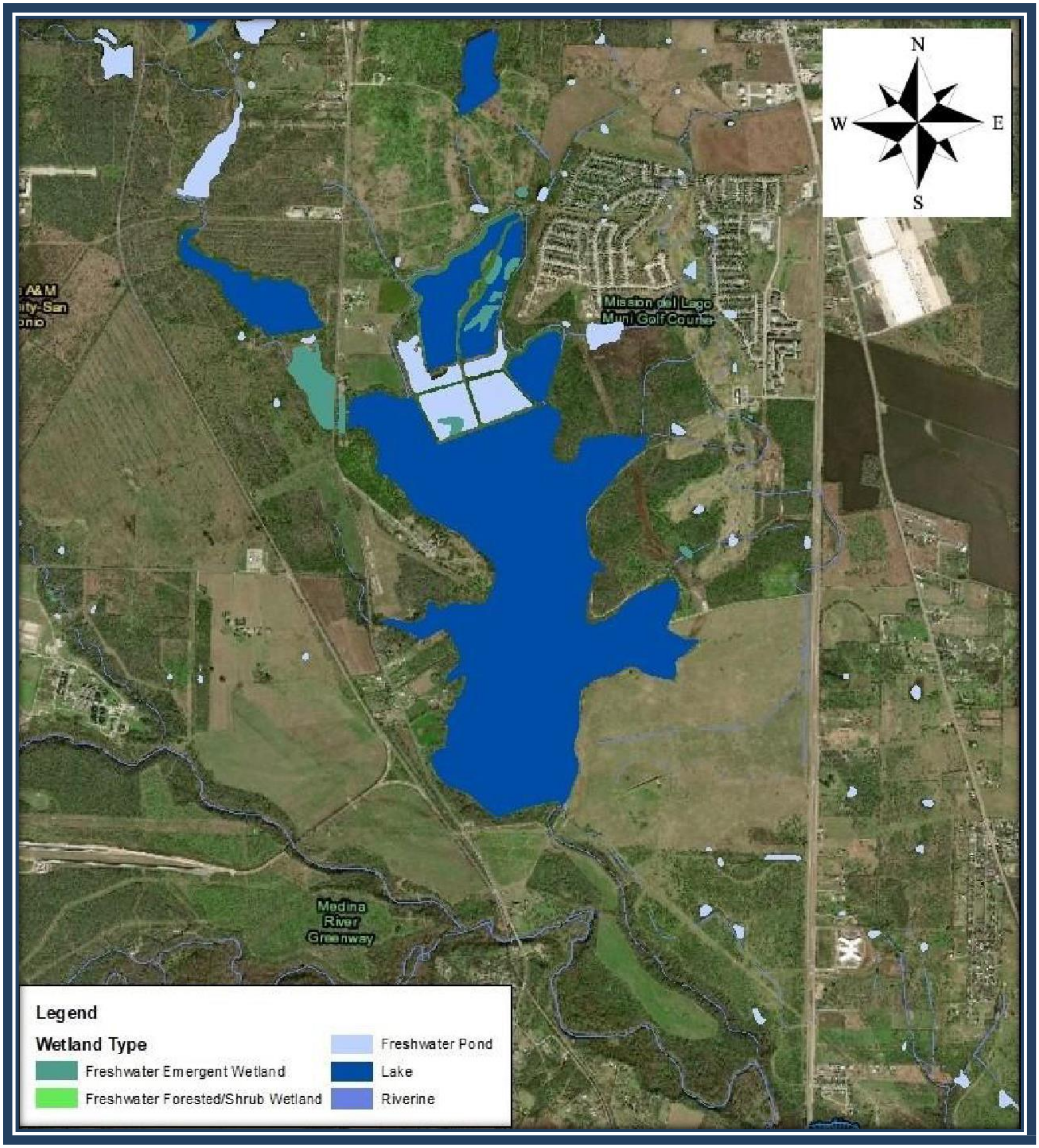

Figure 22 - National Wetlands Inventory of the Study Area (USFWS 2019)

Figure 23 - Field Wetland Survey (June 2019)

A desktop survey was performed to determine where the biological wetlands were located within the study area using the USFWS National Wetlands Inventory mapping system (Figure 22) Generally, wetlands are concentrated along the drainages north of the polders, along the edge of the polder berms and below the Mitchell Lake Dam. The wetlands north of the polders primarily consist of freshwater emergent wetlands with small areas of open water interspersed throughout the wetland. The wetlands below the dam consist of forested wetlands with significant areas of open water (Figure 23).

2.2.8.2 Groundwater

Groundwater in the study area is provided from the Edwards Aquifer (Figure 24).

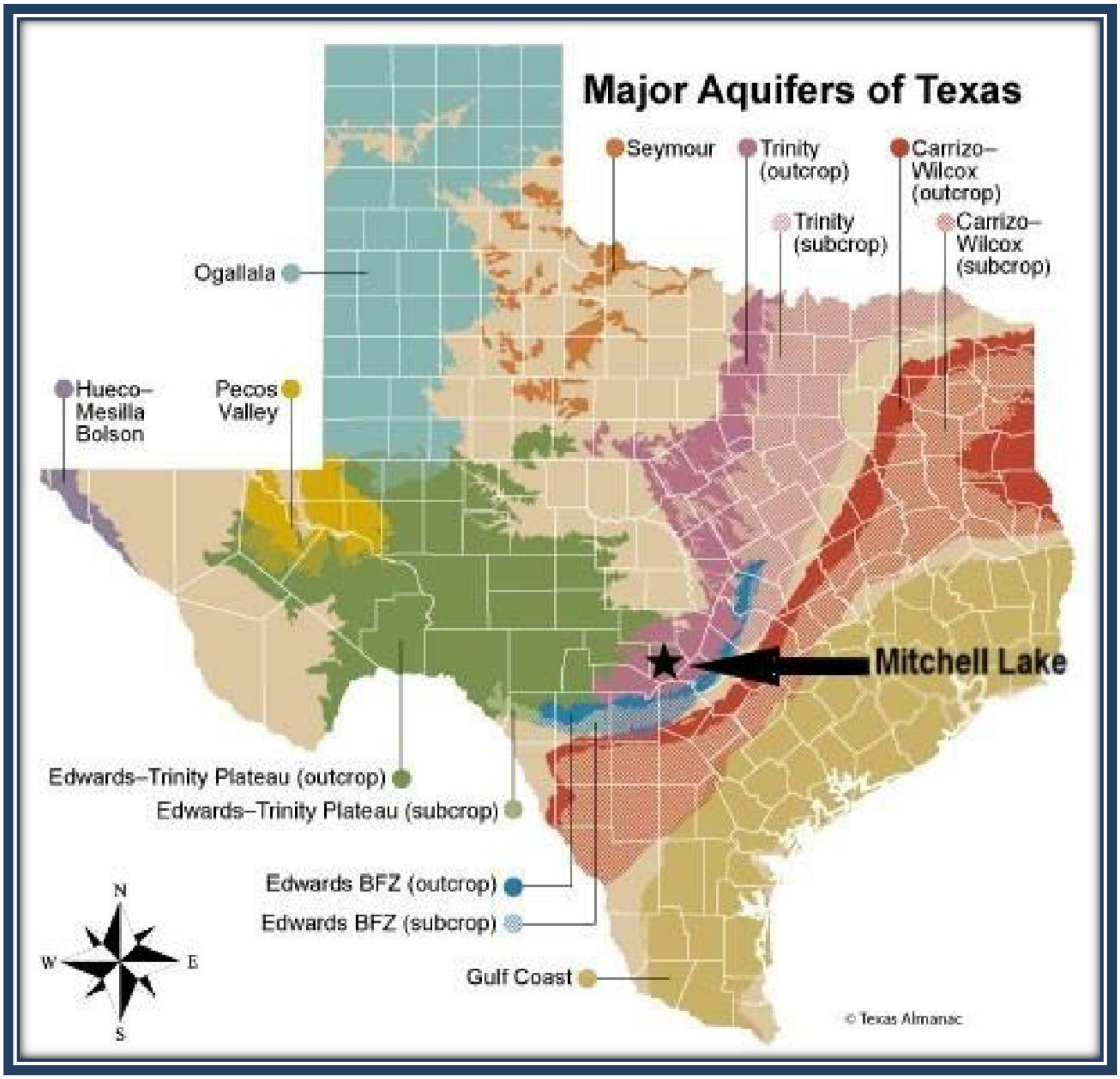

Figure 24 - Major Aquifers of Texas (Texas Almanac 2019)

“The Edwards Aquifer is intensely faulted and fractured carbonate limestone that lies within the Balcones fault zone. The dynamics and size of this geologic anomaly make it one of the most wondrous aquifers in the nation because of its storage capacity, flow characteristics, water producing capabilities and efficient recharging ability. The Edwards Aquifer and its catchment area in the San Antonio region is about 8,000 square miles and includes all or part of 13 counties in South Central Texas. The recharge and artesian areas of the Edwards Aquifer underlie the six counties south and east of the Balconces fault escarpment. The aquifer underlies approximately 3,600 square miles, is about 180 miles long from west to east and varies from 5 to 30 miles wide. The Edwards Aquifer receives most of its water from the drainage basins located on the Edwards Plateau. The catchment area, about 4,400 square miles, contains the drainage basins of the streams that recharge the Edwards Aquifer.

“In the San Antonio region, the Edwards limestone attains a thickness of approximately 450 to 500 feet.

“The water wells supplying SAWS customers number a total of 92 with an average daily pumpage of 136.50 million gallons per day or 418 acre-feet. From 1934 through 1994, the average annual recharge to the Edwards Aquifer was 676,600 acre-feet.

“Groundwater in northern Bexar County is produced from two primary aquifers, the Lower Glen Rose Limestone Aquifer and the Cow Creek Limestone Aquifer. These aquifers are part of the Trinity Aquifer group and are of Cretaceous age. The rock characteristic of the Lower Glen Rose is generally of shaley limestone to a silty dolomite. The Cow Creek formation is a fossiliferous dolomitic limestone with thinly bedded layers of sand and shale. The upper member of the Glen Rose formation is identified by its distinctive stair-step topography in northern Bexar County. It is not considered to be a significant water source due to its high mineral content. The recharge zone for the Lower Glen Rose and Cow Creek formations occur in Kendall and Comal County. The approximate thickness of the Lower Glen Rose Limestone is 300 feet and the Cow Creek Limestone ranges from 40 to 75 feet.” [3]

2.2.8.3 Water Quality

SAWS utilizes natural storm runoff, rainwater and treated wastewater from the Leon Creek WRC to maintain an approximately 520.4’ (NAVD88) water level at Mitchell Lake. The treated water from the Leon Creek WRC goes through a water recycling process that utilizes basic physical, biological and chemical principles to remove pollutants from water.

An AO issued in 2019 from the Environmental Protection Agency (EPA) requires SAWS to take measures as are necessary to comply with all permit conditions under their Texas Pollution Discharge Elimination Systems (TPDES) permit. Under this requirement, SAWS will follow a schedule of activities listed in the AO. Upon completion of each task within the schedule, SAWS must submit a Project Completion Report to the EPA within 45 days. An annual progress report is also required to be submitted beginning March 2021. The reclamation plan has not been completed but is assumed as part of the FWOP conditions due to its suspense date of September 2024. SAWS will continue to operate under their TPDES permit.

The water quality parameters allowed under the TCEQ TPDES permit are provided in Table 12. Discharges only occur during substantial rainfall events out of the uncontrolled primary spillway (Figure 8 and Figure 9). All parameters in the table below are measured at the Leon Creek

[3] Your Aquifer Water - San Antonio Water System (saws.org)

Discharge Station, except E. coli which is measured at the inflow pipe from the Leon Creek WRC.

Table 12 - Mitchell Lake TCEQ TPDES Maximum Allowable Water Quality Parameters (Alan Plummer and Associates, Inc. 2016)

Parameter[a]	Existing Permit[b]
BOD_5, mg/L	30 (30-day average), 45 (7-day average), 70 (Daily Max) and 100 (Single Grab Limit)
TSS, mg/L	90 (30-day average) and 135 (7-day limit)
E. coli	126 (Daily Average Limit) and 399 (Single Grab Limit)
DO, mg/L	>=4
pH, SU	6 - 9
a. Partial list of permit effluent parameters b. Daily average	

Historical water quality information is somewhat limited regarding Mitchell Lake. The Simpson Group conducted sampled water to assess water quality in the polders and lake in 1997 (Alan Plummer and Associates, Inc. 2016) (Table 13). The Simpson Group data represents a single point in time and not a seasonal average. Currently SAWS also monitors water quality in the polders and lake.

Because water is pumped into Mitchell Lake to offset losses of water due to evaporation and no outflow of water occurs under normal operating conditions, nutrients and salts concentrate in the lake. As indicated by the table below, the Total Dissolved Solids (TDS), DO and Nitrogen levels are above average for most waters, contributing to the low water quality in Mitchell Lake.

Table 13 - Mitchell Lake Water Quality (Alan Plummer and Associates, Inc. 2016)

Parameter	Source	
	Simpson Group	SAWS
BOD_5, mg/L	40	25.5 (n=217)
TSS, mg/L	138	114.1 (n=218
Volatile Suspended Solids, mg/L	108	N/A
Total Phosphate, mg/L P	1.1	N/A
Total Nitrogen, mg/L N	15.5	N/A
Total Kjeldahl Nitrogen, mg/L N	15.4	N/A
Organic Nitrogen, mg/L N	15.4	N/A
Ammonia, mg/L N	<0.1	N/A
Nitrate, mg/L N	0.05	N/A
TDS, mg/L	1,450	N/A
DO, mg/L	0 – 20	7.8 (n=219)
pH, SU	9.4	8.7 (n=219)

2.2.9 Visual Aesthetics

Visual resources are defined as the natural and manufactured features that comprise the aesthetic qualities of an area. These features form the overall impressions that an observer receives of an area or its landscape character. Landforms, water surfaces, vegetation and manufactured features are considered characteristic of an area if they are inherent to the structure and function of a landscape. Mitchell Lake and surrounding lands are relatively rural with natural visual aesthetic resources consisting of the lake, grasslands, savannah and forests.

2.2.10 Recreation

The study area has several popular recreation sites: the Mitchell Lake Audubon Center facility (Figure 10 and Figure 11), the Mitchell Lake Trailhead and the Pleasanton Road Trailhead. The Pleasanton Road Trailhead extends 3.4 miles to Mattox Park at the Mission Del Lago Trailhead. This trail runs parallel to the edge of Mitchell Lake, which offers views of vegetation, wetlands and various species of wildlife. Parking at the Pleasanton Road Trailhead is available and easily accessible at all points of entry.

The Mitchell Lake Audubon Center, north of the lake, is owned by SAWS and operated by the Audubon Society. Access to the site is controlled by a single gate located near the Mitchell Lake Audubon Center, which is open 7 AM to 2 PM (Audubon 2019). The Audubon Center offers conservation and outdoor science education classes for more than 4,000 students a year. Due to Mitchell Lake's position along the Central Flyway, birding is a popular hobby within the study area and brings ecotourism dollars to the region. Birding tours are held by the Audubon Center every Sunday morning and second Tuesday all year. A drivable birding trail is available for public use around and in between the polders (Figure 11). The road provides access to otherwise unobtainable wildlife viewing in the study area.

The Pleasanton Road Trailhead is located at the southern end of Mitchell Lake, while the Mitchell Lake Trailhead is located on the western portion. The two trailheads are connected by a single, approximately four-mile long, concrete trail. The trail passes over Cottonmouth Creek and runs adjacent to SAWS property boundary. Access to the lake is restricted and controlled by a 10' fence.

Recreational swimming, boating and other similar activities are not permitted at Mitchell Lake. Guests entering the Audubon Society leased areas within the Mitchell Lake study area are required to register with the Audubon Center before entering the property.

Guests utilizing the hiking trails can park at the trailheads described. The vegetation, which includes hazardous trees, along trails are maintained and/or removed on a regular basis (Figure 25).

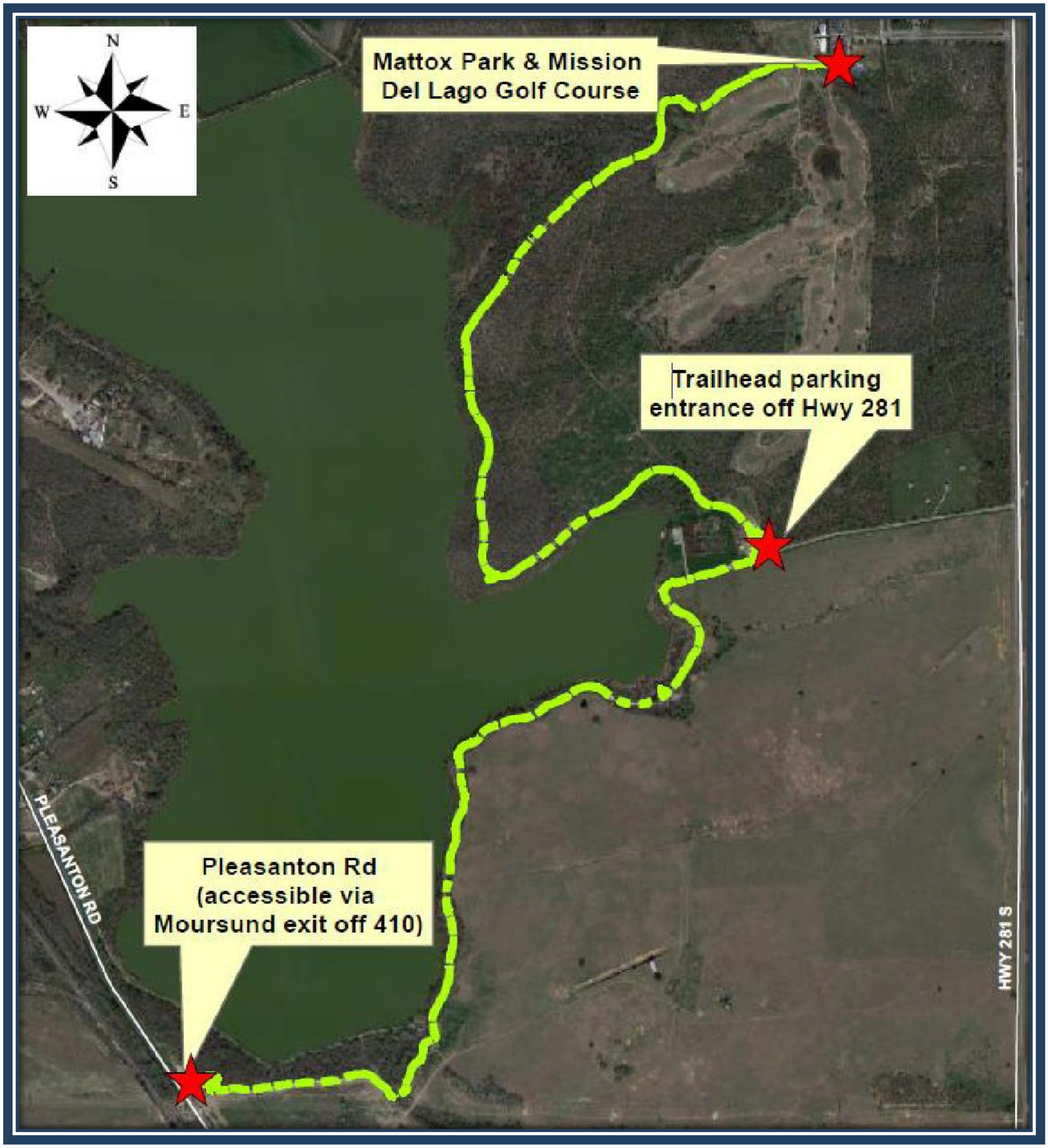

Figure 25 - Pleasanton Road and Mattox Park Trailheads (City of San Antonio, TX 2019)

2.2.11 Vegetation

The Mitchell Lake study area is dominated by non-native invasive and native nuisance species resulting in habitats with low plant diversity. Woody vegetation in the study area is dominated by sugarberry (*Celtis laevigata*), palo verde (*Parkinsonia spp*.), willow baccharis (*Baccharis salicina*), huisache (*Vachellia farnesiana*) and mesquite (*Prosopis spp*.). Cedar elm (*Ulmus crassifolia*), mulberry (*Morus spp*.), willow (*Salix spp*.), box elder (*Acer negundo*) and spiny hackberry (*Celtis ehrenbergiana*) comprised an extremely minor component of the vegetative community and were not observed at all sites. Herbaceous vegetation was dominated by sow thistle (*Sonchus spp*.), hedge parsley (*Torilis arvensis*), western ragweed (*Ambrosia psilostachya*) and bedstraw (*Galium spp*.).

Wetland and aquatic plant species include cattail (*Typha spp*.), spikerush (*Eleocharis spp*.), duckweed (*Lemna spp*.) smartweed (*Polygonum spp*.) and buttercup (*Rununculus spp*.).

Invasive species included johnsongrass (*Sorghum halepense*), bermudagrass (*Cynodon dactylon*), chinaberrytree (*Melia azedarach*), Chinese privet (*Ligustrum sinense*), Chinese tallowtree (*Triadica sebifera*), alligator weed (*Alternanthera philoxeriodes*) and bastard cabbage (*Rapistrum spp*.).

The current condition of the vegetation at Mitchell Lake lacks adequate value for wildlife use and a majority of the vegetative species recorded during the habitat assessment are invasive, nuisance, or low-quality vegetation.

2.2.12 Wildlife

Wildlife inhabiting the study area include species typical of pastoral, savannah and woodland habitats. These include eastern fox squirrel (*Sciurus niger*), Virginia opossum (*Didelphis virginiana),* striped skunk (*Mephitus mephitis*), eastern cottontail rabbit (*Sylvilagus floridanus*) and small rodents. Due to Mitchell Lake's location on the Central Flyway, the lake and the surrounding upland habitats provide significant resources for migratory birds. The study area also provides wintering grounds for temperate species and breeding habitat for neotropical species. The polders and lake provide habitat for herons, egrets, cormorants and migrating shorebirds. Because of the high nutrient load in the polders and lake, the invertebrate biomass of the sediments is substantial and provides significant food resources for migrating shorebirds, waterbirds and waterfowl. Aquatic wildlife species associated with the polders and lake include Guadalupe spiny softshell turtle (*Apalone spinifera guadlupensis*), water snakes and red-eared sliders (*Trachemys scripta*).

It is assumed based on current wildlife activity and frequency that the poor water quality of the polders and Mitchell Lake do not affect the overall health of birds, mammals, reptiles, or amphibians. However, due to the extremely low dissolved oxygen in the lake, fish are unable to survive within its waters.

2.2.13 Federally Listed Threatened and Endangered Species

Wildlife species may be classified as threatened or endangered under the ESA of 1973. The ESA protects threatened and endangered species and their habitats by prohibiting the "take of listed animals and the interstate or international trade in listed plants and animals, including their parts and products, except under federal permit. Take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or to attempt to engage in any such conduct."

The term harm is defined as "an act which actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering."

The USFWS is responsible for the implementation of the ESA. Section 7 of the ESA ensures that federal agencies use their authorities to address the impacts of federal actions on listed species and ensure that those actions would not jeopardize the continued existence of listed species or their critical habitat. Federally listed threatened and endangered species for Bexar County are provided in Attachment A. No critical habitat is designated within the study area. A more thorough discussion of the federally listed threatened and endangered species identified in the USFWS Information for Planning and Consultation report can be found in Appendix C – Environmental Resources, Attachment B. This assessment evaluates Threatened and Endangered species within the study area, their habitats and whether there will be any impacts from the TSP. The Mitchell Lake action area, as defined by 50 CFR §402.02, has five ESA listed birds, two amphibians, one fish, three mollusks, five insects, six arachnids, one crustacean and two plants. The list of Federal and state listed species with the potential to occur within the study area is located Table 14.

Table 14. Federal and State Listed Species for Bexar County, Texas (USFWS, 2020 and TPWD, 2019)

Name	Scientific Name	Federal Listing	State Listing	Habitat Present
Birds				
Golden-cheeked Warbler	*Dendroica chrysoparia*	E	E	No
Piping Plover	*Charadrius melodus*	T	T	Yes
Red Knot	*Calidris canutus rufa*	T		Yes
Whooping Crane	*Grus Americana*	E	E	Yes
Black-capped Vireo	*Vireo atricapilla*		E	No
Reddish Egret	*Egretta rufescens*		T	Yes
White-faced Ibis	*Plegadis chihi*		T	Yes
Wood Stork	*Mycteria americana*		T	Yes
Bald Eagle	*Haliaeetus leucocephalus*		T	Yes
Zone-tailed Hawk	*Buteo albonotaus*		T	Yes
Tropical Parula	*Setophaga pitiayumi*		T	Yes
Amphibians				
San Marcos Salamander	*Eurycea nana*	T		No
Texas Blind Salamander	*Typhlomolge rathbuni*	E		No
Cascade Caverns Salamander	*Eurycea latitans*		T	No
Comal Blind Salamander	*Eurycea tridentifera*		T	No

Name	Scientific Name	Federal Listing	State Listing	Habitat Present
Black-spotted Newt	*Notophthalmus meridionalis*		T	Yes
Mexican Treefrog	*Smilisca baudinii*		T	Yes
Fishes				
Fountain Darter	*Etheostoma fonticola*	E		No
Widemouth Blindcat	*Satan eurystomus*		T	No
Toothless Blindcat	*Trogloglanis pattersoni*		T	No
Mollusks				
Golden Orb	*Quadrula aurea*	C	T	No[1]
Texas Fatmucket	*Lampsilis bracteata*	C		No[1]
Texas Pimpleback	*Quadrula petrina*	C		No[1]
Mammals				
Black Bear	*Ursus americana*		T	No
White-nosed Coati	*Nasua narica*		T	No
Reptiles				
Cagle's Map Turtle	*Graptemys caglei*		T	Yes
Texas Tortoise	*Gopherus berlandieri*		T	Yes
Texas Horned Lizard	*Phyrnosoma cornutum*		T	Yes
Texas Indigo Snake	*Drymarchon melanurus erebennus*		T	Yes
Timber Rattlesnake	*Crotalus horridus*		T	Yes
Insects				
[no Common Name] Beetle	*Rhadine exilis*	E		No
[no Common Name] Beetle	*Rhadine infernalis*	E		No
Comal Springs Dryopid Beetle	*Stygoparnus comalensis*	E		No
Comal Springs Riffle Beetle	*Heterelmis comalensis*	E		No
Helotes Mold Beetle	*Batrisodes venyivi*	E		No
Arachnids				
Braken Bat Cave Meshweaver	*Cicurina venii*	E		No

Name	Scientific Name	Federal Listing	State Listing	Habitat Present
Cokendolpher Cave Harvestmand	*Texella cokendolpheri*	E		No
Government Canyon Bat Cave Meshweaver	*Cicurina vespera*	E		No
Government Canyon Bat Cave Spider	*Neoleptoneta microps*	E		No
Madla's Cave Meshweaver	*Cicurina madla*	E		No
Robber Baron Cave Meshweaver	*Cicurina baronia*	E		No
Crustaceans				
Peck's Cave Amphipod	*Stygobromus (=Stygonectes) pecki*	E		No
Flowering Plants				
Bracted Twistflower	*Streptanthus bracteatus*	C		No
Texas Wild-rice	*Zizania texana*	E		No
[1]Although the habitat may occur in the study area; the poor water quality and lack of fish host species precludes the mussels from inhabiting the aquatic habitats of Mitchell Lake and the Polders C: Candidate, E: Endangered, T: Threatened				

2.2.14 Texas Listed Threatened and Endangered Species

Chapters 67 and 68 of the TPWD Code and Sections 65.171-65.176 of Title 31 of the Texas Administrative Code gives TPWD the authority to develop a list of state-listed threatened and endangered species and to manage, regulate and protect listed species in Texas. In addition to the state-listed species, the State of Texas identities "species of greatest conservation need" (SGCN). SGNC are species that are declining or rare and in need of attention to recover or to prevent the need to list under state or federal regulation. TPWD has identified 112 SGCN; a complete list of these species is in Appendix C – Environmental Resources, Attachment C.

The Texas Natural Diversity Database (TXNDD) is a Geographic Information System (GIS)-based inventory of known locations of state-listed threatened, endangered and SGCN species. The TXNDD is limited to elements of occurrence that are located on public lands and private lands where the landowner has given written consent to include in the database. Therefore, the TXNDD data is not a comprehensive representation of the range of the species, but a tool to identify potential listed species in a specific area. A search of the TXNDD for the study area resulted in the identification of two SGCN: the eastern spotted skunk (*Spilogale putorius*) and the western spotted skunk (*Spilogale gracilis*). Habitat for these species is found throughout the grasslands and savannahs in the study area.

2.2.15 Migratory Birds

The MBTA (16 USC. 703-712) prohibits the take, possession, importation, exportation, transportation, selling, purchasing, bartering, or offer to sell, purchase, or barter any migratory bird, or parts, nests, or eggs of such a bird except under terms of a valid Federal permit. The MBTA applies to native birds migrating or residing within the US, Mexico, Russia and Japan. Additional protections for eagles are provided under the Bald and Golden Eagle Protection Act.

The past several decades has seen a decline in Neotropical migratory bird numbers. Recently, it has been recognized that the loss, fragmentation and degradation of migratory stopover habitat is potentially the greatest threat to the survival and conservation of Neotropical birds. In arid areas of the US, stopover sites are restricted and the riparian corridors of south-central Texas are the primary stopover resource for migrating birds. Naturally functioning aquatic ecosystems in the southwest are decreasing.

The Mitchell Lake study area is an ecologically unique system important to a successful migration and breeding of Neotropical migrants utilizing the Central Flyway. The location and historical diversity of Mitchell Lake supports stopover habitat needs for a wide range of migratory bird species.

2.2.16 Invasive Species

Invasive species are non-native species whose populations tend to outcompete native species and decrease the diversity of the native vegetation communities. Invasive species are one of the most pervasive, widespread threats to indigenous biota and often a major driver in the listing of threatened and endangered species.

The introduction and establishment of invasive species can have substantial impacts on native species and ecosystems. Invasive species capable of spreading and invading into new areas are typically generalists that can easily adapt to new environments, are highly prolific and superior competitors and / or predators and lack the natural predators that keep the species in check in the native habitats. Some are very specialized and more efficient and effective than their native competitors at filling a particular niche. They compete for resources, alter community structure, displace native species and may cause extirpations or extinctions. Invasive species often benefit from altered and declining natural ecosystems by filling niches of more specialized and displaced species with limited adaptability to changing environments.

Habitats in the study area are significantly impacted by exotic plants and animals including Chinese tallowtree, Chinese privet, chinaberrytree, alligator weed, Johnsongrass and Japanese honeysuckle (*Lonicera japonica*).

Chinese tallowtree are fast-growing, medium-sized trees that can reach heights of 50-60’. They are noxious plants that have caused large-scale ecosystem modifications throughout the southeastern U.S. by quickly becoming the dominant plant in disturbed areas. Chinese tallowtree are monoecious, which means that they produce both pollen and seed-bearing flowers. Chinese tallowtree can grow in a variety of conditions, including full sun and low light conditions.

Chinese privet is a shrub or small tree that can grow up to 30’ tall. It has a shallow root system, but they are extensive and suckers are readily produced that have the capability of reproducing. This makes them very difficult to eradicate once established. Chinese privet matures rapidly and produce seeds prolifically. It produces a toxic fruit that can cause a plethora of negative health symptoms in humans. They can grow in a variety of habitat types and can tolerate a wide range of soil and light conditions.

Chinaberrytree is a fast-growing, deciduous tree that can reach heights of 30-50’. It can sprout from its roots and can create dense thickets, usually causing a chinaberrytree monoculture because it will overcrowd native vegetative species. All parts of the plant are poisonous to humans and cause a variety of negative health symptoms. It can reproduce through its root system and through its seeds, which can be carried long distances by birds and other animals.

Faunal invasive species in the study area include red imported fire ants (*Solenopsis invicta*), nutria (*Myocastor coypus*) and feral hogs (*Sus scrofa*). While the invasive plant species play a significant role in converting the vegetative community of the ecosystem, nutria and feral hogs alter the environment by creating physical disturbances through rooting, grubbing, grazing and burrowing that reset the successional stage of the environment. SAWS and the Audubon Society have implemented a hog trapping program in an attempt to limit the impacts of feral hogs on the ecosystem. Although these efforts would be expected to continue under the FWOP condition, the impacts of invasive species on the environment are expected to worsen.

2.3 Cultural Resources

The preliminary project footprint (TSP) and up to a kilometer buffer surrounding (focused study area), was examined for the presence of any known historic properties using the Texas Historical Commission’s (Atlas) database. This review found 21 previous cultural resource surveys that took place within (or partially within) the focused study area and one historic resources study. Eight of these previous cultural resource surveys and the historic resources study resulted in the identification of nine archaeological sites and six identified architectural resources within the focused study area. These recorded archaeological sites were reported to the Texas Historical Commission, with only seven of the identified archaeological sites receiving formal evaluations for potential inclusion in the National Register of Historic Places (NRHP) from the Texas State Historic Preservation Officer (SHPO). Of these seven identified archaeological sites, four were evaluated as not eligible (requiring no further management) with three evaluated as eligible (requiring management). The two remaining identified archaeological sites are considered unevaluated/recommended not eligible (i.e., treated as eligible, until formally evaluated by SHPO/appropriate Tribal Nations).

The historic structure resources listed in Table 15 are part of the historic Mitchell Lake complex and have contractor recommendations ofeligibility and are considered unevaluated, until formally evaluated by SHPO. None of the resources listed are within the TSP and do not have the potential of being affected.

Although the review identified previous surveys, it is important to note that the majority of the focused study area has not been culturally or architecturally surveyed. As the TSP has not currently been subjected to a cultural resource survey there is a potential for encountering newly identified historic properties within the final developed Area of Potential Effect (APE) for this study.

The primary considerations concerning cultural resources are threats from direct impacts to intact terrestrial archeological sites and direct and indirect impacts to historic structures from new construction and / or improvements. Portions of the focused study area have been altered by urban development (Appendix D – Cultural Resources).

Table 15 - Cultural Resource Surveys within (or partially within) the Focused Study Area

Date of Survey	Sponsor	Type of Survey	Identified Resources within
2018	SAWS	Pedestrian Survey	Focused Study Area
2018	SAWS	Architectural	41BX2216
2012	City of San Antonio/	Linear	Embankment dam; Floodgate; Spillway; Purge pond; Irrigation canal system; Electric transmission line
2012	USACE Fort Worth District	Pedestrian Survey	41BX1573
2010	CPS Energy	Linear	N/A
2009	Independent School District	Pedestrian Survey	41BX1871; 41BX1872
2008	SAWS	Pedestrian Survey	41BX1376; 41BX1835
2006	CPS Energy	Linear	N/A
2006	SAWS	Pedestrian Survey	41BX1720
2004	Texas	Pedestrian Survey	N/A
2004	Department of Transportation	Pedestrian Survey	N/A
1995	City of San Antonio	Linear	N/A
1995	City of San Antonio	Pedestrian Survey	N/A
1991	Federal Highway Administration/	Pedestrian Survey	N/A

1990	Texas Department of Transportation	Pedestrian Survey	N/A
1990	Federal Highway Administration/	Linear	41BX629
1984	Texas Department of Transportation	Pedestrian Survey	41BX628
1978	Federal	Linear	N/A
1977	Highway Administration	Pedestrian Survey	N/A
Unknown	Texas	Pedestrian Survey	N/A
Date of Survey	**Sponsor**	**Type of Survey**	**Identified Resources within**
Unknown	Department of Transportation	Pedestrian Survey	N/A
Unknown	Texas	Pedestrian Survey	N/A

2.4 Environmental Engineering

In order to complete a feasibility level HTRW evaluation for the Mitchell Lake Ecosystem Restoration Project, a records search was conducted following the rules and guidance of ER 1165-2-132: *HTRW Guidance for Civil Works Projects* and ASTM E1527-13: *Standard Practice for Environmental Site Assessment: Phase 1 Environmental Site Assessment Process*. In the records review, files, maps and other documents that provide environmental information about the project area are obtained and reviewed. To complete the records review, the USACE reviewed publicly available databases and sources, using the proposed footprint of the project, along with an approximate one-mile search distance for each of the sources. The records search revealed only seven potential HTRW sites in lower Bexar County, although none of these sites has the potential to affect the proposed project. See the future without and alternative analyses and the Appendix E for more information about risks from these sites.

Mitchell Lake is hyper-eutrophic due to its past use as a wastewater treatment site. The entire lake, along with its polders and basins, is reported as polluted with wastewater sludge. Basin 3 is reported as lined with fly ash. Fly ash is a by-product of coal ash (EPA 2019). Coal ash is referred to by the EPA as a coal combustion residual and is produced by the burning of coal in coal-fired power plants. Fly ash is a very fine and powdery material composed of mostly silica that is made from the burning of finely ground coal in a boiler. The EPA has determined that improperly constructed or mismanaged coal ash disposal units have been linked to surface, groundwater and air quality pollution. It is important to consider this if Basin 3 were to be included in any excavation or construction plans. Currently, however, there are no plans to disturb this Basin and the recommended treatment is to leave the fly ash “as is” or undisturbed.

Mitchell Lake has a few potential HTRW sites in relative proximity (one mile) to the proposed project footprint, including three registered petroleum storage tanks and four state and tribal solid waste facilities/landfills, which were primarily for disposal of brush. None of the storage tanks is reported as leaking and the landfills are reported as no longer active. San Antonio is a highly developed city within close proximity and most potential HTRW sites are in or around this settlement (Figure 26).

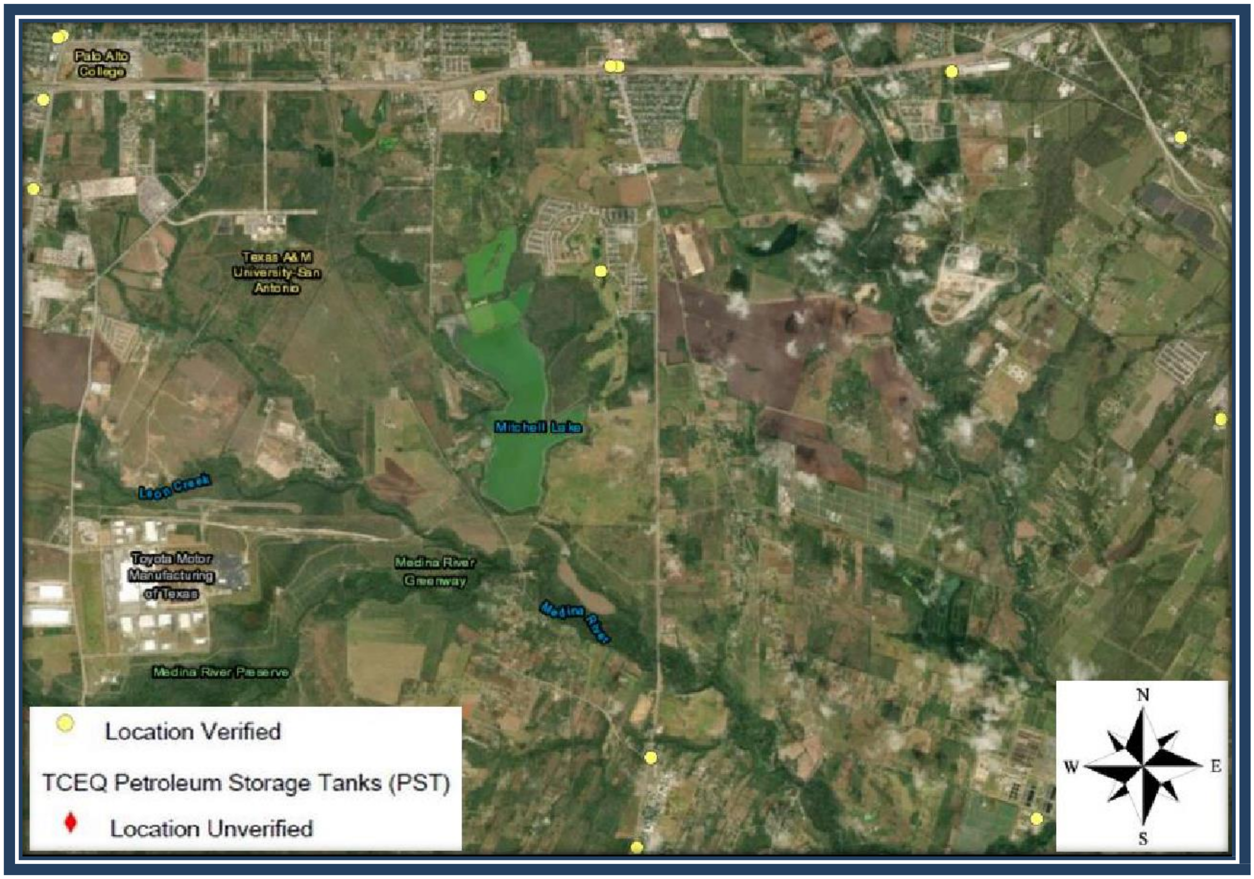

Figure 26 - Mitchell Lake Underground Storage Tanks and Aboveground Storage Tanks

Although not classified as HTRW, pipelines and oil wells may be a significant contributor to the HTRW existing condition in and around Mitchell Lake (Figure 27 and Figure 102). Numerous oil and gas wells are located within 1.0 miles of Mitchell Lake and the restoration area. A Railroad Commission of Texas (RRC) database also shows numerous operating oil, gas and injection wells. Pipelines can be found crossing the lake and restoration areas. Most of the project alternatives have the potential to interact in some way with some type of oil and gas infrastructure and relocations may be required as part of the proposed project. Refer to the Appendix E – HTRW for maps of known pipelines and oil and gas wells surrounding the Lake. However, all these instances have an extremely low potential to affect the proposed project.

A previous study was conducted by UTSA's Environmental Geochemistry laboratory titled *The Spatial Variability of Total and Bioavailable Metal Concentrations in the Sediments of Mitchell Lake*, which provides direction on areas to avoid. The only HTRW issues identified are elevated bioavailable metals at the center of the lake; no HTRW concerns were identified for the polders. The polders are currently used by waterfowl and waterbirds feeding in the sediments. There have not been any bird die-offs reported for Mitchell Lake.

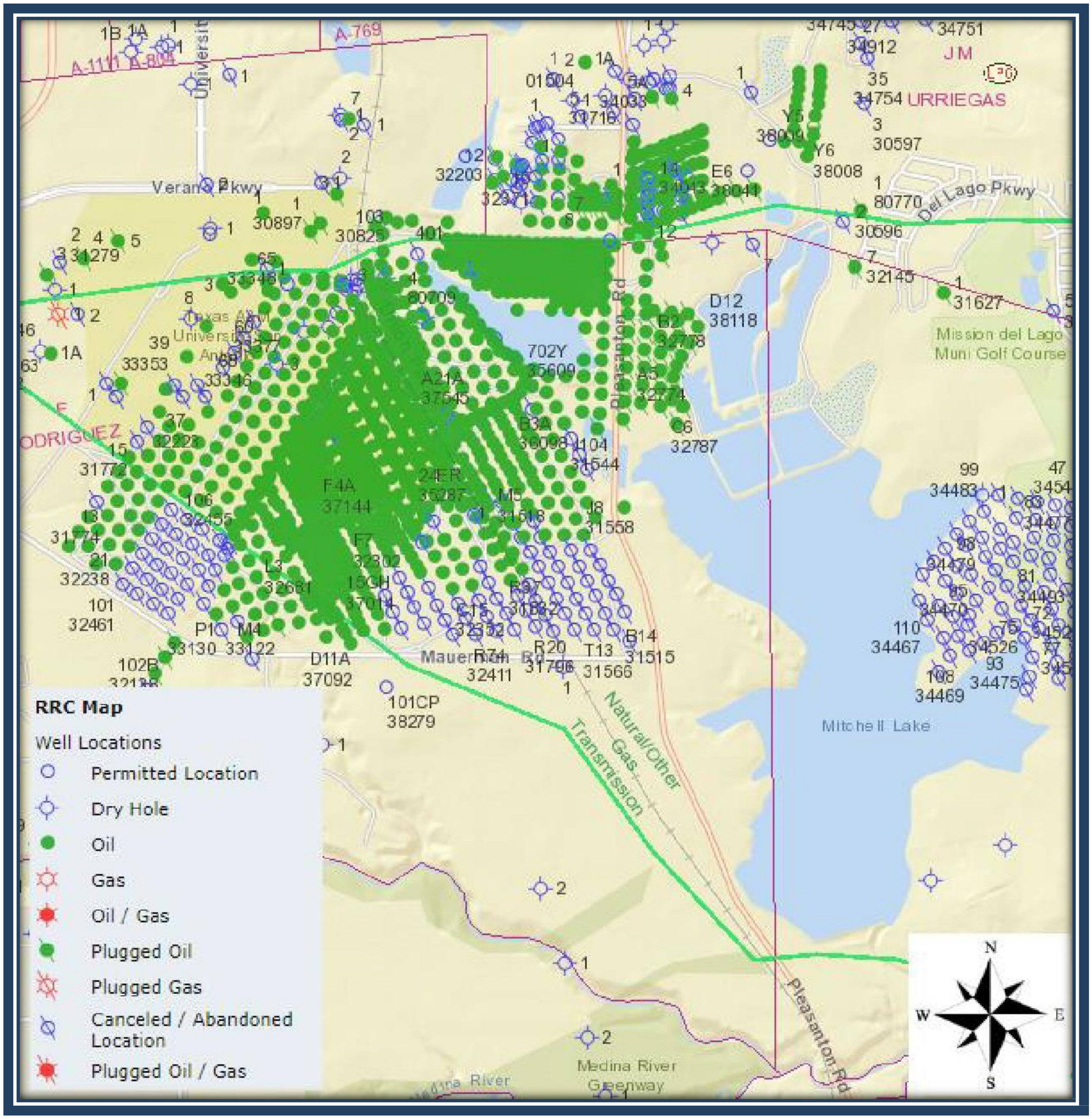

Figure 27 - Map of Local Oil and Gas Sites

2.5 Geology and the Structural Setting

Geotechnical information on the Mitchell Lake and the surrounding area was obtained from NRCS soil surveys and geological information from various sources such as the Texas Geological Society, University of Texas system documents and research papers and the experience of SWF in the general region. The relevant data as it applies to the proposed ecological improvements is discussed in this report.

Additional geotechnical studies will be required after the path forward defines specific objectives. Based on the proposed ecological improvements (such as creation of wetlands, construction of berms, excavation, etc.) site-specific soil sampling, laboratory tests and an engineering analysis would be conducted (Appendix I – Geotechnical Engineering, Chapter 2).

2.5.1 General Geology

San Antonio and Bexar County are on the boundary between the Gulf Coastal and Great Plains physiographical provinces. Dividing these two provinces in this region of Texas is the Balcones Escarpment, part of the Balcones Fault Zone. The escarpment extends from near Del Rio, Texas northwest through Bexar County to Austin. Remnants of the escarpment extend as far north as Waco. The Balcones Escarpment rises ~1,000' (NAVD88) above the coastal prairie to the south and east, creating a marked influence on the area's environment. Northwest of the escarpment lies the Edwards Plateau area of the Great Plains Province.

Leon Creek is located on the western edge of San Antonio in Bexar County. The area is within the Balcones Fault Zone, an area characterized by numerous parallel and echelon faults, downthrown to the south. The topography is characterized by a gently rolling land surface that slopes southeastward toward the Gulf of Mexico. Primary material underlying the Leon Creek area examined from an earlier study conducted by SWF in 2007 consists of strata belonging to three geologic formations. The Edwards Limestone underlying the northern portion of the area. The Taylor Marl, underlying the middle portion consists of soft to moderately hard, calcareous shale. The southern portion of the area is underlain by the Navarro Group consisting of sandy, silty clay shale.

2.5.2 Soils

NRCS Soil Survey maps for the study area were observed to evaluate the type of soils and their implications for the proposed ecosystem restoration and improvement alternatives. The predominant soil type within the study area is Houston Black Clay (HsB) which covers about 740 acres or 12.7% of the study area marked in the soil survey map. Of course, Mitchell Lake covers about 12.9% of the Area of Interest (AOI).

Please note that the study area drawn to extract the soil survey map is much larger than the Study Area (3,768 acres) shown in Figure 28 because the AOI sketched on the web soil survey map is very approximate and consists of a polygon drawn using salient inflection points. It should also be noted that the study area used by the Hydraulics and Hydrology Section differs from both these areas and is larger, as they mapped the drainage area in their study. However, this does not influence the fact that the major soil unit mapped is the Houston Black Clay.

Clay, clay loam and gravely clays make up about 55% of the soils within the AOI. These would include Houston Black clays (HsA and HsB), Heiden clays (HnC2 and HnB) and Branyon clay (HtA). Sandy loams and loamy sands make up about 20.5% of the AOI. These soils include Floresville fine sandy loams (WeC2 and WbB), Miguel fine sandy loams (CfB and CkC2) and Zavala fine sandy loam (Za). Waters of Mitchell Lake take up about 12.7%. Thus, for practical purposes, we can estimate that about 55% of the AOI are clayey soils and about 20.5% are sandy soils. The minor soils consisting of alluvial soils, gravely clays and rock outcrop cover about 11.1% of the AOI and waters of Mitchell Lake cover about 12.9% (751.5 acres).

The above generalization is anticipated as the soil sediments consist of both alluvial deposits and the native clayey strata.

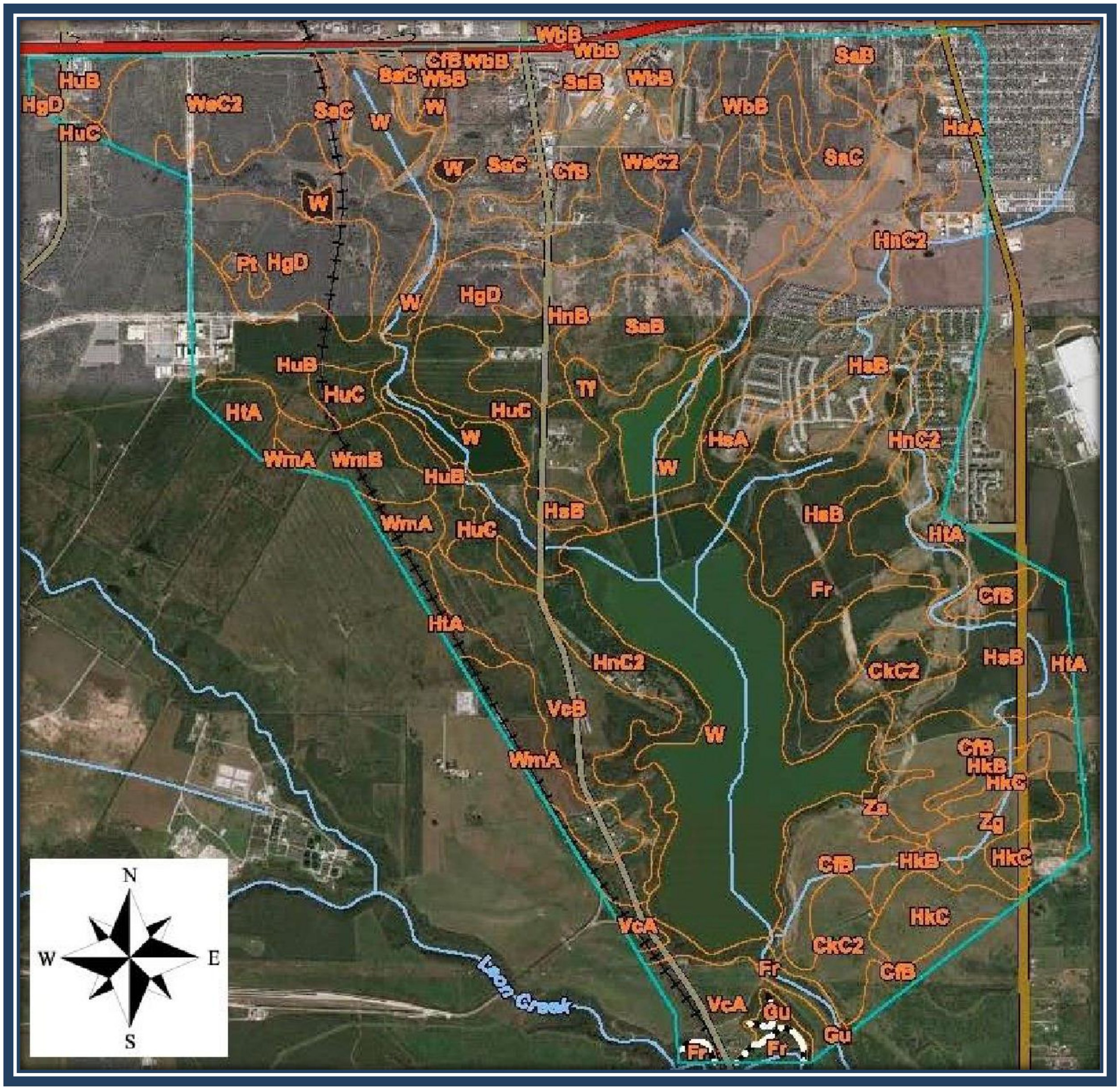

Figure 28 - Mitchell Lake Study Area with NRCS Soil Types

2.6 Socioeconomics

This section will describe the socioeconomics and demographics of the following Areas of Interest (AOI): Bexar County, the city of San Antonio and the census tract in which the lake lies (Census tract 1519). Demographic information for the state of Texas is provided for comparison. The parameters used to describe the demographics and socioeconomic environment include population trends, private sector employment and wage earnings. Other social characteristics such as race composition, age distribution and poverty will be examined in order to recognize any potential environmental justice issues that the improvement project may induce.

2.6.1 Population

Bexar County is expected to experience 77% growth between the 2017 and 2050, compared to a 73% growth rate for Texas (Table 16).

Table 16 - Population Estimates and Projections (2000, 2010, 2017, 2050)

Geographical Area	2000 Population Estimate	2010 Population Estimate	2017 Population Estimate	2050 Population Projection
Texas	20,851,820	25,145,561	27,419,612	47,342,105
Bexar County	1,392,931	1,714,773	1,892,004	3,353,060
San Antonio	1,144,646	1,327,407	1,461,623	4,467,980
Census Tract 1519	3,059	5,113	5,888	N/A
Source: US Census Bureau, Population Division (2000, 2010 Estimates); US Census Bureau, 2013-2017 American Community Survey 5-Year Estimates (2017 Estimate); Texas State Data Center, The University of Texas at San Antonio (2050 Projections)				

2.6.2 Employment by Industry

The labor force by industry for the state and the area of interest is characterized in Table 17. Most of the area of interest is employed in the Educational services and health care and social assistance sector, followed by the Arts, entertainment and recreation and accommodation and food services sector and then Retail Trade.

Table 17 - Employment by Industry

Industry	Texas	Bexar County	San Antonio	Census Tract 1519
Agriculture, forestry, fishing and hunting and mining	3%	1%	1%	5%
Construction	8%	8%	8%	5%
Manufacturing	9%	6%	6%	12%
Wholesale trade	3%	2%	2%	1%
Retail trade	11%	12%	12%	13%
Transportation and Warehousing and utilities	6%	4%	4%	4%
Information	2%	2%	2%	0%
Finance and insurance and real estate and rental and leasing:	7%	9%	9%	10%

Industry	Texas	Bexar County	San Antonio	Census Tract 1519
Professional, scientific and management and administrative and waste management services	11%	11%	11%	9%
Educational services and health care and social assistance	22%	23%	23%	17%
Arts, entertainment and recreation and accommodation and food services	9%	12%	12%	18%
Other services, except public administration	5%	5%	5%	2%
Public administration	4%	5%	4%	4%
Source: US Census Bureau, 2013-2017 American Community Survey 5-Year Estimates (2017 Estimate)				

2.6.3 Income and Poverty

The median household incomes are lower in each of the areas of interest when compared to the state of Texas, with the largest discrepancy between the state and the census tract immediately surrounding the lake. The same trend is observed in per capita income (Table 18).

The poverty level in Bexar County is comparable to the state of Texas but is slightly higher in San Antonio and slightly higher still in the census tract surrounding Mitchell Lake.

Table 18 - Median, Per Capita Income and Poverty Data (2017)

Geographical Area	Median Household Income	% of Families with Incomes Below Poverty Level (Last 12 months)	Per Capita Income	% of People with Incomes Below Poverty Level (Last 12 months)
Texas	$57,051	12.4%	$28,985	16.0%
Bexar County	$53,999	12.9%	$26,158	16.4%
San Antonio	$49,711	14.7%	$24,325	18.6%
Census Tract 1519	$41,869	18.7%	$19,164	20.0%
Source: US Census Bureau, 2013-2017 American Community Survey 5-Year Estimates (2017 Estimate)				

2.6.4 Labor Force and Unemployment

The 2017 annual average unemployment rate in Texas was 4.3%. The unemployment rate in Bexar County was slightly lower than in the state (Table 19).

Table 19 - 2017 Unemployment rate in Texas

Geographic Area	Civilian Labor Force	Number Employed	Number Unemployed	Unemployment Rate
Texas	13,538,385	12,960,595	577,790	4.3%
Bexar County	924,590	892,277	32,313	3.5%
Source: Bureau of Labor Statistics, Current Population Survey (State estimate, 2017), LAUS (County estimates, 2017)				

2.6.5 Race and Ethnicity

Within each of the areas of interest, the Hispanic population is significantly higher when compared to the state of Texas and comprises most of the population. The Hispanic population accounts for 87% of the total population in the census tract surrounding the lake (Table 20).

Table 20 - Racial and Ethnic Composition by Geographical Area (2017)

Area	White	Black	Hispanic or Latino	American Indian and Alaska Native alone	Asian alone	Native Hawaiian and Other Pacific Islander alone	Some other race alone	Two or more races
Texas	43%	12%	39%	0%	4%	0%	0%	2%
Bexar County	28%	7%	60%	0%	3%	0%	0%	2%
San Antonio	25%	7%	64%	0%	3%	0%	0%	1%
Census Tract 1519	8%	1%	87%	0%	3%	0%	1%	1%
Source: US Census Bureau, 2013-2017 American Community Survey 5-Year Estimates (2017 Estimate)								

2.6.6 Age

The age distribution is similar between San Antonio, Bexar County and the state of Texas. In terms of percentage of total population, the census tract that encompasses the lake has slightly larger population ages 0 to 14 when compared to the state of Texas (Table 21).

Table 21 - Population by Age Group (2017)

Area	Age Group									
	<5	5 to 14	15 to 24	25 to 34	35 to 44	45 to 54	55 to 64	65 to 74	75 to 84	85 and over
Texas	7%	14%	14%	15%	14%	13%	11%	7%	3%	1%
Bexar County	7%	14%	15%	16%	13%	12%	11%	7%	3%	1%
San Antonio	7%	14%	15%	16%	13%	12%	11%	7%	3%	1%
Census Tract 1519	10%	18%	16%	13%	16%	11%	8%	6%	2%	0%

Source: US Census Bureau, 2013-2017 American Community Survey 5-Year Estimates (2017 Estimate)

3 Expected Future Without-Project Conditions

FWOP conditions are defined as those conditions that would exist within the study area, during the 50-year period of analysis (2024 – 2073), in the absence of a proposed water resources project. The expected FWOP condition is the same as the "No Action" Plan, is therefore a projection of how these conditions are expected to change over time if the USACE plan is implemented.

A quantitative and qualitative description of resources within the study area is characterized, for both existing and future conditions. The second step of plan formulation and the starting point in any the USACE analysis, is to develop an accurate picture of the existing and FWOP conditions.

Forecasts should extend from the base year (the year when the proposed project is expected to be operational) to the end of the period of analysis.

The FWOP condition forms the basis against which Plans are developed, evaluated and compared. Proper definition and forecasting of the expected FWOP condition are critical to the success of the Planning process. The expected FWOP condition constitutes the benchmark against which Plans are evaluated.

3.1 Hydrology, Hydraulics and Climate

FWOP Conditions is based on the premise that the Mitchell Lake and watershed area would be allowed to develop without a constructed environmental restoration project. The watershed may continue to develop. For example, the nearby Texas A&M Campus has a master plan for campus expansion as enrollment increases, with the final stage of development beginning once enrollment surpasses 25,000 students. The future hydrologic conditions would likely remain constant, that is, the magnitude of the frequency flood event discharges would not increase in any significant way. San Antonio and Bexar County have floodplain ordinances that limit stormwater runoff impacts of new development. San Antonio's 2006 Unified Developed Code (UDC) and their Stormwater Design Criteria Manual give criteria for effective stormwater management and the mitigation of downstream impacts.

According to San Antonio's UDC, "Peak stormwater runoff rates from all new development shall be less than or equal to the peak runoff rates from the site's predevelopment conditions for the 5-year, 25-year and 100-year design storm events. Peak stormwater runoff rates from an area of redevelopment due to zoning or replatting shall be less than or equal to the peak runoff rates produced by existing development conditions for the 5-year, 25-year and 100-year design storm events." These programs were developed to prevent increases of downstream impacts due to proposed future development within the city of San Antonio (Appendix A – Hydrology, Hydraulics and Climate, Chapter 3).

3.1.1 Qualitative Climate Assessment

Engineering and Construction Bulletin No. 2018-14 "Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects" provides guidance for incorporating climate change information in hydrologic analyses in accordance with the USACE overarching climate preparedness and resilience policy and ER 1105-2-101. The objective of ECB-2018-14 is to boost USACE climate preparedness and resilience by incorporating relevant information about observed and expected climate change impacts in hydrologic analyses for planned, new and existing USACE projects. This includes consideration of both past (observed) changes as well as potential future (projected) changes to relevant climatic and hydrologic variables. The ECB helps support a qualitative assessment of potential climate change threats and impacts, focusing on those aspects of climate and hydrology relevant to the project's problems, opportunities and alternatives and include consideration of both past (observed) changes as well as projected, future (modeled) changes (Appendix A – Hydrology, Hydraulics and Climate, Chapter 5).

Several on-line tools developed by the USACE were used in this analysis: Climate Hydrology Assessment Tool, Non-stationarity Detection Tool and the Civil Works Vulnerability Assessment Tool. Other literature sources, as listed in Appendix A – Hydrology, Hydraulics and Climate, Chapters 5 and 6, were also used in this assessment.

3.1.1.1 Project Hydrologic Location and Gage Resources

The Mitchell Lake drainage area is located in the southern San Antonio regional area. It is located within Hydrologic Unit Code (HUC) 121003 - Central Texas Coastal. Figure 29 and Figure 30 show the HUC location maps for Texas and the location of the study area.

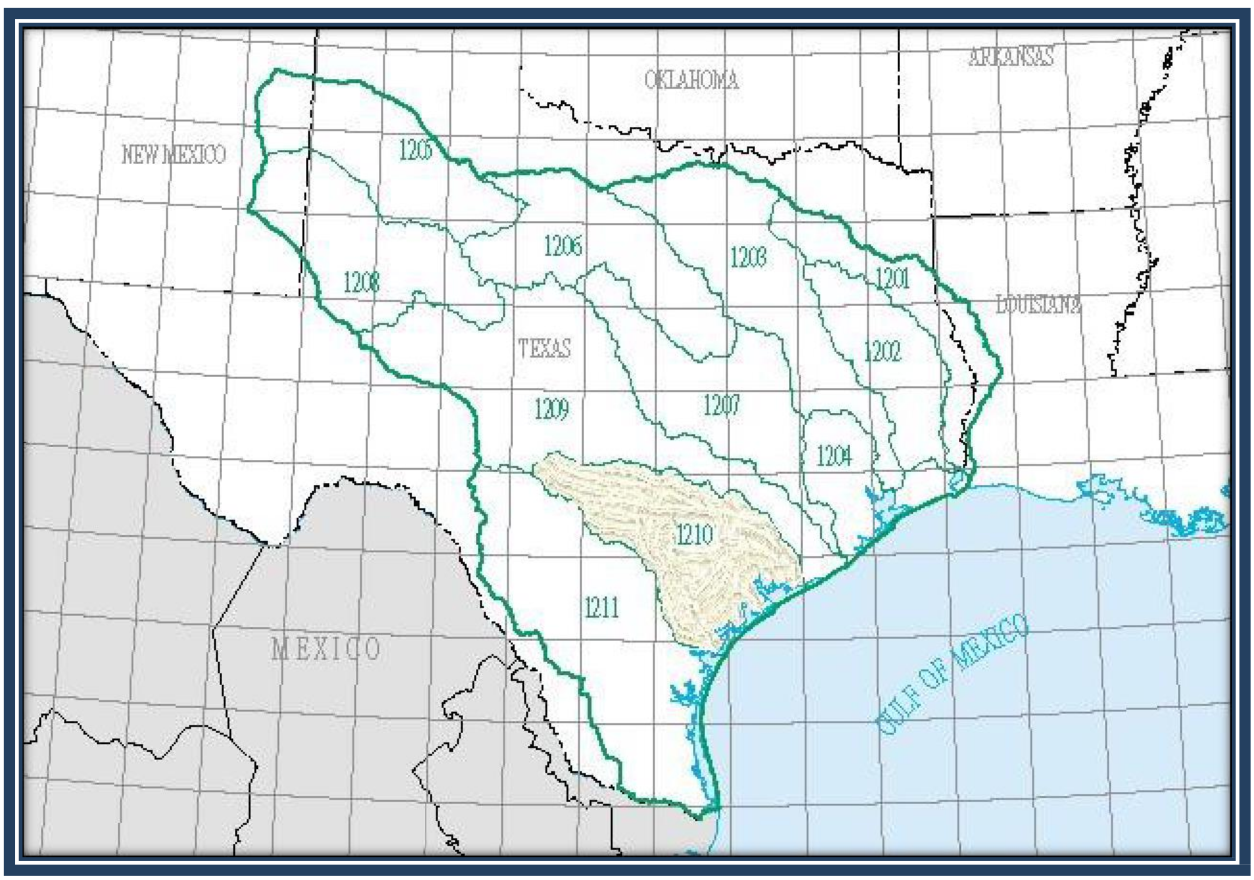

Figure 29 - Texas Gulf Region 12 HUC Map

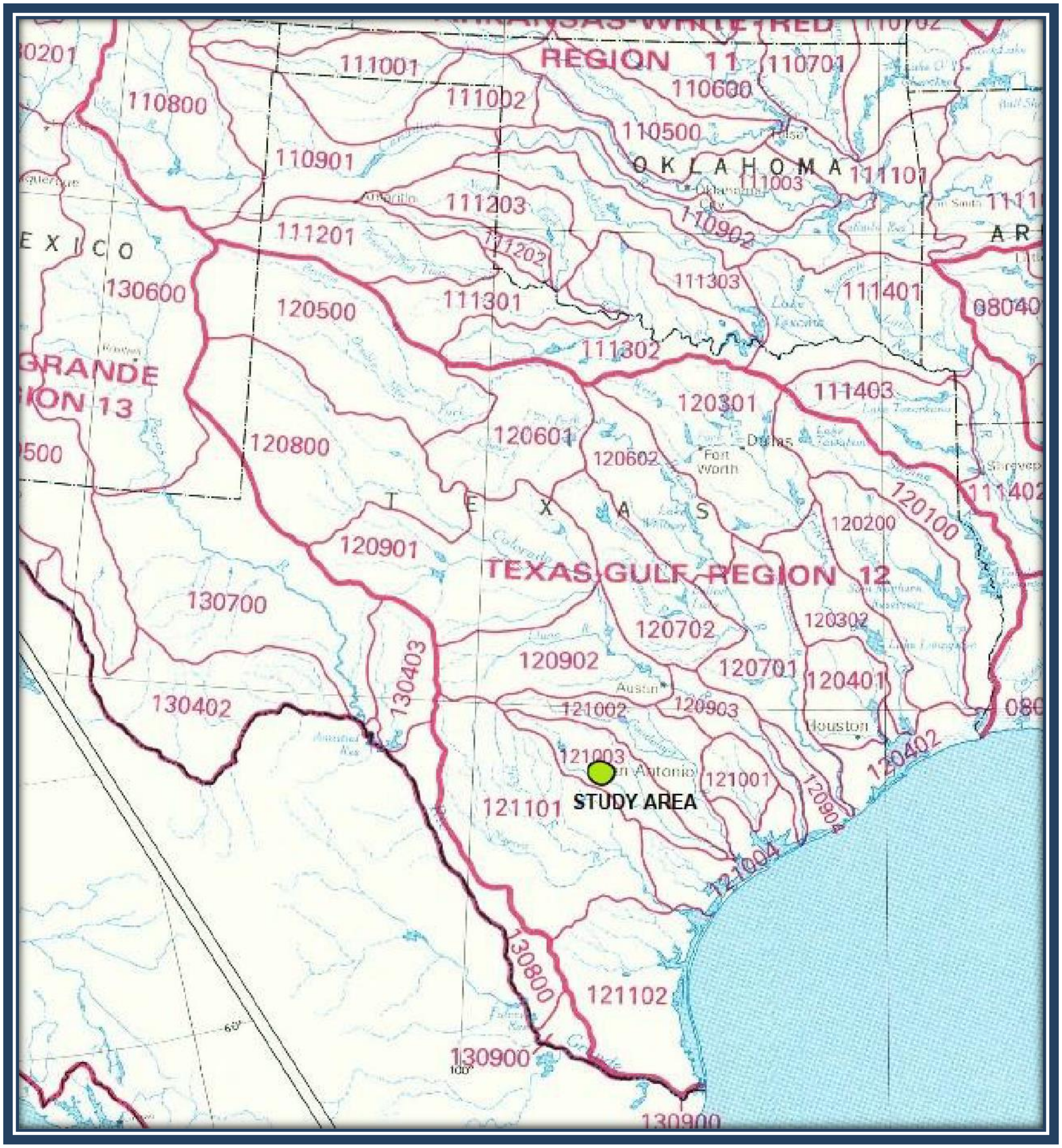

Figure 30 – Map Showing Texas Gulf Region 12

The nearest stream gage to the project area is the USGS 08181500 Medina River at San Antonio, Texas. The gage is located along the Medina River on the upstream side of the US 281/Pleasanton Road bridge, within a mile downstream of Mitchell Lake Dam. Pertinent gage data is as follows:

Bexar County, Texas
Hydrologic Unit Code 12100302
Latitude 29°15'50", Longitude 98°29'26" NAD27
Drainage area 1,317 square miles
Gage datum 439.03’ above NGVD29
Gage installed in 1939

The gage is only slightly affected by regulation. The sole dam on the river is Medina Dam and Lake located about 40 miles northwest of San Antonio. Medina dam is basically a pass-through structure with incidental flood control capacity (Appendix A – Hydrology, Hydraulics and Climate, Chapter 5).

3.1.1.2 Temperature

A literature search was conducted to locate information related to observed and projected climate trends. On a larger scale, there has been an increase in the average temperature of the contiguous United States over the past several decades. Figure 31 and Figure 32 show the change in annual average temperature across the United States. Texas is located in the Great Plains South region and is shown in comparison with the other regions in the United States.

NCA Region	Change in Annual Average Temperature	Change in Annual Average Maximum Temperature	Change in Annual Average Minimum Temperature
Contiguous U.S.	1.23°F	1.06°F	1.41°F
Northeast	1.43°F	1.16°F	1.70°F
Southeast	0.46°F	0.16°F	0.76°F
Midwest	1.26°F	0.77°F	1.75°F
Great Plains North	1.69°F	1.66°F	1.72°F
Great Plains South	0.76°F	0.56°F	0.96°F
Southwest	1.61°F	1.61°F	1.61°F
Northwest	1.54°F	1.52°F	1.56°F

Figure 31 - Change in Average Annual Temperature United States

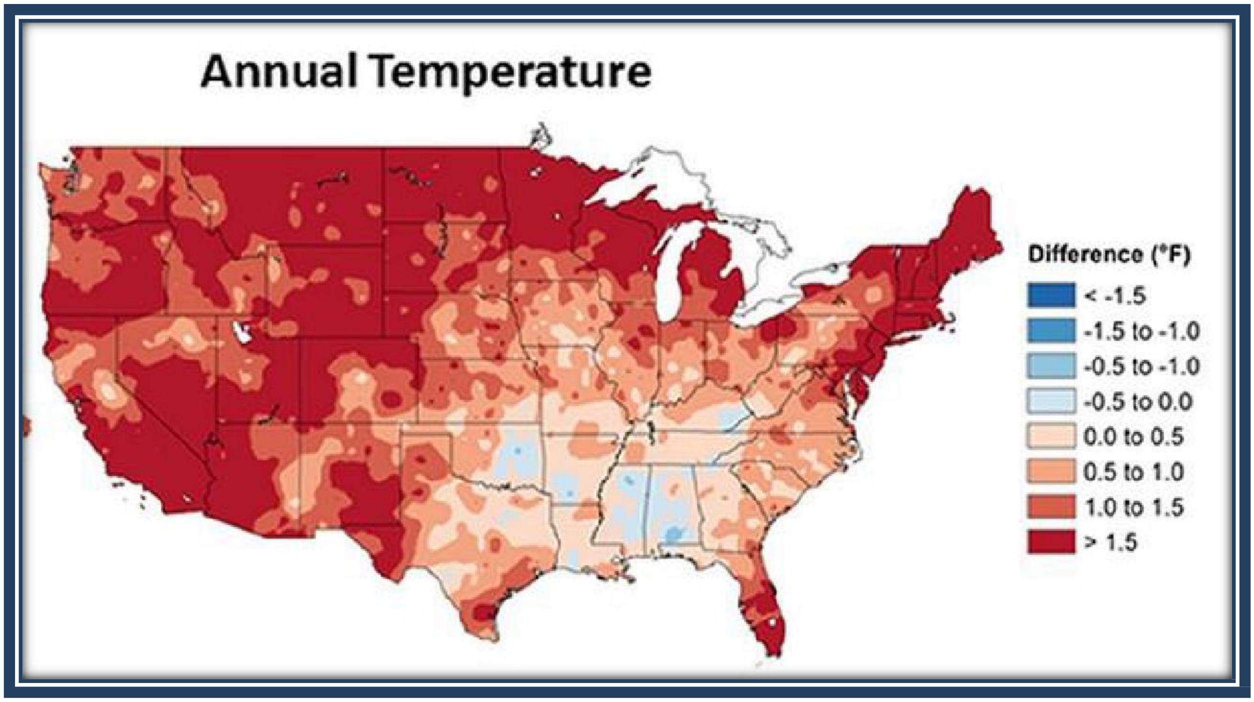

Figure 32 - Change in Average Annual Temperature United States

Analysis of observed daily temperature and rainfall records at the San Antonio International Airport weather station shows trends that are consistent with those observed for the United States. Table 22 shows the monthly and yearly average temperatures from 1960 – 2019 for the San Antonio area.

Table 22 - San Antonio Monthly and Yearly Average Temperatures 1960 - 2019

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
	50.0	49.8	56.0	69.7	74.0	83.2	84.2	83.5	78.6	73.2	62.2	50.1	67.9
	47.9	55.8	65.6	68.5	78.4	81.3	82.5	82.5	80.5	71.1	58.0	54.2	68.9
	45.8	62.8	59.1	69.7	77.9	82.3	86.8	87.5	80.9	75.5	60.3	52.1	70.1
	46.2	52.5	65.5	74.6	77.7	83.4	85.4	85.7	81.1	74.1	62.4	45.6	69.5
	51.0	49.8	61.5	70.5	77.6	82.4	86.3	86.2	80.0	66.3	62.6	52.2	68.9
	54.4	49.8	54.9	71.6	75.0	81.6	84.9	84.0	80.7	66.8	64.5	55.5	68.6
	45.3	49.7	60.0	68.6	73.5	78.8	84.2	81.9	77.5	66.9	63.0	50.6	66.7
	50.2	51.8	66.9	76.5	76.6	84.5	85.2	82.6	75.5	66.9	60.4	51.0	69.0
	49.8	48.2	58.0	68.1	75.3	80.5	82.7	84.1	75.9	72.2	56.4	50.7	66.8
1969	52.5	53.6	54.9	69.0	73.4	81.2	86.8	85.7	79.6	69.8	58.1	55.1	68.3
1970	45.5	54.8	56.8	70.1	72.9	80.6	83.9	85.6	81.1	67.7	58.0	60.1	68.1
1971	56.0	57.4	64.6	69.4	78.1	83.6	85.9	81.5	80.1	73.8	63.1	57.2	70.9
1972	52.8	56.7	66.2	73.7	72.8	80.3	82.2	82.1	81.9	71.9	54.0	50.2	68.7
1973	47.2	51.9	66.1	66.0	74.7	79.2	83.1	82.1	79.3	72.5	65.7	52.1	68.3
1974	51.0	56.4	67.9	69.7	77.3	79.4	83.0	81.1	72.3	68.1	57.3	50.9	67.9
1975	53.2	53.5	61.4	68.4	73.5	80.0	80.9	81.7	76.0	71.1	60.3	53.0	67.8
1976	49.6	61.2	63.8	68.9	71.3	79.8	79.8	81.6	77.5	61.0	52.1	49.8	66.4
1977	44.0	52.8	61.8	66.9	74.8	81.5	84.8	84.7	82.3	71.2	61.4	53.3	68.3
1978	43.3	46.4	59.6	68.9	77.0	82.7	86.0	83.0	78.5	69.3	62.4	51.7	67.4

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
1979	43.7	52.4	63.3	69.7	73.8	80.8	84.7	83.1	78.7	74.7	58.2	55.3	68.2
1980	52.6	53.6	61.4	67.5	76.1	85.1	88.1	85.3	83.6	70.7	58.3	55.0	69.8
1981	50.8	53.7	60.6	72.9	75.3	81.5	84.2	84.7	78.9	71.8	62.4	53.0	69.1
1982	50.8	49.6	63.0	66.9	74.5	81.6	85.5	86.0	80.0	69.3	59.3	52.4	68.2
1983	48.9	52.1	58.7	65.2	73.6	79.2	82.9	84.5	78.5	70.8	62.5	43.0	66.7
1984	46.6	54.1	64.2	69.7	77.0	82.7	84.9	84.7	77.6	71.2	58.7	59.6	69.3
1985	44.2	50.5	64.0	69.4	76.6	80.2	82.2	85.5	79.4	71.7	64.4	49.9	68.2
1986	53.4	58.0	62.9	72.6	74.6	81.4	85.8	85.7	83.7	69.7	59.3	51.6	69.9
1987	50.6	55.8	57.8	66.1	75.7	80.5	83.8	86.0	79.2	71.2	60.6	54.2	68.5
1988	47.5	54.2	61.3	69.0	76.1	81.1	84.6	86.4	80.7	73.2	65.1	56.0	69.6
1989	56.1	51.6	61.9	70.3	81.7	83.3	86.6	86.0	79.0	71.2	61.8	43.4	69.4
1990	56.4	58.8	61.5	69.6	79.3	87.4	83.3	85.2	80.0	69.3	63.0	51.9	70.5
1991	48.9	56.6	64.0	72.4	77.6	82.8	84.5	85.8	77.8	73.2	57.4	55.5	69.7
1992	50.7	59.1	63.3	69.0	73.7	82.5	84.7	82.1	81.7	73.4	57.2	56.2	69.5
1993	51.1	55.5	61.5	67.3	73.9	81.5	86.0	87.2	81.5	70.6	56.3	55.0	69.0
1994	52.3	56.1	63.9	69.8	76.0	84.5	87.8	86.1	78.4	72.6	64.7	56.9	70.8
1995	53.5	57.4	61.8	69.8	78.6	79.3	84.3	85.5	80.1	69.8	59.5	55.6	69.6
1996	51.0	57.9	57.6	69.5	81.9	84.1	87.3	84.4	78.4	71.0	61.3	54.5	69.9
1997	49.1	53.1	63.2	63.9	74.0	79.8	85.0	86.1	82.2	70.2	57.3	50.2	67.8
1998	56.4	55.3	59.7	66.7	79.8	86.3	88.0	83.6	80.5	71.4	62.4	52.7	70.2
1999	54.6	61.8	62.6	71.2	76.1	81.8	82.8	86.1	80.3	69.6	63.0	54.0	70.3
2000	55.2	62.6	67.0	70.7	78.6	81.0	85.9	86.3	80.9	73.0	56.9	46.4	70.4
2001	49.2	57.5	56.5	70.8	76.3	82.6	85.4	85.5	76.9	67.9	62.9	53.7	68.8
2002	54.0	50.8	60.3	73.2	76.8	83.4	82.5	85.3	78.7	70.7	57.8	53.8	68.9
2003	50.1	53.1	60.6	71.6	80.3	81.7	81.9	83.7	76.7	70.6	63.0	53.9	68.9
2004	54.5	52.6	65.9	67.2	76.1	80.8	82.9	83.3	80.5	76.9	61.1	53.1	69.6
2005	55.9	56.3	61.3	68.4	75.0	82.6	85.3	85.7	84.3	70.9	64.9	53.0	70.3
2006	58.2	55.9	67.5	76.7	78.7	83.6	85.7	88.3	79.7	72.4	63.8	54.4	72.1
2007	48.3	54.8	65.0	65.2	75.5	80.7	80.4	83.7	80.2	73.1	62.7	56.1	68.8
2008	51.8	61.7	64.5	70.6	80.1	86.8	84.1	84.4	79.5	71.4	63.7	55.0	71.1
2009	54.9	62.9	65.1	69.8	79.5	86.3	88.7	88.3	78.4	69.9	60.7	48.3	71.1
2010	49.7	49.4	59.3	68.6	77.5	83.5	84.0	87.5	80.1	70.2	62.1	53.8	68.8
2011	50.5	55.4	66.8	75.7	78.6	86.2	87.9	90.0	82.9	71.0	62.9	53.8	71.8
2012	56.2	57.4	66.4	73.9	78.1	84.8	85.4	87.2	79.6	70.7	63.2	57.1	71.7
2013	53.9	59.0	62.7	67.6	75.8	83.9	86.1	88.6	83.4	73.5	59.9	52.1	70.5
2014	51.1	57.4	60.6	71.3	75.7	83.1	84.9	88.1	82.0	76.3	57.3	56.7	70.4
2015	49.5	53.2	60.9	71.7	76.3	81.6	85.6	87.4	83.5	75.7	63.1	58.2	70.6
2016	51.8	59.2	65.9	69.7	75.1	82.0	86.9	83.9	81.8	74.4	66.4	55.8	71.1
2017	57.5	64.1	67.5	71.1	75.6	83.3	87.6	84.6	79.4	70.4	66.5	52.9	71.7
2018	49.3	58.4	67.0	68.0	80.5	86.4	86.1	86.6	79.3	69.8	56.7	53.7	70.2
2019	52.1	57.5	60.6	68.6	77.0	81.7	84.8	88.6	85.8	71.5	58.7	55.5	70.2

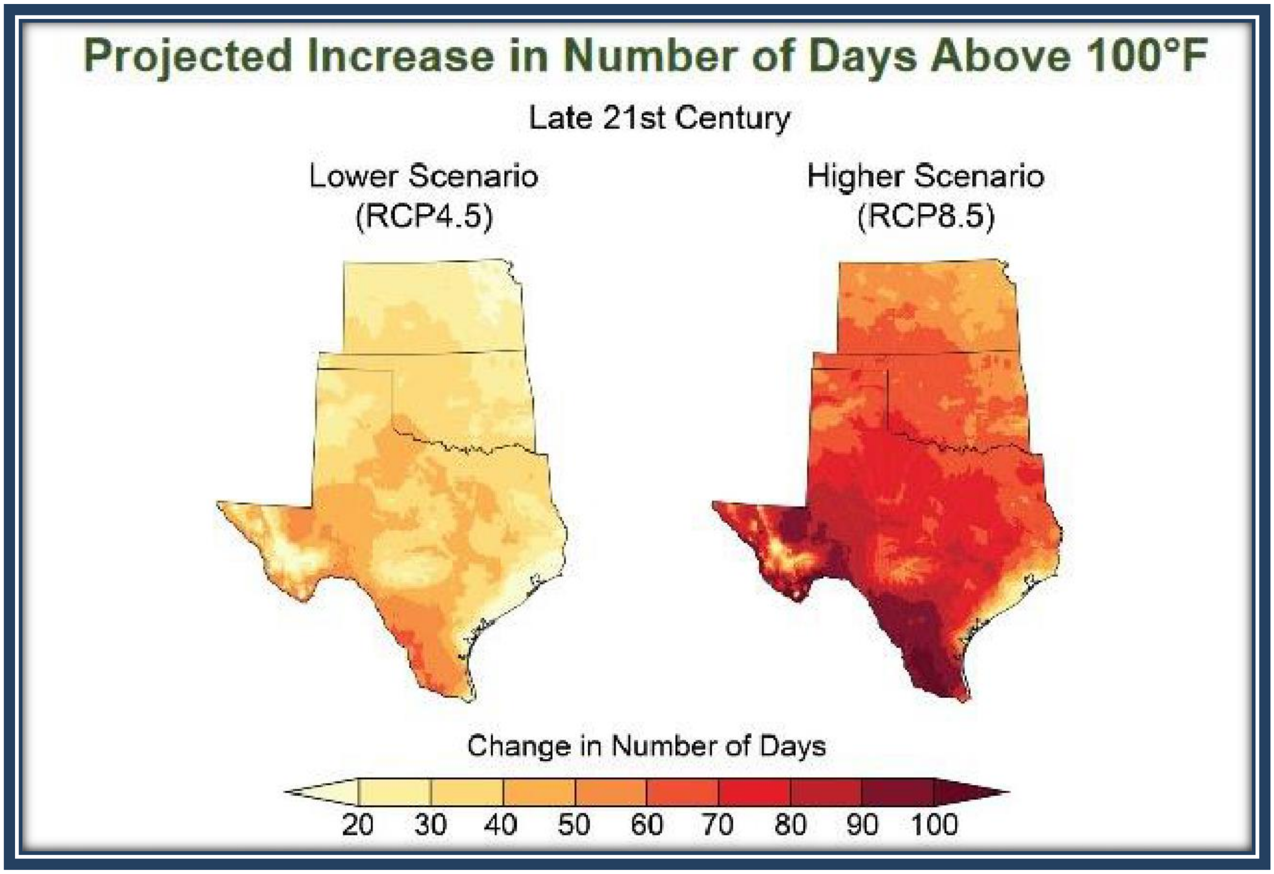

Figure 33 - Projected Increase in the Number of Days Above 100ºF

The maximum temperatures reach more than 100º F in the Southern Plains for an average of seven days per year. These high temperatures are projected to occur much more frequently and projected to double in number in the north regions and quadruple in the south by mid-century (Figure 33). A result of these increases will be the increase in surface water losses.

This trend should not adversely affect the operation of any proposed project as the project area can be supplemented by water supplied by the Leon Creek Wastewater Recycling Center.

A summary matrix of the trends and literary consensus of observed and projected primary variables for the Texas Gulf Region is shown in Figure 34 and Figure 35. Under both lower- and higher-scenario climate change projections, the number of days exceeding 100°F is projected to increase markedly across the Southern Great Plains by the end of the century (2070 – 2099 as compared to 1976 – 2005).

Figure 34 shows the trend in the temperature data in graphical form[4]. The graphs show the observed year-to-year values (thin lines) and long-term trends (thick lines) in winter and summer mean temperature (top) and in the number of days per year with maximum temperature exceeding 80, 90 and 100°F (bottom) at the San Antonio International Airport weather station from 1960 to 2014 (Appendix A – Hydrology, Hydraulics and Climate, Chapter 5).

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[4] Climate trends in San Antonio and an Overview of Climate projections for the South-Central Region, Katherine Hayhoe, Ph.D., ATMOS research & Consulting, May 2015 Revised

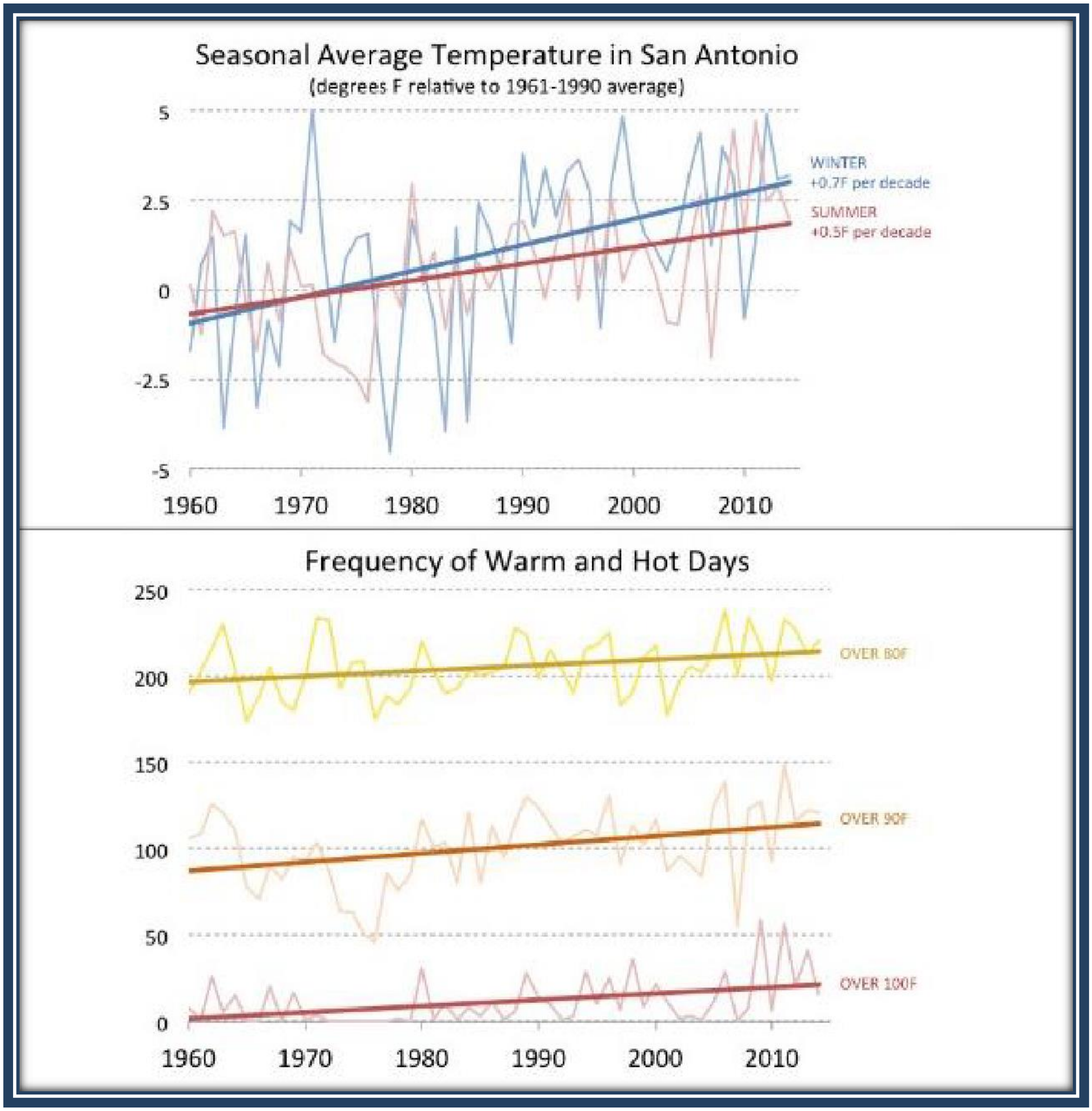


Figure 34 - Trend in San Antonio Temperatures

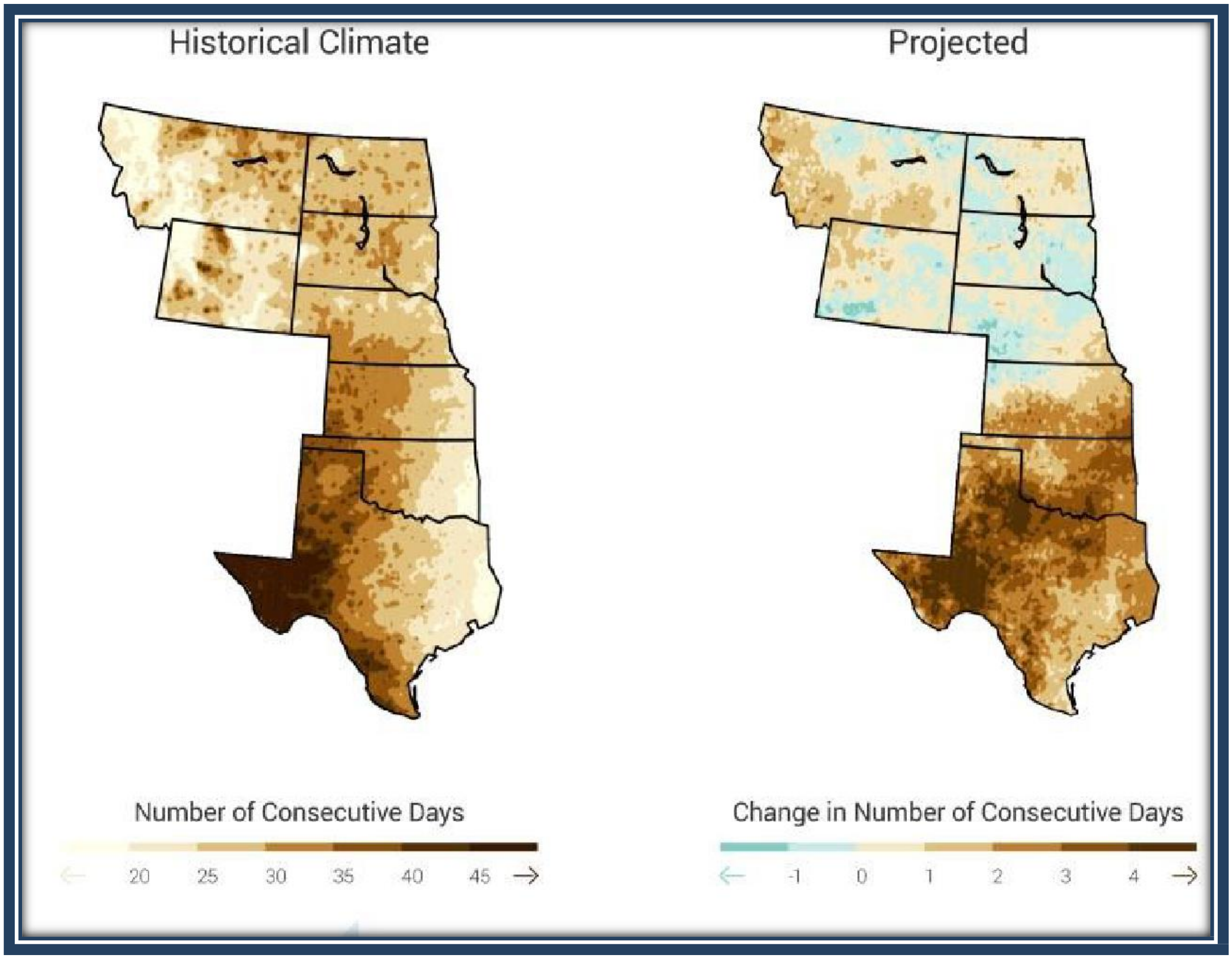


Figure 35 - Projected Change in Number of Hot Days

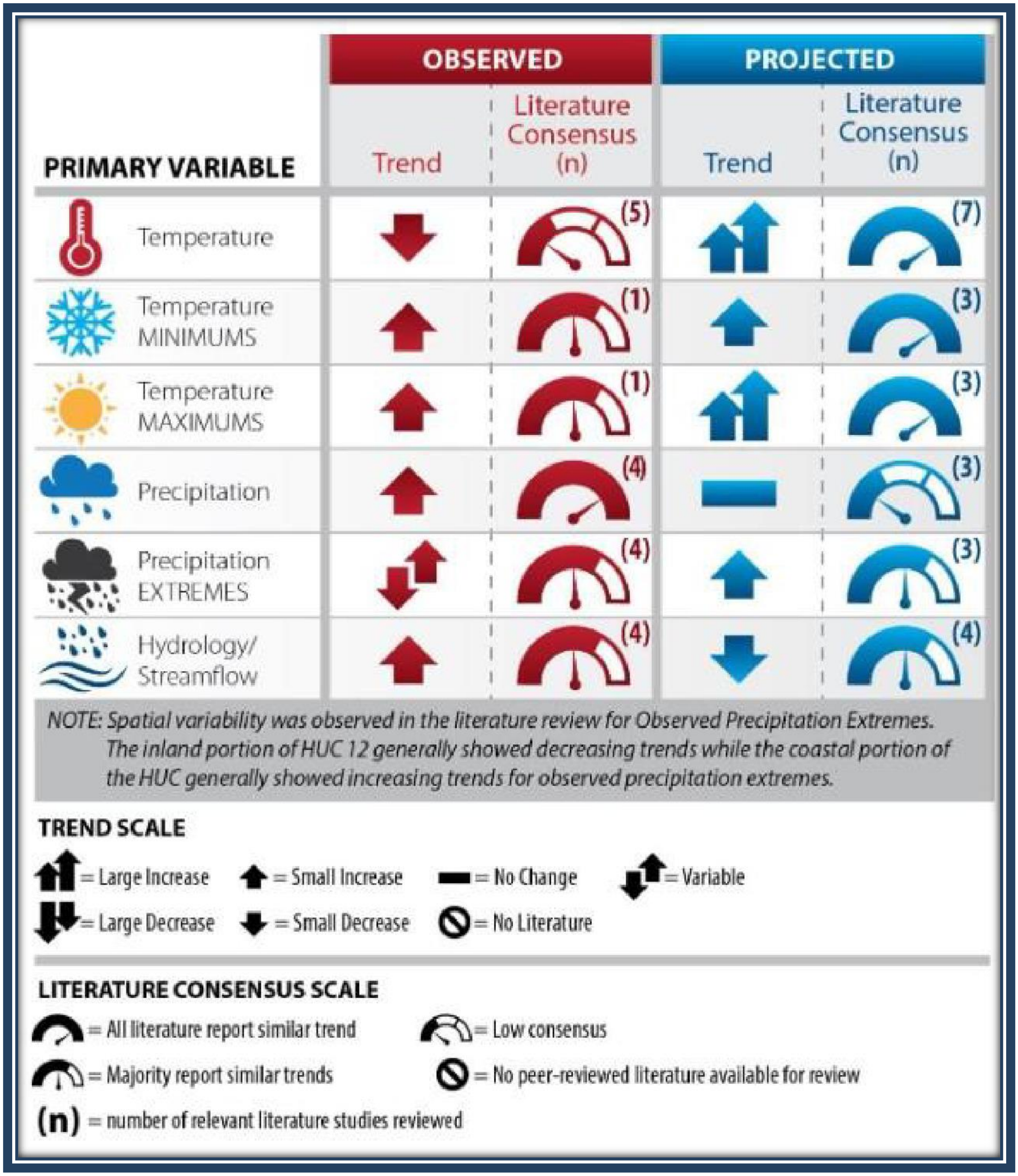


Figure 36 - Summary Matrix of Observed and Projected Climate Trends and Literary Consensus

3.1.1.3 Precipitation

Climate studies project that the observed increase in heavy precipitation events will continue in the future and increases are expected in all regions, even those regions where total annual precipitation is projected to decline, such as the southwestern United States. The projections indicate a slight increase in the numbers of dry days and the very lightest precipitation days and a large increase in the heaviest days. Figure 38 shows projections of changes in the 20-year return period amount for daily precipitation – large percentage increases for both the middle and late 21st century. A lower emission scenario show increases of around 10% for mid-century and up to 14% for the late century projections. A higher emission scenario shows even larger increases for both mid- and late-century projections, with increases of around 20% by late 21st century.

Drought conditions in Texas have been an on-going concern. Several Texas state agencies monitor drought conditions and develop drought contingency plans and guidance to local communities. The San Antonio Water System proactively manages the region's water resources by using rules and restrictions established by city ordinance. The rules and restrictions limit water use based on specific levels of the Edwards Aquifer.

Figure 35 shows that parts of Texas are projected to experience more frequent hot days. Figure 36 is a visual representation of the Summary Matrix of Observed and Projected Climate Trends and Literary Consensus. Future projected precipitation information from the Fourth National Climate Assessment for the Southern Great Plains region is shown in Figure 37, Figure 38 and Figure 38. The study area will be subject to a general decrease in projected seasonal precipitation (Appendix A – Hydrology, Hydraulics and Climate, Chapter 5).

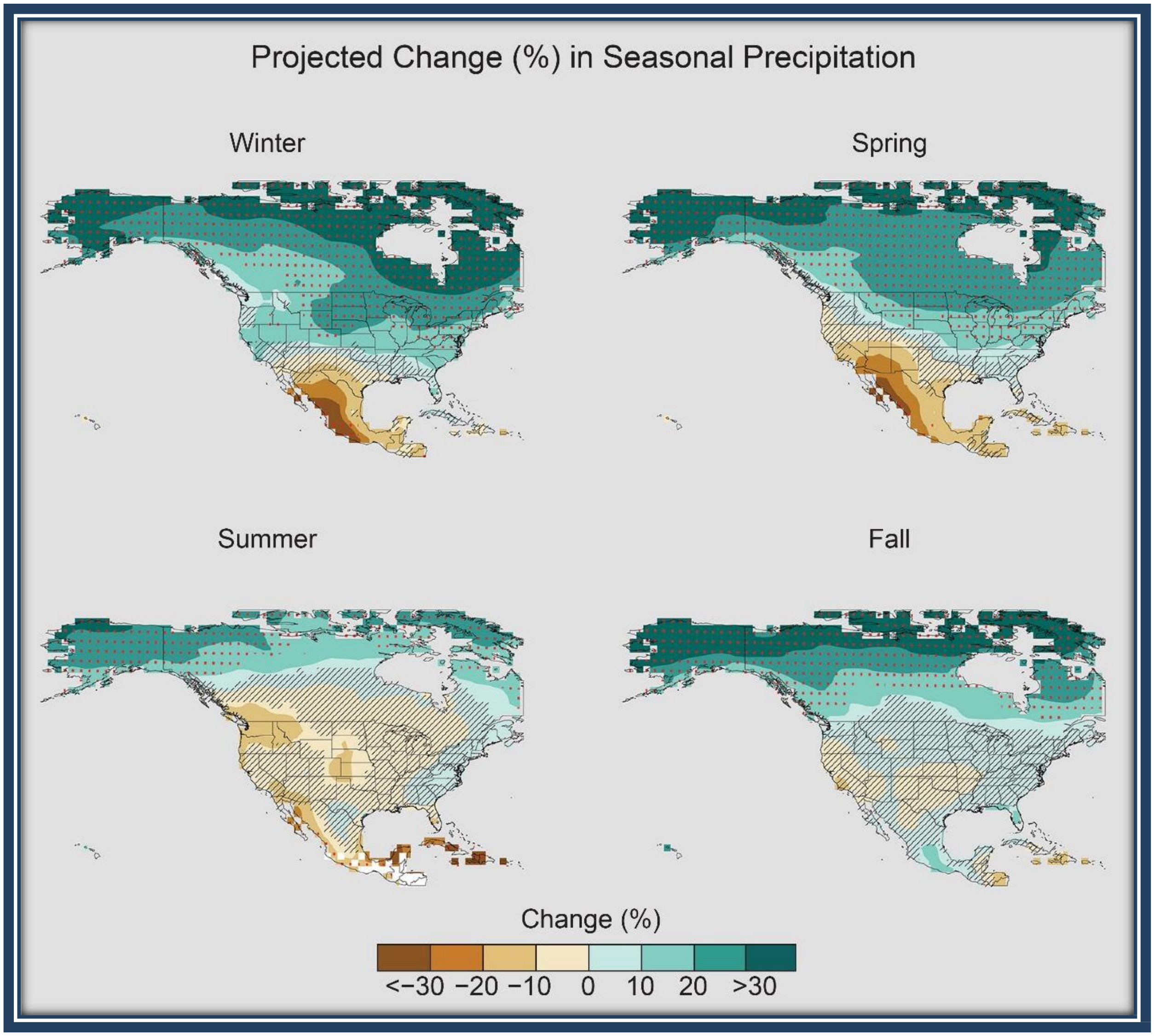
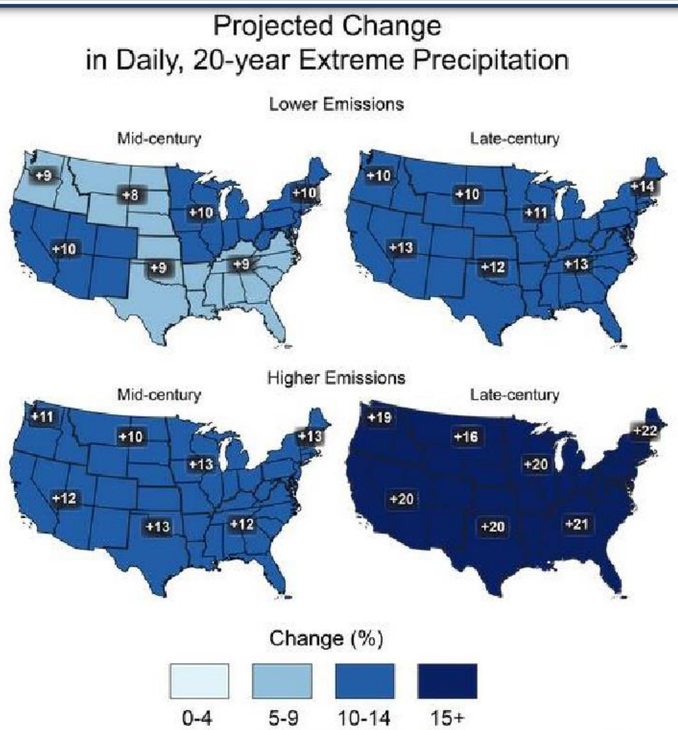
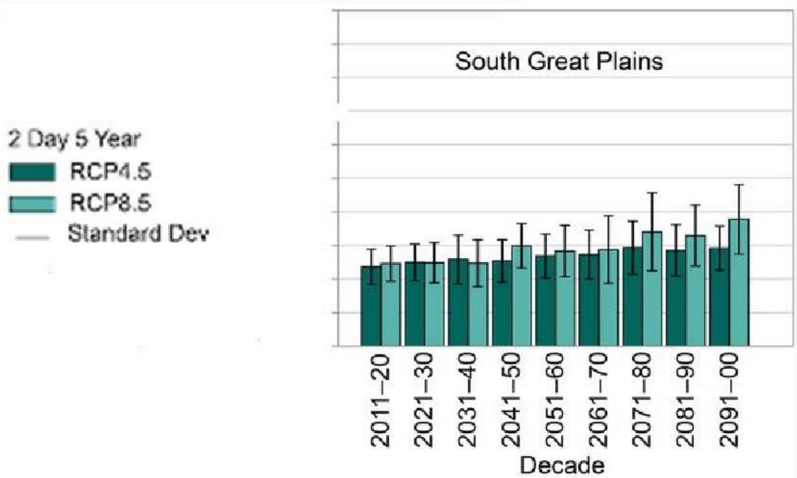


Figure 37 - Projected Change (%) in Seasonal Precipitation (2070 – 2099)



Projected change in the 20-year return period amount for daily precipitation for mid- (left maps) and late-21st century (right maps). Results are shown for a lower scenario (top maps; RCP4.5) and for a higher scenario (bottom maps, RCP8.5). These results are calculated from the LOCA downscaled data. (Figure source: CICS-NC and NOAA NCEI).



Regional extreme precipitation event frequency for a lower scenario (RCP4.5) (green; 16 CMIP5 models) and the higher scenario (RCP8.5) (blue; 14 CMIP5 models) for a 2-day duration and 5-year return. Calculated for 2006–2100 but decadal anomalies begin in 2011. Error bars are ±1 standard deviation; standard deviation is calculated from the 14 or 16 model values that represent the aggregated average over the regions, over the decades, and over the ensemble members of each model. The average frequency for the historical reference period is 0.2 by definition and the values in this graph should be interpreted with respect to a comparison with this historical average value. (Figure source: Janssen et al. 2014[84]).

Figure 38 - Future Projected Precipitation Information for the Southern Great Plains

3.1.1.4 USACE Climate Hydrology Assessment Tool (CHAT)

CHAT was used to provide information on historic trends in observed data. This tool aids in preparing a qualitative analysis regarding climate change impacts for projects with hydrologic based aspects. The tool utilizes selected gage data located within the project area. For this qualitative assessment, the USGS 08181500 Medina River at San Antonio, Texas gage was used in the analysis, based on the proximity to the project area. A plot of the observed annual peak stream flow at the gage is shown in Figure 39. There is not a statistically significant trend for this region as the p value is approximately 0.66. This p value is significantly greater than the typically adopted threshold of significance of less than 0.05.

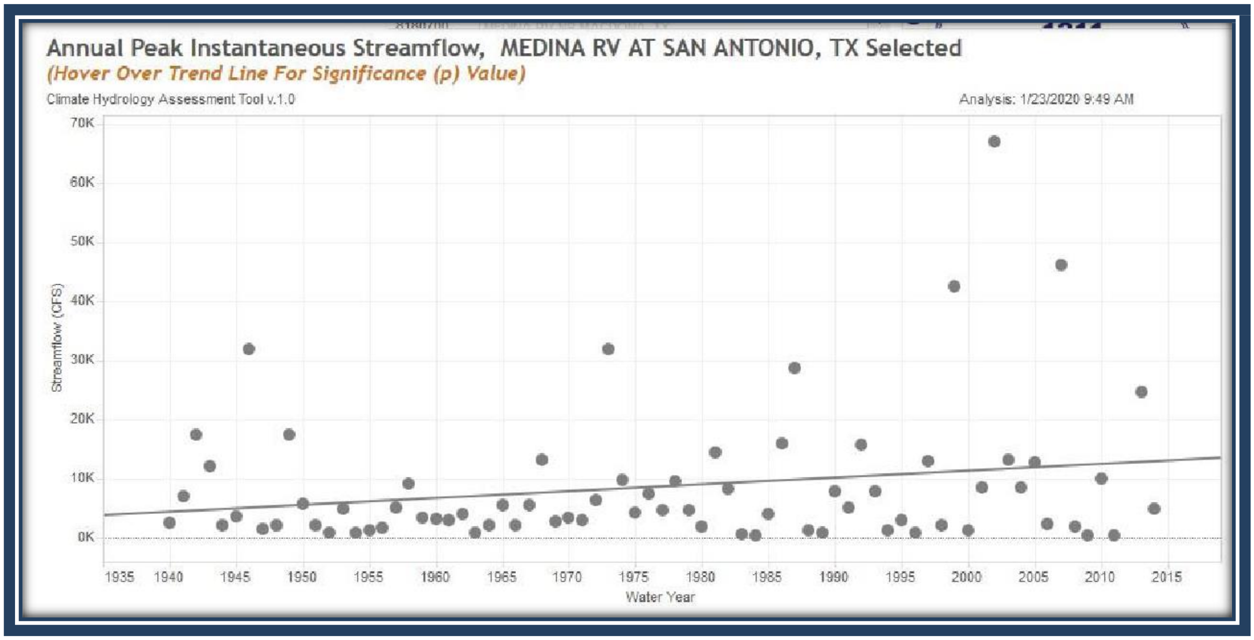


Figure 39 - Annual Peak Instantaneous Streamflow Medina River at San Antonio, TX

The USACE Climate Hydrology Assessment Tool was also used to investigate potential future trends in stream flow for the Medina River watershed. Figure 40 displays the range of projected annual maximum monthly stream flow computed from 93 different climate changed hydrologic model runs for the period of 2005-2099.

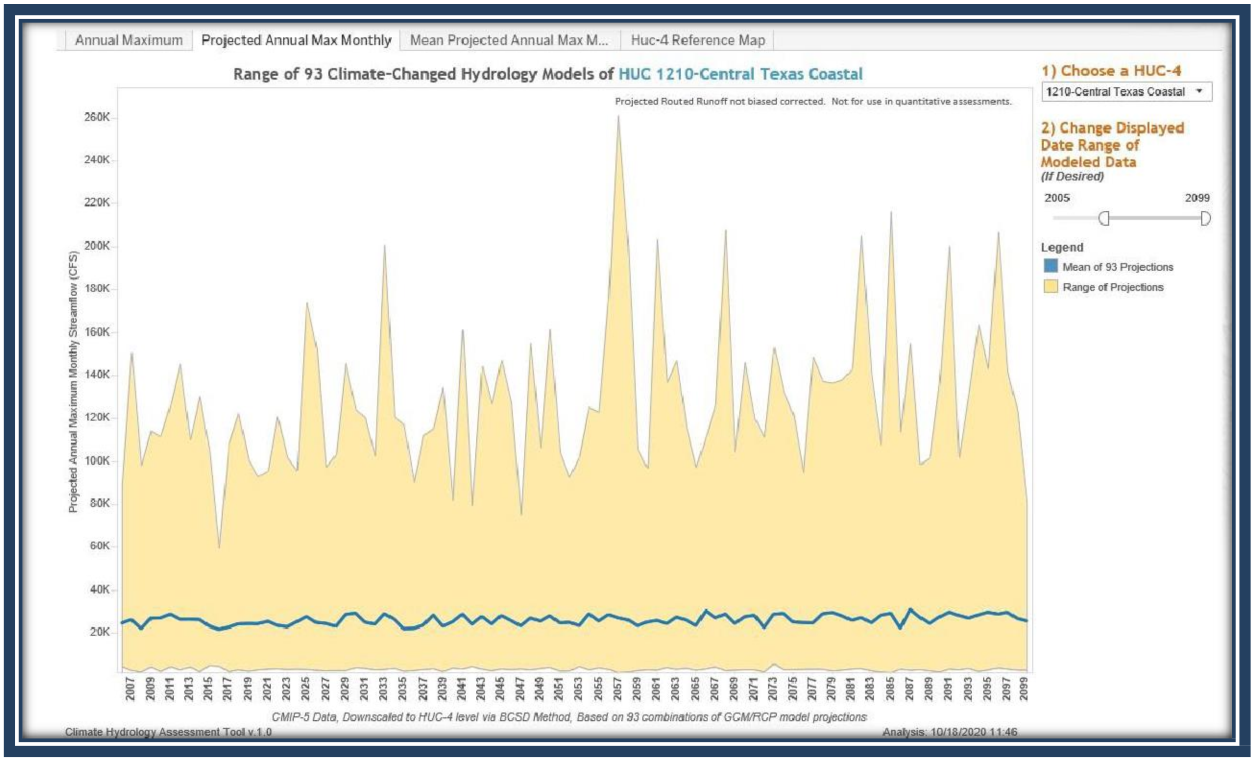


Figure 40 - Range of Projected Annual Maximum Monthly Streamflow

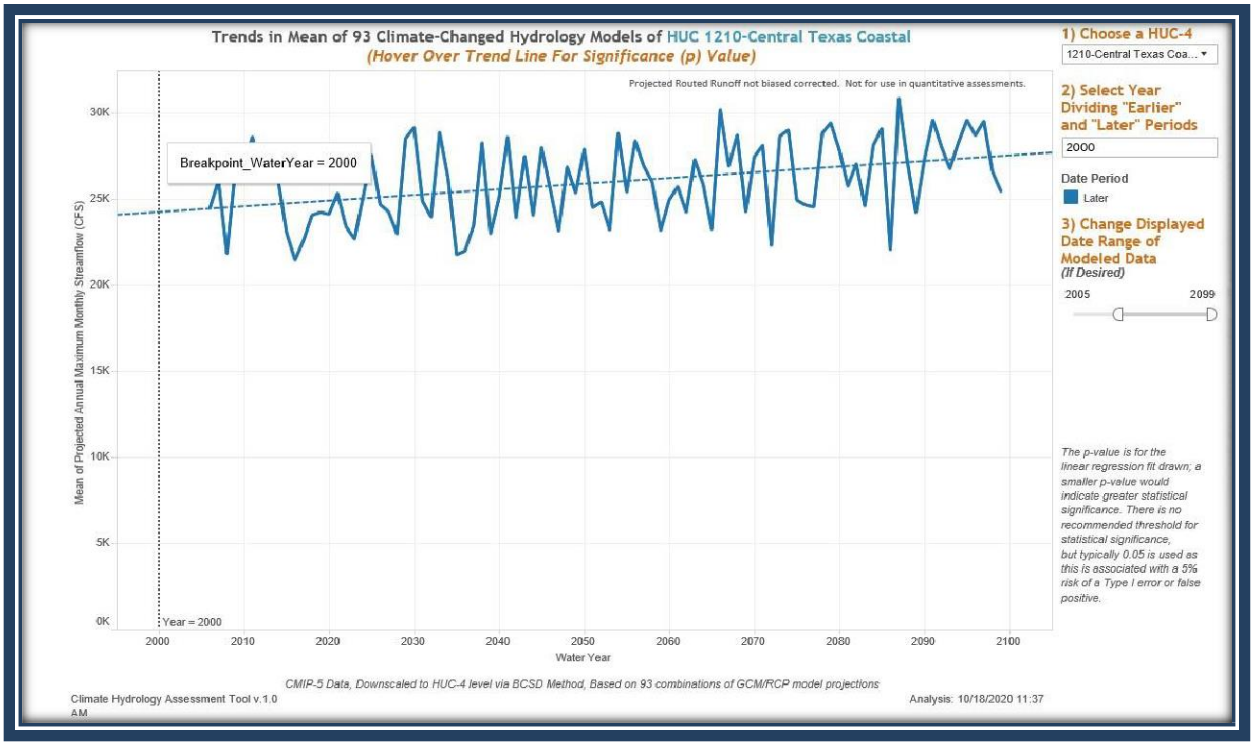


Figure 41 - Mean Projected Annual Maximum Flows

The p value is 0.000104, which indicates a significant trend in the future projection (Figure 41).

3.2 Environmental Resources – Affected Environment

Under the FWOP condition, there would be no ecosystem restoration within the Mitchell Lake study area, however, it is anticipated that normal activities by the public and natural ecological processes would continue to occur in the study area. Chapter 3 is a general description of the likely future conditions in the study area over the 50-year Period of analysis in the FWOP. The habitat types analyzed for the FWOP include riparian forest, emergent wetland and mudflat habitat. Life requisite values and metric variables will be mentioned throughout this section.

The Habitat Suitability Index (HSI) model metric variables for the FWOP and FWP conditions were projected at meetings on 22 and 23 June 2019. The projections for each of the HSI model metric variables were based on professional judgment and existing conditions. Representatives from the TCEQ, NRCS, USACE, SAWS and the USFWS assisted with this process. (Appendix C – Environmental Resources, Chapter 3).

Unless stated otherwise, it is assumed the existing conditions will continue to persist and degrade in the FWOP scenario.

3.2.1 Geology and Topography and Soils (including Prime Farmlands)

No change from the existing condition is expected.

3.2.2 Land Use

Land Use is expected to change from agricultural to an urban landscape. Bexar County is expected to have a significant increase in population size over the next 50 years. Additional homes and businesses will be required to expand and will most likely result in urbanization within the study area, outside of SAWS' owned property (Main Report, Chapter 2).

3.2.3 Air Quality

Due to Bexar County's increasing population size, it is assumed that air quality will degrade with the influx of additional vehicles.

3.2.4 Noise

Noise from growing residential areas is expected to increase over a 50-year period. This will be due to an increased population size, leading to additional vehicular noise and home maintenance.

3.2.5 Transportation

It is expected that with growing population rates transportation will be impacted, leading to increased vehicular traffic.

3.2.6 Light

Because of the urban landscape, sky glow (diffuse light escaping from urban sources) will potentially be the greatest source of artificial light within the study area, however; a significant portion of the study area is owned by the NFS and will be relatively protected from light. This will be due to the increased size of trees and shrubs within the area that will block some of the light around the edges of Mitchell Lake and the study area.

3.2.7 Water Resources

There will be some changes to water resources in the FWOP conditions, which are described below.

3.2.7.1 Surface Water

In the FWOP condition, the Mitchell Lake Water Management Plan is to decrease the surface water elevation from 520.4’ to 518.5’ (NAVD88), thereby decreasing the open water surface area of the lake. This condition will expose approximately 35 acres of shoreline that has been historically inundated.

3.2.7.2 Groundwater

The Mitchell Lake study area is located outside of the Edwards and Carrizo Wilcox Aquifer Recharge Zones; therefore, no changes are expected from existing conditions (Main Report, Chapter 2).

3.2.7.3 Water Quality

Urbanization will continue to be a contributing factor to the water quality of the northern wetlands, polders and Mitchell Lake itself. Although there are not permittable actions that would allow runoff from adjacent properties to enter Mitchell Lake, this may continue to impact water quality of the study area. SAWS will implement constructed wetlands downstream of Mitchell Lake as part of the “Schedule of Activities” as listed in the EPA AO. Water from the lake will be gravity-fed into the wetlands. This water will eventually enter Cottonmouth Creek after being treated by bulrush species, thereby slowly improving water quality within the study area over a 50-year period.

A pilot study wetland is currently in place on the southwestern boundary of Mitchell Lake and is performing to SAWS’ satisfaction. The pilot study is being used to evaluate the feasibility of using a constructed wetland to remove algae and nutrients in order to improve water quality and meet water quality goals. Completion of the constructed wetlands downstream of Mitchell Lake is expected to occur by September 2024.

3.2.7.4 Wetlands

There would be no change to the quantity or quality of the wetlands north of the polders or to the water management of the polders. Water quality would not be improved, although a complex of water quality treatment proposed for construction by SAWS would increase the water quality for the Mitchell Lake outflows. However, the treatment wetlands would not affect the water quality of Mitchell Lake. Proposed construction by SAWS at the spillway (Figure 8 and Figure 9) and downstream would increase the water quality entering Cottonmouth Creek.

3.2.8 Visual Aesthetics

Under the FWOP conditions, SAWS property would remain the same as the existing conditions as the property is managed for wildlife habitat by the Mitchell Lake Audubon Center facility (Figure 10 and Figure 11). However, the visual aesthetics of the areas adjacent to SAWS property will be obstructed by residential and commercial development as urban sprawl continues in San Antonio.

3.2.9 Recreation

Under the FWOP, the Pleasanton Road and Mattox Park trails will connect to the Mission Reach trail on the San Antonio River and will be extended to additional trails to the west (Figure 42). Recreation is expected to improve within the study area through efforts by the Mitchell Lake Audubon Center and SAWS. Under the FWOP, recreational features and improved wildlife habitat will increase as the Audubon Center continues to develop wildlife habitat around Mitchell Lake and increase ecotourism opportunities in San Antonio.

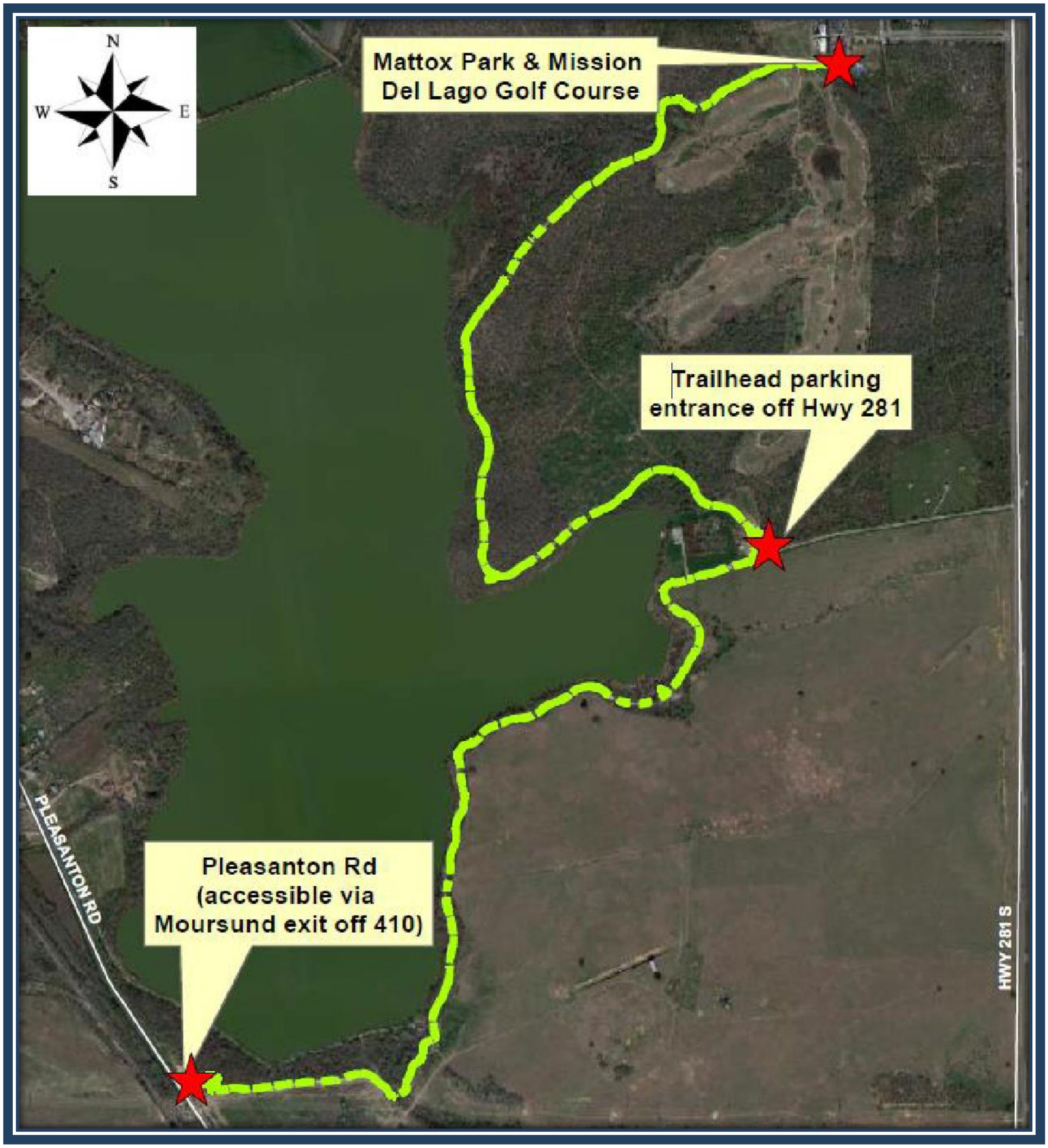


Figure 42 - Pleasanton Road and Mattox Park Trails

3.2.10 Vegetation

Unless supplemented by focused efforts of integrated pest management and native species plantings, Mitchell Lake and the surrounding areas will continue to exhibit low quality wildlife habitat value.

There will be approximately 35 acres of shoreline exposed in the FWOP conditions due to the drop in water elevation from 520.4’ to 518.5’ (NAVD88). It is assumed low quality and invasive species such as Chinese privet (*Ligustrum sinense*), chinaberrytree (*Melia azedarach*), Chinese tallowtree (*Triadica sebifera*), alligator weed (*Alternanthera philoxeriodes*) and western ragweed (*Ambrosia psilostachya*), will continue to persist and spread in the newly exposed areas of Mitchell Lake. Hedge parsley (*Torilis arvensis*) and bedstraw (*Galium* spp.) will also soon dominate the areas that are no longer inundated with water. The marginal existing native vegetation within the study area will continue to provide very poor wildlife habitat quality because of the abundance of low-quality vegetation and non-native invasive species.

3.2.11 Wildlife

There are not any foreseeable plans in the Future Without Project to stock Mitchell Lake with fish and die-offs of wildlife species are not expected to occur. The habitat conditions are expected to degrade, yielding low benefits for wildlife use.

3.2.12 Federally Listed Threatened and Endangered Species

No change from the existing condition is expected.

3.2.13 Migratory Birds

No change from the existing condition is expected.

3.2.14 Invasive Species

SAWS and the Audubon Society have implemented a hog-trapping program to limit the impacts of feral hogs (*Sus scrofa*) on the ecosystem. Although these efforts would be expected to continue under the FWOP condition, the impacts of invasive species on the environment are expected to worsen because of the overabundance of invasive vegetative and animal species within the study area.

3.3 Cultural Resources

Under the future without-project condition, there will be no foreseeable horizontal or vertical impact to known cultural resources within the study area, aside from natural formation processes that occur over time.

3.4 Environmental Engineering

The FWOP HTRW situation in and around Mitchell Lake will most likely stay the same in the FWOP condition. Southern Bexar County is a relatively lightly developed area but contains a high concentration of oil and gas infrastructure. The petroleum industry can be reasonably expected to grow in conjunction with this developing region. The manufacture and use of petroleum, chemicals and other hazardous materials will continue in the project vicinity with or without the implementation of the proposed project. The extent to which HTRW sites continue to be created and discovered is impossible to predict. Existing HTRW sites may be remediated over time. (Appendix E – HTRW, Chapter 3)

3.5 Geology and the Structural Setting

The FWOP condition is not likely to change in any significant way in either the geology or structural setting of the study area (Appendix I – Geotechnical Engineering, Chapter 3).

3.6 Socioeconomics

Under the No Action Plan, the population of San Antonio is expected to increase as depicted in the Main Report, Chapter 2.

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4 Plan Formulation

Plan formulation is the process of building Plans that meet planning objectives and avoid planning constraints. The PDT defines the combination of management measures that comprise a plan in enough detail that realistic evaluation and comparison of the plan's contributions to the planning objectives and other effects can be identified, measured and considered. This process requires the views of stakeholders and others in agencies and groups outside the Corps to temper the process with different perspectives. Plan formulation capitalizes on imagination and creativity wherever it is found, across technical backgrounds and group affiliations.

Alternatives, sometimes known as alternative plans or just plans, are formulated to address the planning objectives. Combinations of management measures make up these plans and are defined is enough detail, that realistic evaluation and comparison of each plan's contributions to the objectives and other effects, can be identified, measured and considered. Usually multiple alternatives meet planning objectives. Good planning eliminates the least suitable alternatives while refining the remaining alternatives fairly and comprehensively.

Sometimes, the formulation process emphasizes structural details, costs, project outputs, safety, reliability and other technical matters. However, plan formulation must be balanced with environmental, social, institutional and other information that is less quantifiable, such as ecosystem benefits.

Ecosystem restoration is a priority for the USACE with the aim being to restore degraded ecosystem structure, function and dynamic processes.

To recap from Chapter 1,

Opportunities exist to:

1. reconnect the upstream and downstream hydrologie
2. improve water quality through ecosystem restoration
3. provide additional recreation and ecotourism benefits to the community

Specific Study Planning Objectives:

1. increase the areal extent and quality of fish and wildlife habitat in the study area for the 50-year Period of analysis
2. increase the floral and faunal species diversity and richness in the study area for the 50-year Period of analysis

Specific Planning and Institutional Constraints

<u>Institutional Constraints:</u>

1. Avoid increasing flood risks
2. Plans must be consistent will existing Federal, State and Local laws.
3. Ecosystem restoration may not principally result in treating, or otherwise abating, pollution, or other compliance responsibilities of the NFS.
    a. The NFS is under an AO by the EPA to improve water quality of Mitchell Lake water prior to entering the Medina River.

Specific Planning Constraints:

1. avoid mobilization of pollutants that would exceed Environmental Protection Agency water quality criteria limits
2. avoid currently developed areas

4.1.1 Conceptual Model

A Conceptual Ecological Model (CEM) is a qualitative representation of a system or sub-system that serves as a basis for organization of processes that can be utilized to understand and communicate the function of that process and the identification of factors impairing the optimal performance of the systems. These models, as applied to ecosystems are simple, qualitative models, represented by a diagram, which describes general functional relationships among the essential components of an ecosystem (Appendix C – Environmental Resources, Chapter 3).

The CEM provides a framework enabling the team to characterize the drivers and effects of impediments to ecosystem functions, potential measures to address these impediments and methodologies to characterize and quantify ecosystem benefits resulting from any restoration actions. The CEM format utilized here follows a top-down hierarchy of information. The Mitchell Lake CEM does not attempt to explain all possible relationships or include all possible factors influencing the performance measure targets within natural systems in the study area. Rather, the model attempts to simplify ecosystem function by containing only information deemed most relevant to ecosystem restoration and monitoring goals.

The CEM includes the following components (Figure 43):

- **Drivers:** This component includes major external driving forces that have large-scale influences on natural systems. Drivers may be natural (e.g. climate change) or anthropogenic (e.g. hydrologic alteration) in nature. Anthropogenic drivers provide opportunities for finding relevant solutions to problems. Natural drivers, however, cannot be influenced directly by human interference. Some drivers are both anthropogenic and natural in nature. The Mitchell Lake CEM introduces six drivers: Urban Development, Adjacent Agriculture and Land Use, the Mitchell Lake Dam, Wastewater Operations, Wildlife and Ecological Function and Climate Change.
- **Ecological Stressors:** This component includes physical or chemical changes that occur within the natural systems, which are produced or affected by drivers and are directly responsible for significant changes in biological components, patterns and relationships in natural systems.
- **Ecological Effects:** This component includes biological, physical, or chemical responses within the natural system that are produced or affected by stressors. CEMs propose linkages between one or more ecological stressors and ecological effects and attributes to explain changes that have occurred in ecosystems.
- **Attributes:** This component is a prudent subset of all potential elements or components of natural systems representative of overall ecological conditions. Attributes may include populations, species, communities, or chemical processes.
- **Performance Measures**: This component includes specific features of each attribute to be monitored to determine the degree to which attribute is responding to projects designed to correct adverse effects of stressors (i.e. to determine success of the project).

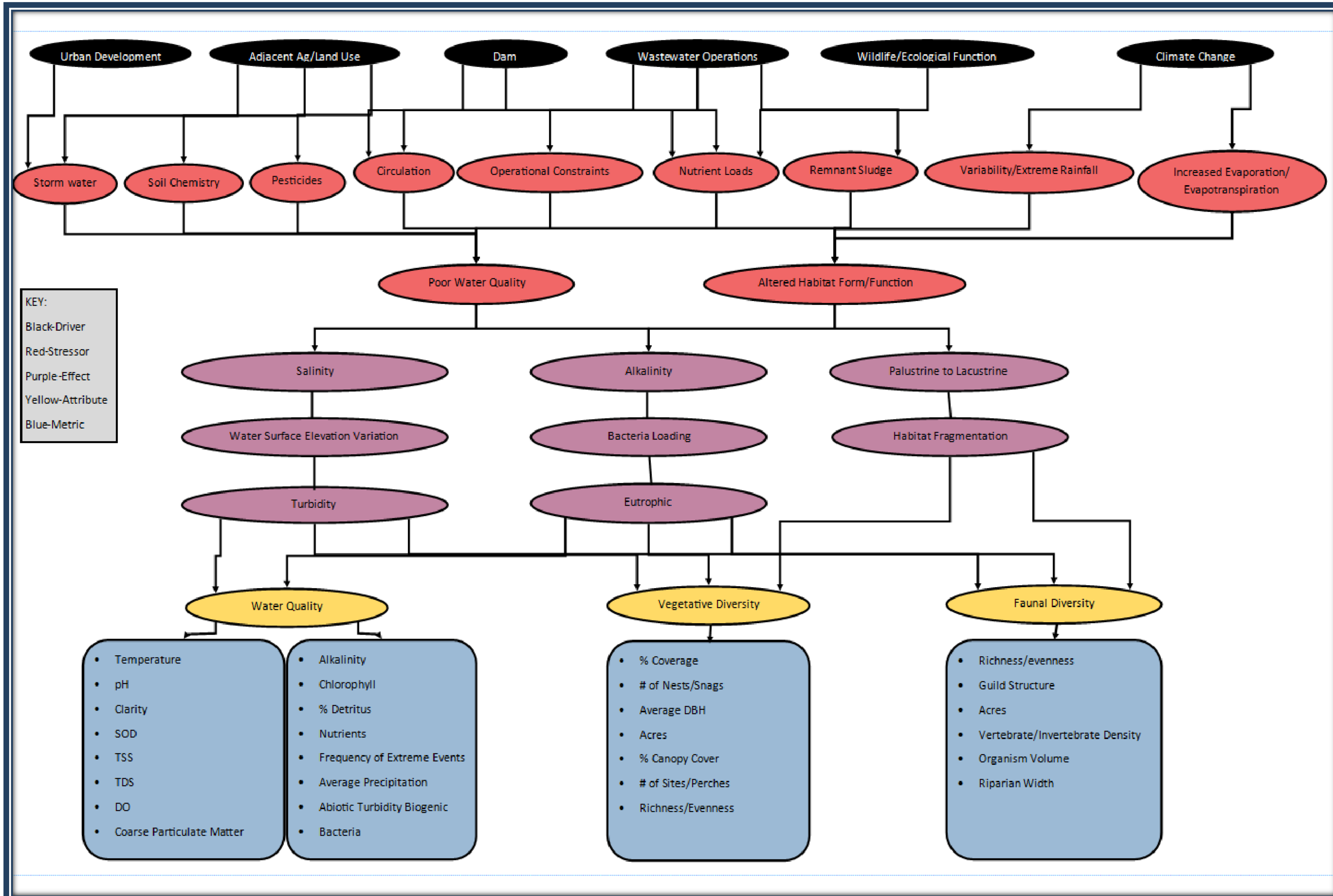

Figure 43 - CEM Components

4.2 Description of Preliminary Management Measures

In May of 2019, the full PDT (USACE and NFS), along with local stakeholders (the TCEQ, NRCS, TPWD and the USFWS), met in San Antonio. This team met to identify individual restoration sites for feasible project implementation (Figure 44). The team brainstormed measures and alternatives based upon existing site conditions. Discreet restoration areas were generally identified as locations where site appropriate measures could be applied. Specific restoration areas were delineated after field verification of the proposed restoration boundaries were verified.

After the problems, opportunities, objectives and constraints were agreed upon by the PDT (USACE and the NFS), the next part of the plan formulation process was to brainstorm both structural and non-structural / non-mechanical management measures (measures) (Table 23).

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. Measures are the building blocks of Plans and are categorized as structural and non-structural / non-mechanical. Equal consideration was given to these two categories of measures during the Planning process.

Table 23 - Preliminary Management Measures

Measure Name	Non-Structural / Non-Mechanical or Structural
Aeration	Structural
Chemical Water Treatment	Non-Structural
Polder Operations Management	Structural
Seasonal Water Pulses	Structural
Sonification	Structural
Berm Construction	Structural
Clearing / Excavation	Non-Structural
Construction of Pools / Riffles / Runs / Glides	Structural
Dam Modification	Structural
Dam Removal	Structural
Dredging	Structural
Floating Vegetation Mats	Structural
Habitat Structure Augmentation	Non-Structural
Installation of Bat and Bird Nest Boxes	Structural
Invasive Animal Management	Non-Structural

Measure Name	Non-Structural / Non-Mechanical or Structural
Invasive Vegetation Management	Non-Structural
Island Creation	Structural
Low Quality Vegetation Removal	Non-Structural
Medina River Erosion Control Structures	Structural
Native Submergent Wetland Plantings	Non-Structural
Native Riparian Plantings	Non-Structural
Native Emergent Wetland Planting	Non-Structural
Pipeline and Pump Installation	Structural
Relocation of Leon Creek Discharge Outfall Structure and Pipe	Structural
Spillway Modification	Structural
Spillway Removal	Structural
Water Control Structures	Structural

4.2.1 Non-structural / Non-Mechanical Measures

Non-structural measures may be used in combination with other measures, or independently.

1. **Chemical Water Treatment** - This measure entails the application of biological or chemical agents to Mitchell Lake to react with the high nutrient loads of the lake and convert the nutrients into their elemental form.
2. **Clearing / Excavation** - In order to create the hydrology required for the target restoration habitats, excavation might 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.
3. **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.
4. **Invasive Animal Management** - Non-native invasive animals such as feral hogs and nutria (*Myocastor coypus*) cause significant damage to existing habitats due to grubbing and grazing foraging strategies. The removal and continual management of invasive animals would reduce the impacts these species have on the habitats in the study area and specifically the newly restored areas.

5. **Invasive Vegetation Management** - This measure includes the removal and management of non-native 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. The main non-native species that will need to be eradicated to ensure success of the Proposed Action are Chinese tallowtree, Chinese privet and chinaberrytree. Early removal of Chinaberrytree is the best course of action, when the trees are young and have not produced any seeds. Seeds can remain dormant within soil for months or years and can be very persistent. Chinaberrytree can be removed through mechanical means such as cutting, but chemical treatment with herbicide is the best method of control. Chinese tallowtree can be treated through chemical and mechanical controls. Herbicides such as clopyralid, imazapyr and triclopyr can be applied with foliar sprays, frill treatments, basal bark and cut stump treatments. Control for Chinese privet can utilize the same methods while adding an additional herbicide, glyphosate. These methods have been utilized in several other USACE Aquatic Ecosystem Restoration projects. They have shown success in controlling these species on the Mission Reach Aquatic Ecosystem Restoration project in San Antonio, Texas and the Resacas Aquatic Ecosystem Restoration project in Brownsville, Texas with a 95% rate of success. The U.S. Department of Agriculture has also listed plant guides regarding these invasive vegetative species.

6. **Low Quality Vegetation Removal** - The vegetative communities in the Mitchell Lake study area are skewed towards low quality hackberry (*Celtis laevigata*), huisache (*Vachellia farnesiana*), Palo verde (*Parkinsonia spp*.), willow baccharis (*Baccharis salicina)* 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. Like 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 over story canopy cover opening gaps in the canopy for the establishment of seedling shrubs and trees.

7. **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.

8. **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 (*Taxodium distichum*) and other species native to the San Antonio area.

9. **Native Emergent Wetland Planting** - The core areas of the existing wetland habitats are dominated by cattails or willow baccharis fringed by a single species of spike sedge (*Carex spicata*). This measure entails the planting of native high-quality emergent wetland species to increase the diversity and sustainability of the wetland vegetation community.

Section 2039(e) of WRDA 2007, as amended, directs that the responsibility of a non-federal interest for operations and maintenance (O&M) of the nonstructural and non-mechanical elements of a project (or component of a project) for ecosystem restoration shall cease 10 years after the date on which the Secretary makes a determination of success per Section 2039 (b)(2).

Implementation Guidance for Section 1161 of the WRDA 2016, Completion of Ecosystem Restoration Projects, states, "The monitoring plan will also specify that the monitoring will continue until such time as the Secretary determines that the success criteria will be met. Within a period of ten years from completion of construction of an ecosystem restoration project, monitoring shall be a cost-shared project cost. Any additional monitoring required beyond 10 years will be a non-federal responsibility."

4.2.2 Structural Measures

Like non-structural measures, structural measures may be used in combination with other measures, or independently.

1. **Aeration** - The water quality of Mitchell Lake could be improved by the aeration of the water through mechanical means (fountains, aerators, oxygen injection, etc.).
2. **Polder Operations 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. Average depth determined during this study is 7-inches of water, however, this may change as the plan develops further. The polder management would require the modification and / or construction of water control structures to facilitate the draining and filling of the polders. A portable pump, operated and maintained by SAWS, would be used to move water from one polder to the other and allow flexibility in the control of the water levels. The current conceptual pumping rate is determined to be between 800 and 1,300 gallons per minute (gpm) allowing the operator to fill empty polders in approximately 3 to 5 days. It is anticipated that the operation of the polders will depend on the weather and how these areas are operated. It is anticipated that hoses will be used to move the water around so the pumping unit will be provided with adequate hoses to feed the water as required. Annual operation and maintenance costs are roughly estimated to be around $5,000 to $8,000.
3. **Seasonal Water 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 current plan indicates that the water levels in the wetland areas should be controlled to maintain 6-inch to 4-foot depths with some freeboard. Water control structures will allow the wetlands to be drained to 2', so that deeper holes retain water for refugia habitat. Water will be maintained at maximum depths during spring and fall months, allowed to draw down up to 1' during the summer and drain during the winter months to control cattails and promote diverse emergent vegetation. The seasonal pulse measure would be dependent on the construction of two new 30 horsepower pumps and a 10,500' pipeline from Mitchell Lake to the upstream portions of the study area. The new 10" pipeline would extend from the southwest corner of the polders to the northern inlet of the birds pond wetlands. It has been determined that the most likely route for the pipeline would be along the east side of the polders and wetland areas to avoid conflicts with existing infrastructure. The new pumps would be hand operated by SAWS. Two pumps will be provided for redundancy if one of the pumps fails or requires maintenance. The conceptual pumping rate is approximately 1,755 gpm. There is power on site and based on the existing pumps in this location, it is assumed that it is adequate to operate the new pumps, this will be verified in the future. The measure would also include the construction or modification of water control structures and drainage improvements to allow manipulation of the flows and inundation of the wetlands. Water control structures would include stop log structures at the outlet of Bird Pond. Drainage improvements required to improve and manage flows through the wetland areas include the construction of a 100-foot culvert to convey the drainage under the existing access road and channel improvements to improve the flows between Bird Pond and the Central Wetlands. Annual operational and maintenance costs are roughly estimated to range from $10,000 to $15,000.

4. **Sonification** - This measure employs the use of ultrasound waves to decrease algae, nutrients and organic pollutants. The process relies on the cavitation caused by the waves to create conditions that dissolve organic compounds.
5. **Berm Construction** - his 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.
6. **Construction of Pools / Riffles / Runs / Glides** - This measure would create the diverse aquatic habitat required by certain aquatic organisms in Cottonmouth Creek below the Mitchell Lake Dam. The creation of pool/riffle habitats would increase the aquatic habitat quality of impaired streams.
7. **Dam Modification** - The modification of the dam and / or overflow structure would facilitate the fluctuation of water levels for Mitchell Lake and could be used as a method to address the seasonal pulses measure above. This measure could create and sustain wetland habitats adjacent to the lake and allow controlled flushing of the water in Mitchell Lake.
8. **Dam Removal** - This measure would entail the removal of the dam providing the hydrology to support the historic wetland conditions within the footprint of the lake. As the dam has changed the topography of the lake footprint due to sedimentation, it may

be necessary to construct a water control structure at the dam removal site to ensure the area would still support the habitat.

9. **Dredging** - The dredging measure would entail the removal and disposal of the high nutrient load sediments to improve the water quality of Mitchell Lake. The dredged material would require appropriate disposal depending on the HTRW issues with the sediments.

10. **Floating Vegetation Mats** - Floating vegetative mats provide a framework for emergent and wetland vegetation that can be anchored in the middle of the lake, essentially providing artificial island structures. Although the primary purpose of the floating mats is to take up nutrients and improving water quality, the islands would also provide benefits as foraging and nesting habitats for waterfowl and waterbirds.

11. **Installation of Bat and Bird Nest Boxes** - This measure would include the installation of artificial nesting structures for bats, wood ducks, bluebirds and other cavity nesting species in the study area.

12. **Island Creation –** This plan entails the construction of island habitats within Mitchell Lake. An opportunity exists for using excavated material from wetland construction in other areas as well as outside source material.

13. **Medina River Erosion Control Structures** - This measure would entail construction of erosion control structures such as gabion baskets, stabilization grids, riprap, plantings, etc. at locations on the Medina River that are subject to excessive erosional forces.

14. **Pipeline and Pump Installation** - 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. A mobile pump would also be required for the polders in order to pump water between the polder and basin cells.

15. **Relocation of Leon Creek Discharge Outfall Structure and Pipe –** With the stormwater runoff from small watershed of the lake, water supply to the lake provided by an outfall structure of a treated effluent outlet from the Leon Creek Wastewater Treatment located several miles west of the lake. The outfall structure is located at the downstream side of the lake and does not provide treated water to the upstream portions of the lake. This measure would involve relocating the Leon Creek Discharge outfall structure and pipe to another area of the lake.

16. **Spillway Modification** - This measure would entail modifying the spillway structure in some way, which could include removal or addition of gates, extension of spillway structure, removal, or addition of concrete, etc. By providing a water control structure at the spillway, the water surface elevation could be controlled; flows and stage of the lake could be modified (Figure 8 and Figure 9).

17. **Spillway Removal** - This measure would entail the complete removal of the Mitchell Lake spillway.

18. **Water Control Structures –** This measure would be utilized to control the depth of water by blocking or opening a water channel within the proposed areas. Stop logs will be used to ensure water inundates the appropriate areas during the appropriate times.

4.2.3 Initial Ecosystem Restoration Areas

Individual restoration sites were identified as feasible for project implementation (Figure 44). The measures were built in combination with one another based upon site conditions. Discreet restoration areas were generally identified as locations where site appropriate measures could be applied; however, specific restoration areas were not delineated until field verification of the proposed restoration boundaries could be verified. During field verification, the team located existing degraded wetland habitat within the study area.

Each area was evaluated and deemed suitable for restoration based on existing vegetation quality, water flow and concentration. Measure success is dependent upon site conditions at Mitchell Lake.

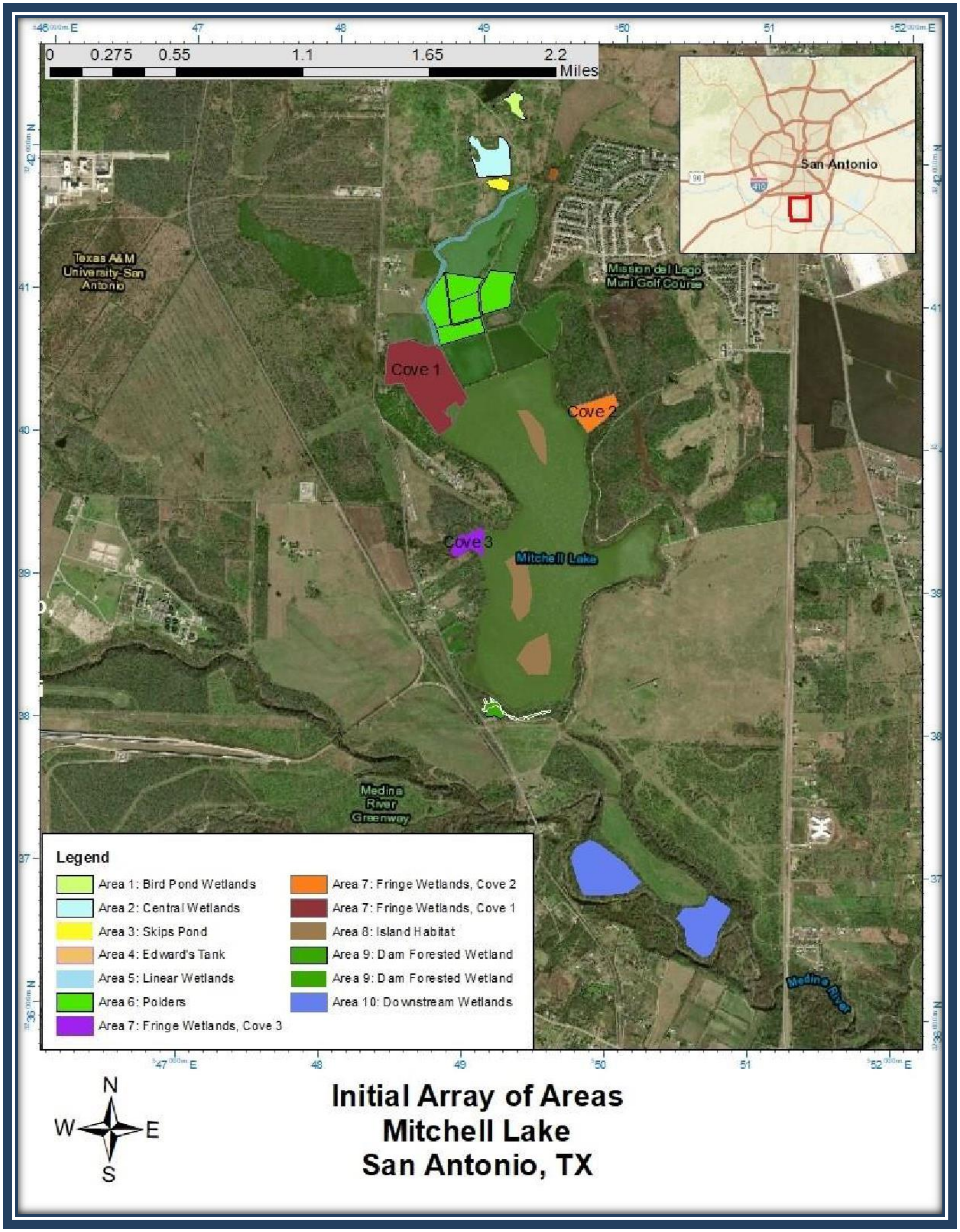

Figure 44 - Initial Areas for Plan Formulation for Ecosystem Restoration

<u>Area 1: Bird Pond Wetlands</u> - Area 1 is located at the northern extent of the study area adjacent to Bird Pond near the Mitchell Lake Audubon Center (Figure 45). The small existing wetland is located east of the levee/road on the downstream end of Bird Pond. The existing wetland (Area 1A) has limited habitat value due to the shallow surface water (less than six inches) and a monoculture of cattails. The lack of water surface level fluctuations has contributed to the dominance of cattails in this wetland. Area 1A is approximately 3.17 acres.

Figure 45 - Area 1: Bird Pond Wetlands

Area 2: Central Wetland - Area 2 is directly south of Area 1: Bird Pond Wetlands. Area 2 consists of a complex of emergent wetlands connected to each other by swales with higher, interspersed upland areas (Figure 46). It is comprised of a shallow wetland with areas of deeper water (6-12” in depth) and dominated by cattail and willow baccharis. This area is ~10.46 acres.

The two wetland-complexes are connected to each other by a shallow, nondescript drainage channel. This area consists of a complex of wetlands connected to each other by wetland swales with higher, upland areas interspersed throughout. Central Wetland is part of the same wetland complex as Area 3 Skip’s Pond but is separated from that area by a petroleum pipeline right-of-way between the two areas; therefore, the areas are treated as separate areas. Central Wetland is comprised of a shallow wetland with areas of deeper water (6-12” in depth) and dominated by cattails and willow baccharis.

Figure 46 - Area 2: Central Wetland

<u>Area 3: Skip's Pond</u> – As noted in the Area 2 discussion above, Skip's Pond is part of the same wetland complex as Central Wetland, but is separated from that area by a pipeline that transects the area (Figure 47). This area consists of vegetation such as buttercup (*Ranunculus spp*.), alligator weed and bedstraw. The existing wetland does not hold high quality vegetation. Area 3 is comprised of deeper water emergent/submergent wetlands, up to 2' in depth. It supports different vegetation than Area 2. Therefore, Skip's Pond was separated from the Central Wetland complex. It is ~2.18 acres.

Figure 47 - Area 3: Skip's Pond [bright yellow]

<u>Area 4: Edward's Tank</u> - Area 4 was assessed during habitat surveys in May 2019. Edward's Tank is comprised of a ponded area surrounded by native woody vegetation and bordered by emergent and submerged vegetation (Figure 48). Although, opportunities exist to improve the habitats, the potential lift that could be attained would be limited. *Area 4 is hydrologically disconnected from the remaining restoration areas; thereby limiting any synergistic benefits resulting from its restoration. Therefore, Area 4 was not carried forward into Plan formulation efforts.*

Figure 48 – Area 4: Edward's Tank

<u>Area 5: Linear Wetlands</u> – Area 5 is hydraulically linked to Areas 1 Bird Pond Wetlands, Area 2 Central Wetland and Area 3 Skip's Pond via two water control structures downstream of Area 3. The linear wetland borders the northern and western polder berms and empties into the upstream end of Mitchell Lake (Figure 49). *Area 5 provides a relatively native and diverse vegetative community. Because of the quality and function of the linear wetlands, it was not carried forward for Plan formulation.*

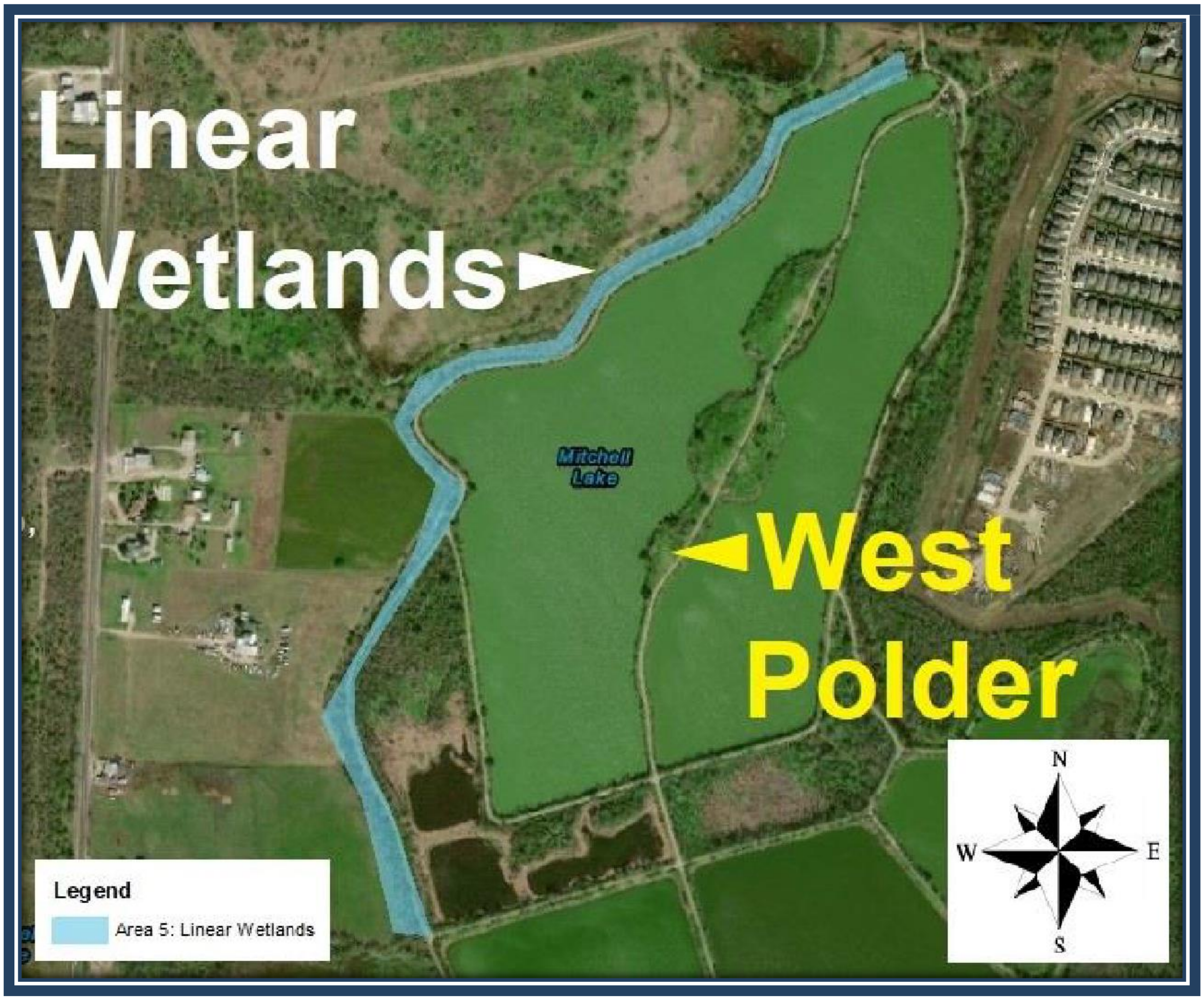

Figure 49 - Area 5: Linear Wetlands on west side of West Polder [light blue]

<u>Area 6: Polders</u> - The upper polder complex (Figure 50) currently consists of five decant basins designated one through five and two polders (East and West). The polders complex has two pumping stations at the southern end of Basins 5 and 4 to allow for water circulation flows. Three pumps at the southwest corner of Basin 5 allow water to be pumped from the Mitchell Lake to the Polders complex. The water is pumped into Basin 5 then flows into Basin 1, which then flows into the West Polder. From there water will circulate to the East Polder, then to Basin 3 and finally into Basin 4. There is a single pump at the pump station on the southeast corner of Basin 4 (Figure 11) allows for the water to be discharged back into Mitchell Lake.

Figure 50 – Area 6: Mitchell Lake Polder System

A<u>rea 7: Fringe Wetlands / Coves 1 - 3</u> – The Fringe Wetlands are separated into coves, which can all be implemented as stand-alone areas or included in combination with each other. Cove 1 is approximately 53.68 acres on the northwest portion of Mitchell Lake. Cove 2 is approximately 11.84 acres on the northeast portion of Mitchell Lake. Cove 3 is on the southwest section of Mitchell Lake, within proximity of the dam and is approximately 6.84 acres. (Figure 51).

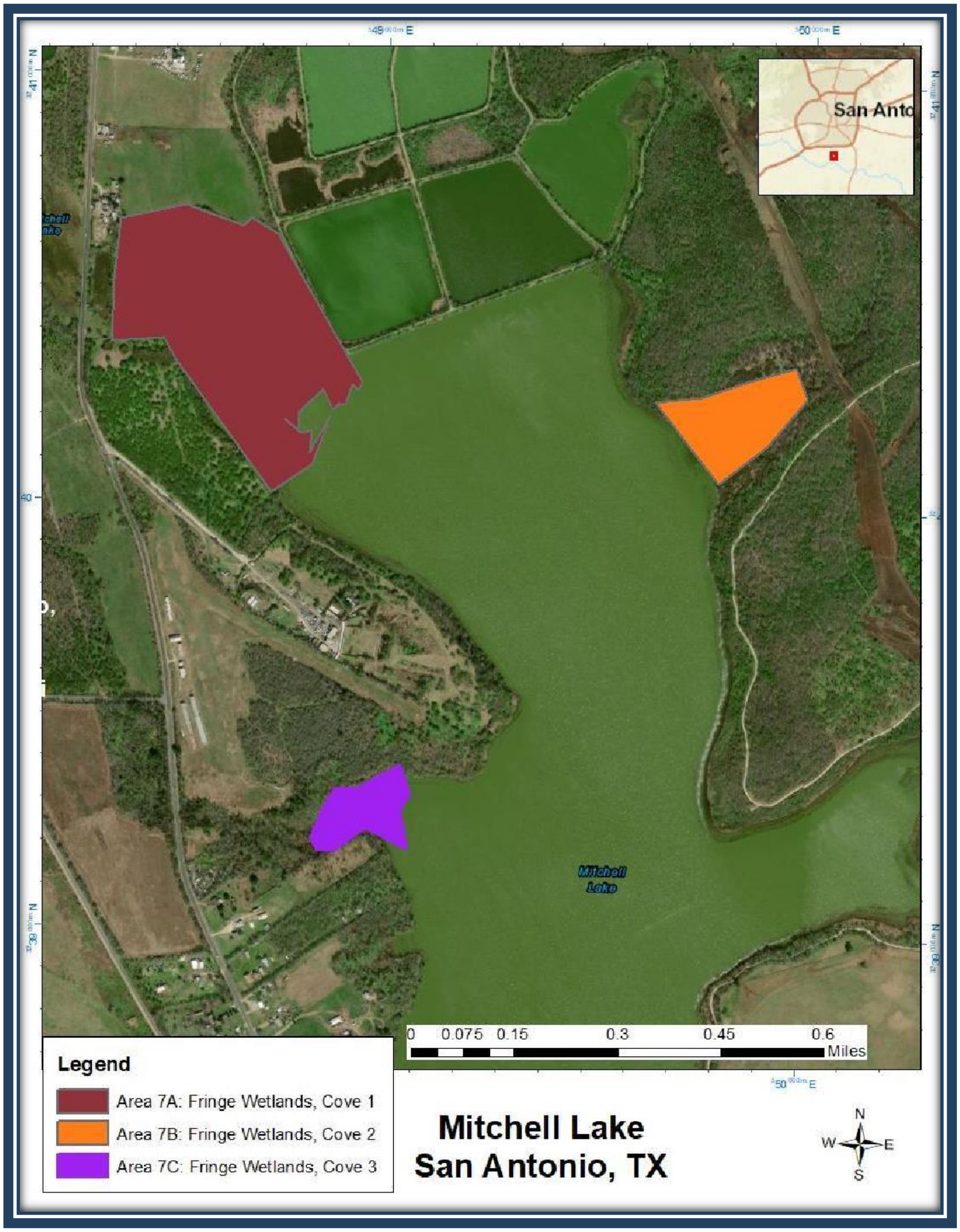

Figure 51 - Area 7: Fringe Wetlands, [Cove 1 is maroon, Cove 2 is orange and Cove 3 is in purple]

Area 8: Islands - This plan entails the construction of island habitats within Mitchell Lake (Figure 52). An opportunity exists for using excavated material from wetland construction in other areas as well as outside source material. However, this plan has been screened out of the final CE/ICA process, due to lack of NFS support and engineering infeasibility.

Creation of islands will require a haul road through the lake, which is an environmentally sensitive area. Even if the area could be restored after the haul roads have been removed, the restored area will have some residual sedimentation of fine soil particles and colloids that could not be removed. From the constructability point of view, there is a possibility of constructing islands with minimal disturbance by using a dredger and a discharge pipeline that will float on the water causing minimal disturbance to water quality. However, the source for dredged material may have to be determined, which may include areas that will affect the lake boundaries, lake waters or the surrounding areas. Islands could be created with minimal disturbance by using a cofferdam and limiting the discharge of the dredged materials to create the islands within the confines of the cofferdam. This would be the least disruptive but most expensive method of constructing islands.

Maintenance costs of the islands depend on how they are constructed. The least disruptive way to maintain is to use floating equipment. Handling more than a ton of equipment and materials would be difficult without building some form of permanent structural modifications (such as a boat ramp or floating dock. *Considering these potential issues, construction of islands was deemed infeasible.*

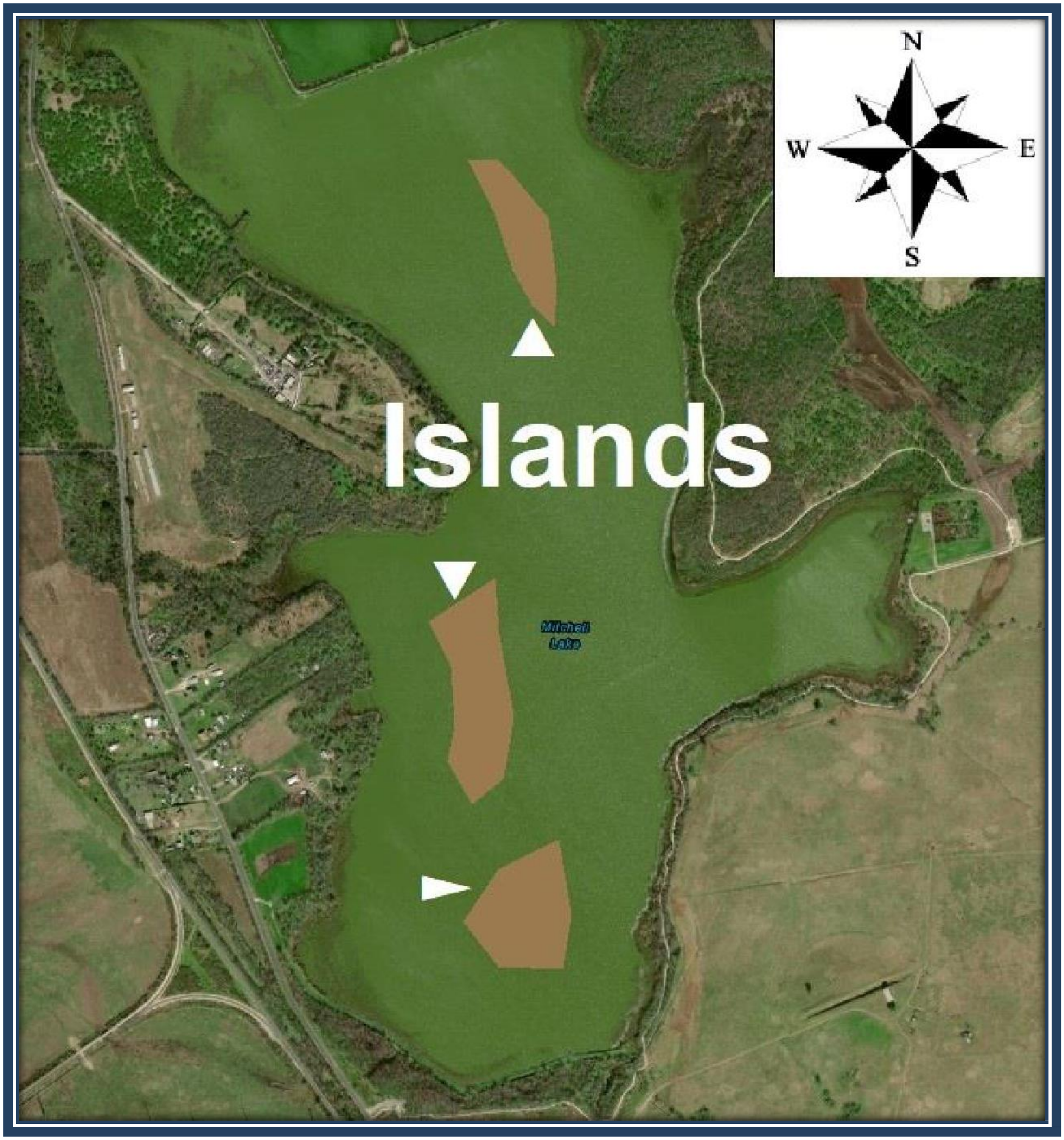

Figure 52 - Area 8: Islands [in brown]

<u>Area 9: Dam Forested Wetland</u> - The forested wetland areas below the Mitchell Lake Dam comprise the proposed restoration area for Area 9 (Figure 53). The wetland hydrology is maintained by seepage through the dam and is 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.

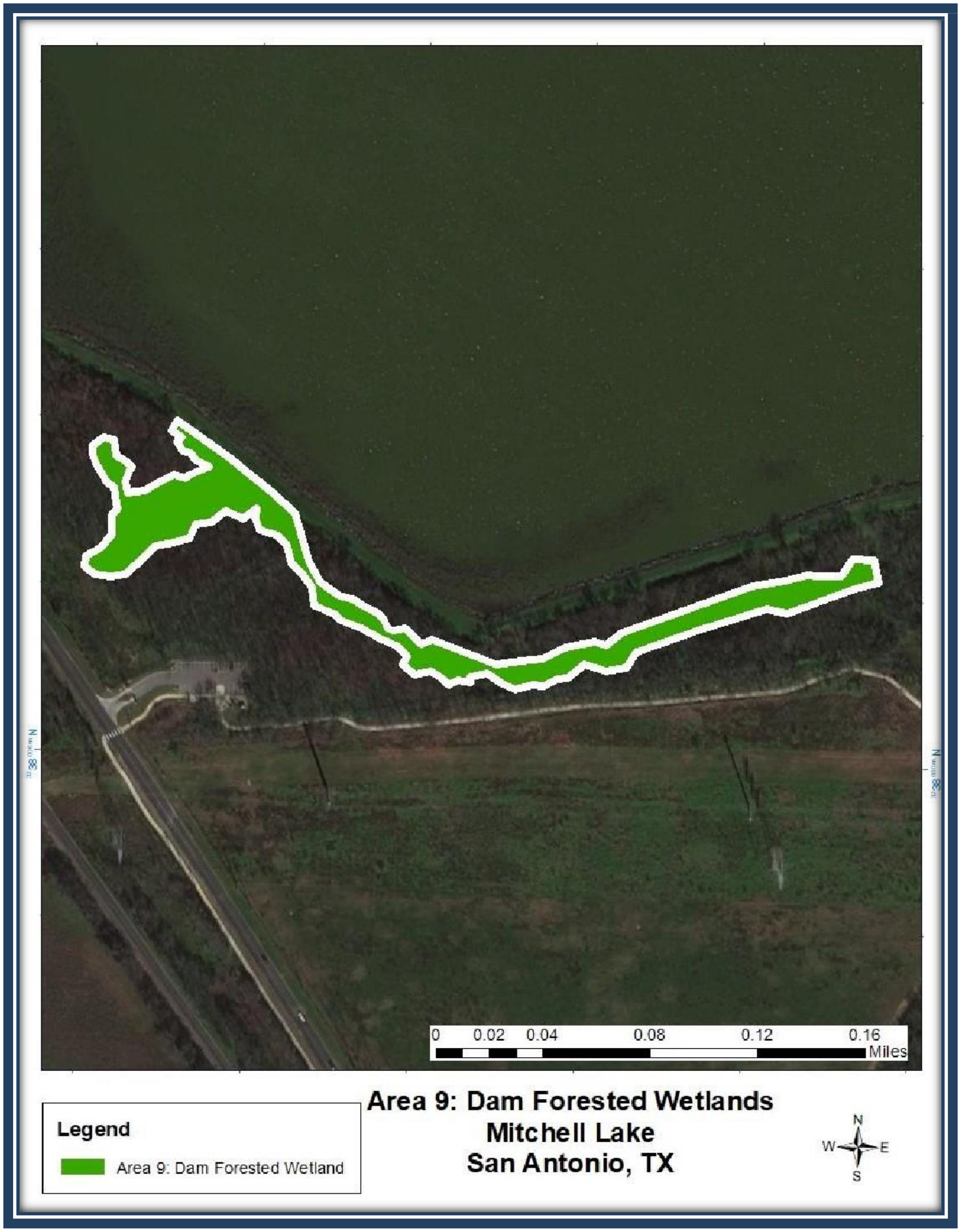

Figure 53 - Area 9: Dam Forested Wetlands [bright green]

Area 10: Downstream Wetlands - The existing forested wetlands below the dam (Figure 54) are dominated by hackberry which provide limited wildlife habitat. This area was evaluated because of its existing low-quality habitat and its proximity to the future wetlands that will be constructed by SAWS.

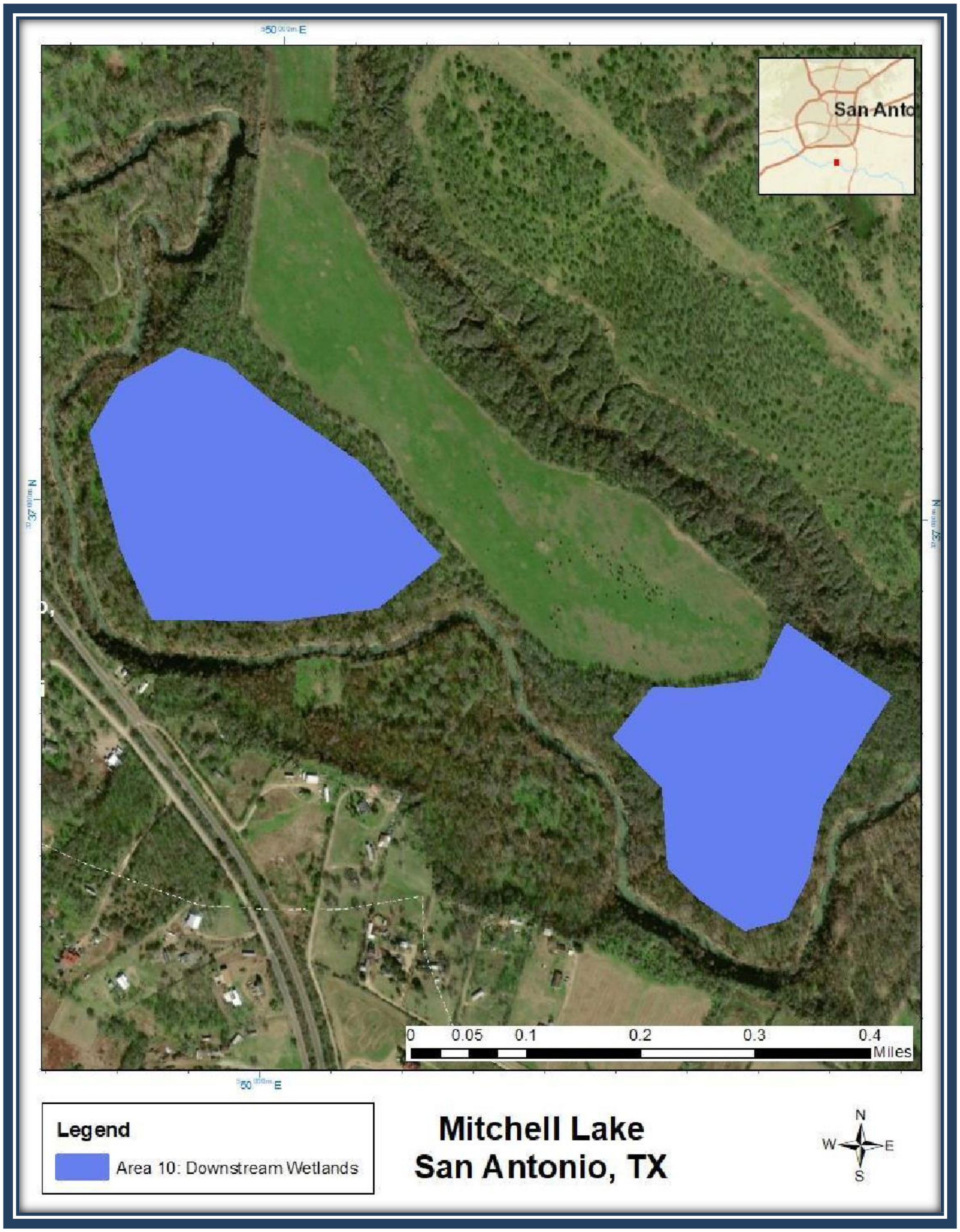

Figure 54 - Area 10: Downstream Wetlands [in blue]

4.2.4 Restoration Areas Removed from Further Consideration

To recap, Area 4: Edward's Tank, Area 5: Linear Wetlands and Area 8: Islands were removed from further consideration (Table 24).

Table 24 – Restoration Areas Removed from Further Consideration

Area Removed	Reason for Removal
Area 4: Edward's Tank	It is disconnected from the remaining restoration areas; thereby limiting any synergistic benefits resulting from its restoration.
Area 5: Linear Wetlands	It provides a relatively native and diverse vegetative community.
Area 8: Islands	Lack of NFS support and engineering infeasibility. See Chapter 4 for rationale.

4.2.5 Restoration Areas Remaining

Table 25 - Restoration Areas Remaining for Plan Formulation (Figure 55)

Restoration Areas Remaining for Plan Formulation	
Area 1: Bird Pond Wetlands	**Area 7: Fringe Wetlands / Coves 1 – 3**
Area 2: Central Wetland	**Area 9: Dam Forested Wetlands**
Area 3: Skip's Pond	**Area 10: Downstream Wetlands**
Area 6: Polders	

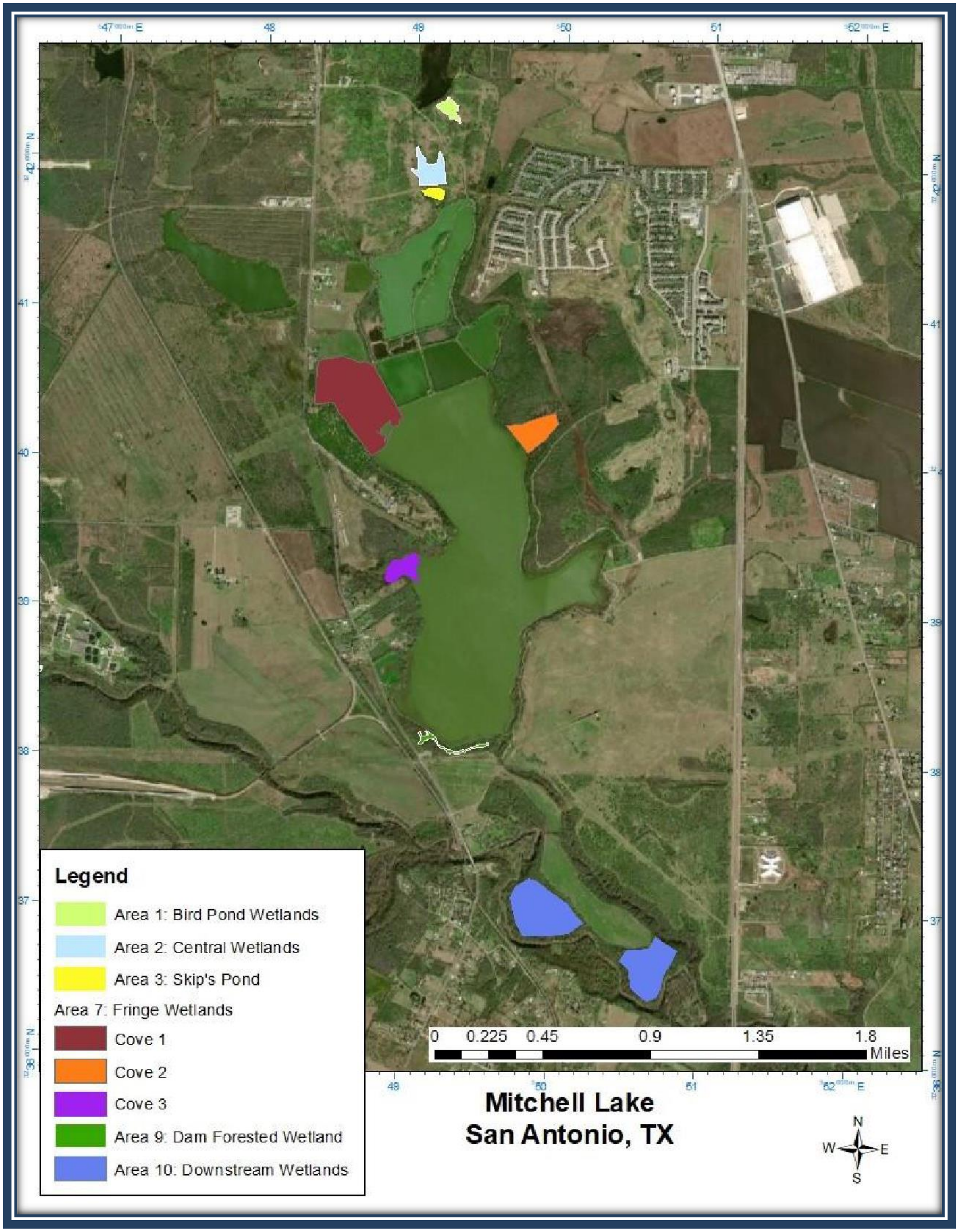

Figure 55 - Areas remaining for further study

4.3 Preliminary Evaluation and Screening of Management Measures

The USACE and the NFS conducted a preliminary screening of management measures to evaluate the applicability of each measure and the potential for each measure to contribute to the study's specific planning objectives consistent with planning constraints.

Specific Study Planning Objectives:

1. increase the areal extent and quality of fish and wildlife habitat in the study area for the 50-year Period of analysis
2. Increase the floral and aunal species diversity and richness in the study area for the 50-year Period of analysis

First, each measure was identified as either meeting a specific study objective (**Yes**) or failing to meet a specific planning objective (**No**) (Table 26). All measures met study objectives and no measures were removed from further consideration at this time.

Table 26 – Screening of Preliminary Management Measures with the Planning Objectives

Measure Name	Planning Objectives	
	1	2
Aeration	Yes	Yes
Chemical Water Treatment	Yes	Yes
Polder Operations Management	Yes	Yes
Seasonal Water Pulses	Yes	Yes
Sonification	Yes	Yes
Berm Construction	Yes	Yes
Clearing / Excavation	Yes	Yes
Construction of Pools / Riffles / Runs / Glides	Yes	Yes
Dam Modification	Yes	Yes
Dam Removal	Yes	Yes
Dredging	Yes	Yes
Floating Vegetation Mats	Yes	Yes
Habitat Structure Augmentation	Yes	Yes
Installation of Bat and Bird Nest Boxes	Yes	Yes
Invasive Animal Management	Yes	Yes
Invasive Vegetation Management	Yes	Yes

Measure Name	Planning Objectives	
	1	2
Island Creation	Yes	Yes
Low Quality Vegetation Removal	Yes	Yes
Medina River Erosion Control Structures	Yes	Yes
Native Submergent Wetland Plantings	Yes	Yes
Native Riparian Plantings	Yes	Yes
Native Emergent Wetland Plantings	Yes	Yes
Pipeline and Pump Installation	Yes	Yes
Relocation of Leon Creek Discharge Outfall Structure and Pipe	Yes	Yes
Spillway Modification	Yes	Yes
Spillway Removal	Yes	Yes
Water Control Structures	Yes	Yes

4.4 Preliminary Management Measures Eliminated from Further Study

Each management measure was then judged as to whether it was a Water Quality Only, a combination Water Quality + Ecosystem Restoration, or Ecosystem Restoration Only measure. Those measures deemed to be Water Quality Only measures were removed from further consideration.

ER 1105-2-100 *Planning Guidance Notebook*, as amended, states, “While measures to improve water quality parameters may be included in projects with an ecosystem restoration component, the ecosystem restoration portion of these projects should not principally result in treating or otherwise abating pollution or other compliance responsibility”. The PDT deemed that Water Quality Only measures did not have, or would not contribute, to ecosystem restoration and its components (Table 27).

This guidance also states, “…projects or features that would result in treating or otherwise abating pollution problems caused by other parties where those parties have, or are likely to have a legal responsibility for remediation or other compliance responsibility shall not be recommended for implementation”. Prior to 1973, Mitchell Lake was used as a wastewater treatment area and still receives effluent from the Leon Creek Wastewater Treatment Plant.

The NFS sponsor has a legal responsibility for remediation or other compliance responsibilities for water entering the Medina River after being released from Mitchell Lake, per the 2019 EPA AO.

Table 27 - Management Measures for Water Quality Only

Measure Name	Water Quality Only?
Aeration	Yes
Chemical Water Treatment	Yes
Sonification	Yes
Dredging	Yes
Floating Vegetation Mats	Yes

On 20-21 May 2019, the PDT conducted a final survey of habitats in the study area to delineate specific areas that would be appropriate for restoration. The PDT and resource agencies met on 22-23 May 2019 to assess these locations of potential restoration and identify specific restoration measures or combinations of measures that would be applicable for each specific area. Restoration measures that are not applicable to any of the delineated restoration areas were screened out from the final array, as there would be no areas to implement these measures (Table 28).

Table 28 - Non-Water Quality Management Measures Removed from Further Consideration

Management Measure Removed	Reason for Removal
Construction of Pools / Riffles / Runs / Glides	During habitat surveys, Cottonmouth Creek was surveyed and found to be in excellent condition. Any effort to improve the aquatic habitat of the stream has a high probability of decreasing the high-quality habitat.
Dam Modification	Modification of the existing dam and its structures, in partnership with USACE, does not have NFS support. The NFS is considering Dam Modifications at some point in the future for engineering reasons.
Dam Removal	Removal of the dam would result in uncontrolled release of polluted sediments into Cottonmouth Creek and the Medina River.
Invasive Animal Management	Invasive animal management is currently provided by the Audubon Society and SAWS.
Medina River Erosion Control Structures	The confluence is located at the extreme extent of the study area and does not provide the connectivity of the other restoration areas that would utilize the measures identified in the interim array of measures. Because of the isolated nature of the erosion, the lack of connectivity with the other restoration areas and the low restoration value of this measure, it was screened out of further review.
Relocation of Leon Creek Discharge Outfall Structure and Pipe	Relocation of the outfall structure and pipe was not necessary for the implementation of any other measures and was not supported by the NFS.

Management Measure Removed	Reason for Removal
Spillway Modification	SAWS will implement their own spillway modifications in the FWOP.
Spillway Removal	SAWS will implement their own spillway modifications in the FWOP.

4.5 Preliminary Management Measures Carried Forward for Further Study

Those management measures remaining after screening are listed below in Table 29.

Table 29 - Preliminary Management Measures Carried Forward for Further Study

Measure Name	Non-Structural / Non-Mechanical or Structural
Polder Operations Management	Structural
Seasonal Water Pulses	Structural
Berm Construction	Structural
Clearing / Excavation	Non-Structural
Habitat Structure Augmentation	Non-Structural
Installation of Bat and Bird Nest Boxes	Structural
Invasive Vegetation Management	Non-Structural
Island Creation	Structural
Low Quality Vegetation Removal	Non-Structural
Native Submergent Wetland Plantings	Non-Structural
Native Riparian Plantings	Non-Structural
Native Emergent Wetland Plantings	Non-Structural
Pipeline and Pump Installation	Structural
Water Control Structures	Structural

4.6 Management Measures Considered Suitable by Area

The USACE and NFS combined the remaining management measures into alternatives for each of the ten discreet. Table 30 lists each Area, the measures that were screened out from the area and the reason for its exclusion. Any measures not listed for an Area within this table were moved forward into alternative formulation.

Table 30. Management Measures Carried Forward by Area

Area	Measures Excluded	Reason for Exclusion
Bird Pond Wetlands	Native Riparian Planting	Site does not include stream habitat
	Native Submergent Wetland Plantings	Site will not have shallow or deep open water habitat
	Polder Operational Management	No polders in this area
	Berm Construction	Not necessary
Central Wetlands	Native Riparian Planting	Site does not include stream habitat
	Native Submergent Wetland Plantings	Site will not have shallow or deep open water habitat
	Polder Operational Management	No polders in this area
	Berm Construction	Not necessary
Skip's Pond	Native Riparian Planting	Site does not include stream habitat
	Polder Operational Management	No polders in this area
	Berm Construction	Not necessary
Polders	Native Riparian Planting	This area is not conducive for riparian plantings nor are they necessary for mudflat creation.
	Invasive Vegetation Management	Any existing invasive plant species in a polder cell would be eliminated due to prolonged inundation.
	Clearing / Excavation	Will not be widened or deepened
	Native Emergent Wetland Planting	Polders would be managed as mud flats, and planting is not necessary.

Area	Measures Excluded	Reason for Exclusion
	Native Aquatic Species Planting	Polders would be managed as mud flats, and planting is not necessary.
	Seasonal Pulses	Polders would be self-contained with no seasonal pulses flowing through the system.
	Habitat Structure Augmentation	No additional habitat structure would be incorporated into the mudflats to support shorebird foraging in these areas.
Fringe Wetlands	Clearing / Excavation	Not required to maintain water levels
	Low Quality Vegetation Removal	Existing aquatic vegetation is extremely limited. In addition, the lowering of the water surface elevation will shift existing open water habitats lacking existing vegetation to emergent habitats.
	Seasonal Pulses	FWOP and FWP water levels will be held consistently at 518.5' (NAVD88).
	Polder Operational Management	Polders do not exist in this Area.
	Berm Construction	Polders do not exist in this Area.
	Pipeline and Pump Installation	Mitchell Lake water is sustained through the Leon Creek WRC, pumping is not necessary.
Dam Forested Wetlands	Polder Operational Management	No polders in this area
	Berm Construction	Not applicable
	Pipeline and Pump Installation	Redundant with dam modifications.
Downstream Wetlands	Native Riparian Planting	Area does not include stream habitat.
	Low Quality Vegetation Removal	All the existing vegetation would be removed during the excavation of the wetland cells.
	Polder Operational Management	No polders in this area
	Pipeline and Pump Installation	The water source is SAWS treatment wetland complex.

4.7 Alternative Formulation

This section addresses the Plans Section in a NEPA document, per 40 Code of Federal Regulations (CFR) 1502.10 “Recommended format”. For each area remaining, the final array of management measures was combined into individual alternatives. Each of these alternatives could be a standalone plan or combined with other alternatives to form a suite of Plans to establish connectivity of habitats, achieve a landscape/watershed scale of restoration and to maximize the ecological benefits associated with the eventual tentatively selected plan.

In addition, several scales for most alternatives were developed for each area in order to achieve differing levels of captured and uncaptured benefits.

NOTE: Much of the information in this Section has been updated in Section 4.12 RECOMMENDED PLAN at FINAL REPORT due to a change in plan selection after the DRAFT report was reviewed. The final recommended plan is the same as the TSP minus Area 10. Some information has been updated and numbers have been refined.

The No Action Alternative

The CEQ regulations (40 CFR 1500–1508) for implementing NEPA do not define the “No Action Alternative,” stating only that NEPA analyses shall “include the alternative of No Action” (40 CFR 1502.14).

The USACE regulations [33 CFR 325 9.b (5) (b)] define the No Action Alternative as “one which results in no construction requiring a USACE permit”.

For purposes of this integrated detailed project report and EA, under the No Action Alternative, the USACE would implement no changes to Mitchell Lake. FWOP conditions are expected.

4.7.1 Area 1: Bird Pond Wetlands

The goal for Area 1 (Figure 56) is to restore the existing wetland below Bird Pond. As mentioned above, the degraded wetland is shallow, dominated by cattails and has little or no variation in water depth. The restoration strategy is to increase the depth of the wetland, establish water supply to sustain the wetland, manage the water to inundate the wetland with seasonal pulses and establish a diverse native wetland vegetation community.

From this point forward, the alternatives formulated for Area 1 - Bird Pond Wetlands will be called Area (Alternative) 1A and Area (Alternative) 1B. As documented in Table 31, the Area 1 Alternatives incorporate Clearing/Excavation, Installation of Pipeline, Seasonal Pulses, Native Emergent Wetland Plantings, Invasive Species Management, Low Quality Vegetation Removal, Habitat Structure Augmentation and the Installation of Bat/Nest Boxes measures. Except for the Bat/Nest Boxes measure, each one of these measures provide hydraulic and ecological components that are critical for the creation of a resilient, sustainable wetland. Although the Bat/Nest Box measure is not critical to the function of the wetland, it provides significant, uncaptured ecological benefits for bat and bird species with very low costs that would be indistinguishable from alternatives without this measure in a CE/ICA. Therefore, it is included as part of the alternative and not as a separable scale.

The Clearing/Excavation measure would create the variable water depths required to support a diverse wetland habitat and eliminate the homogenous shallow depths that promote cattail monocultures. The Installation of a Pipeline measure would provide a dependable water supply to ensure that the wetland is inundated to a level that supports a diverse vegetation community.

Similarly, the water control structures required for the Seasonal Pulses measure would provide water management to vary the depths of the wetland seasonally to manage for the diverse vegetative community and control of cattails.

The woody material cleared as part of the Clearing/Excavation Measure would be stock piled and placed back into the excavated wetland as fallen logs or debris piles to increase to create wildlife habitat structure in the wetland. In addition, excavation of the existing wetlands near large trees could be designed to preserve the tree allowing the conversion of the trees to standing snags by treating the tree with an aquatic labeled herbicide.

Site-specific, native emergent and submergent plant species would be planted to establish a diverse community. Non-native invasive species would be managed and controls implemented in order to reduce the impacts on the native species planted. An integrated Invasive Species Management Plan would be developed and implemented utilizing chemical, mechanical and / or biological control.

Water levels within the wetlands should be controlled to maintain 6" to 4' depths with appropriate freeboard. Water will be maintained at maximum depths during spring and fall months, allowed to draw down up to 1' during the summer and drain during the winter months to control cattails and promote diverse emergent vegetation.

Table 31 - Alternatives 1A and 1B Measures

Measure	Comments
Invasive Vegetation Management	Non-native and native (noxious) invasive species occur in the study area. Their removal will be necessary to ensure the sustainability of a diverse system
Clearing/Excavation	The excavation would increase the depth and diversity of the wetland bed topography to increase structural diversity in the wetland and create additional wetland habitat
Low Quality Vegetation Removal	The restoration area is dominated by cattails, which decrease plant species diversity in wetlands and provide limited habitat value for many wildlife species.
Native Emergent Wetland Planting	The planting of native, site-specific plant emergent species is key to the establishment of a resilient, self-sustaining emergent wetland habitat and is a key component of wetland restoration.
Seasonal Pulses	Seasonal pulses would ensure the sustainability and extent of existing and excavated wetlands. Dependent upon Installation of Pipeline
Habitat Structure Augmentation	The area has limited large woody vegetation that could be used as fallen logs within the wetland or for brush piles adjacent to the wetland. Dependent upon Low Quality Habitat Removal and / or Clearing/Excavation
Installation of Bat/Nest Boxes	This simple measure can be enacted in any Area. The number of installed bat/nest boxes will be dependent on the size of the area and the species that frequent the area.

Measure	Comments
Installation of Pipeline	Installation of a pipeline to Area 1 would restore and provide resilience for the wetland.
Water Control Structure	Stop Logs will be used to control the depth of water by blocking or opening a water channel within the proposed areas.
Scaled Alternatives	
Alternative 1A	Restoring approximately 3.17 acres of existing degraded emergent wetland
Alternative 1B	Restoring the existing 3.17-acre wetland and 3.25 acres of shrubland/upland habitat surrounding the existing wetland expanding it to form a 6.42-acre wetland

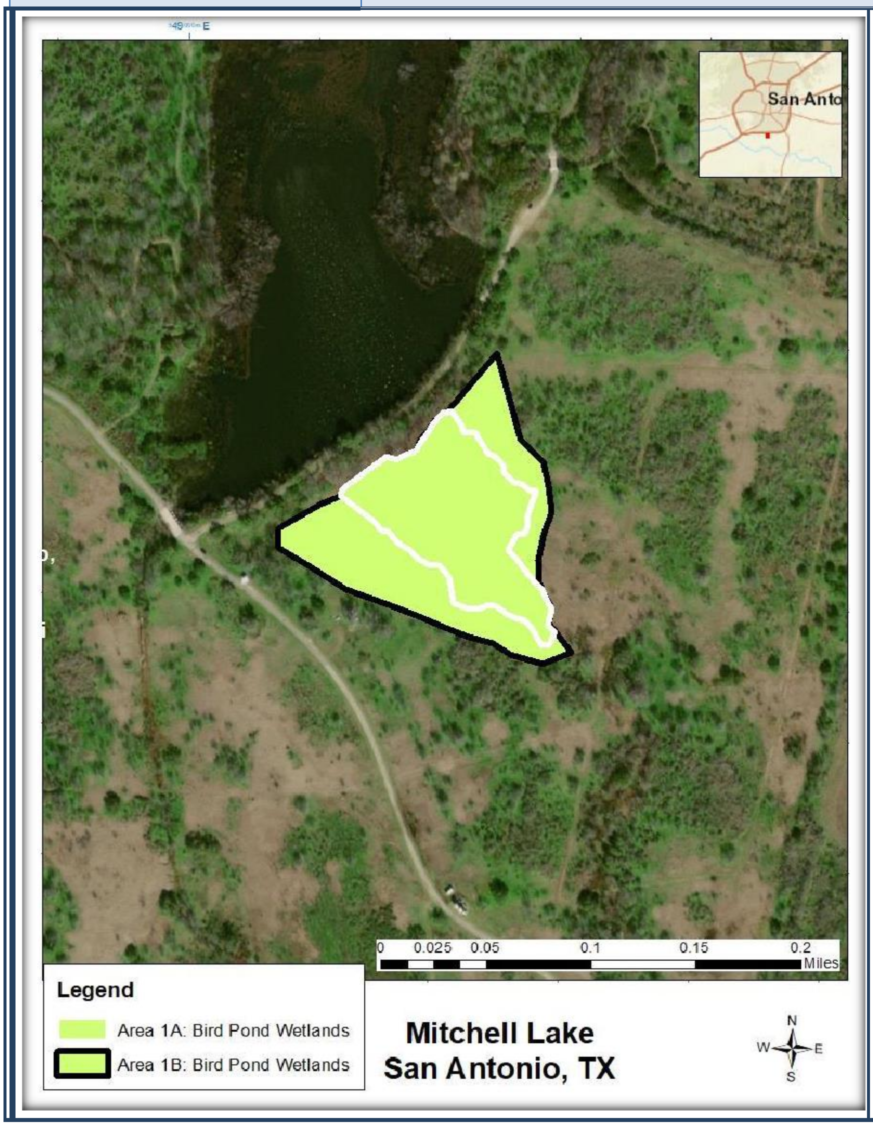

Figure 56. Area 1: Bird Pond Wetlands (Alternatives 1A and 1B)

4.7.2 Area 2: Central Wetland

The Area 2 alternatives (Figure 58 and Table 32) would have an identical combination of measures to those described for Area 1 above. From this point forward, the alternatives for Area 2 - Central Wetlands will be known as either Area/Alternative 2A or Area/Alternative 2B. The main difference between Alternatives 1A and 1B and Alternatives 2A and 2B is the location of the pipeline outfall structure. The expansion is mostly shrubland/upland habitat with vegetation like Palo verde, spiny hackberry and bastard cabbage. Because there are already existing wetlands in this area, it is assumed a modification of elevation and contouring would allow for better wetland suitability, increasing the overall size of the wetlands in this area.

For plans that combine the alternatives pertaining to the Bird Pond Wetlands and Central Wetlands, the pipeline would be placed north of Area 1. Since the existing drainage connects the existing wetlands, flows from the pipeline from the Bird Pond Wetlands would reach the Central Wetlands with no additional water supply requirements. However, for Plans that include the Central Wetlands, but not the Bird Pond Wetlands, the pipeline outfall would be located at the upstream portion of the Central Wetlands (Figure 57).

Estimated pipeline lengths to reach the north end of Bird Pond is ~10,500’. Estimated pipeline lengths to reach the north end of the Central Wetlands is ~9,000’.

Table 32 - Alternatives 2A and 2B Measures

Measure	Comments
Invasive Vegetation Management	Non-native and native (noxious) invasive species occur in the study area. Their removal will be necessary to ensure the sustainability of a diverse system
Clearing/Excavation	The excavation would increase the depth and diversity of the wetland bed topography to increase structural diversity in the wetland and create additional wetland habitat
Low Quality Vegetation Removal	The restoration area is dominated by cattails and willow baccharis, which decrease plant species diversity in wetlands and provide limited habitat value for many wildlife species.
Native Emergent Wetland Planting	The planting of native, site-specific plant emergent species is key to the establishment of a resilient, self-sustaining wetland habitat and is a key component of emergent wetland restoration.
Seasonal Pulses	Seasonal pulses would ensure the sustainability and extent of existing and excavated wetlands. Dependent upon Installation of Pipeline
Habitat Structure Augmentation	The area has limited large woody vegetation that could be used as fallen logs within the wetland or for brush piles adjacent to the wetland. Dependent upon Low Quality Habitat Removal and / or Clearing/Excavation

Measure	Comments
Installation of Bat/Nest Boxes	This simple measure can be enacted in any Area. The number of installed bat/nest boxes will be dependent on the size of the area and the species that frequent the area.
Installation of Pipeline	Installation of a pipeline to Area 2 would restore the wetland, ensure longer periods of inundation and provide resilience for the wetland.
Scaled Alternatives	
Alternative 2A	Restoring the footprint of the existing 10.46-acre wetland
Alternative 2B	Restoring the existing 10.46-acre wetland and expanding it to form an 18.37-acre wetland

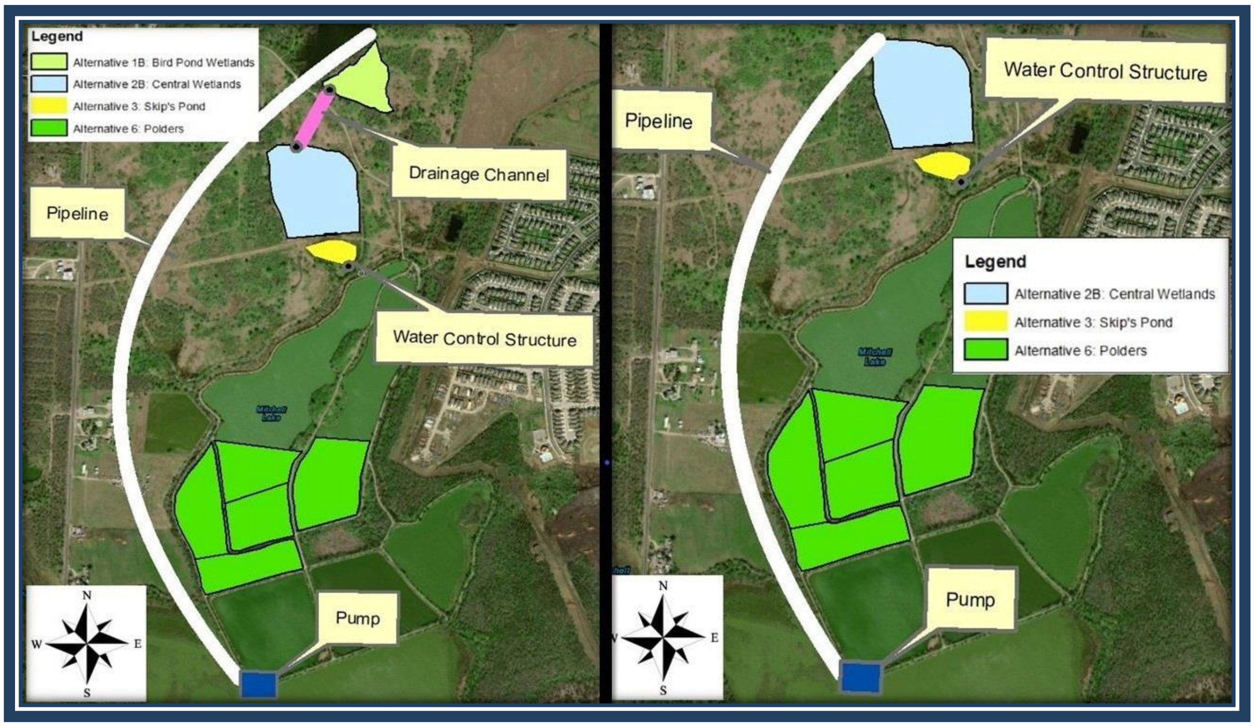

Figure 57 - Map showing Waterline Differences for Alternatives 1A, 1B, 2A and 2B (Bird Pond and Central Wetland)

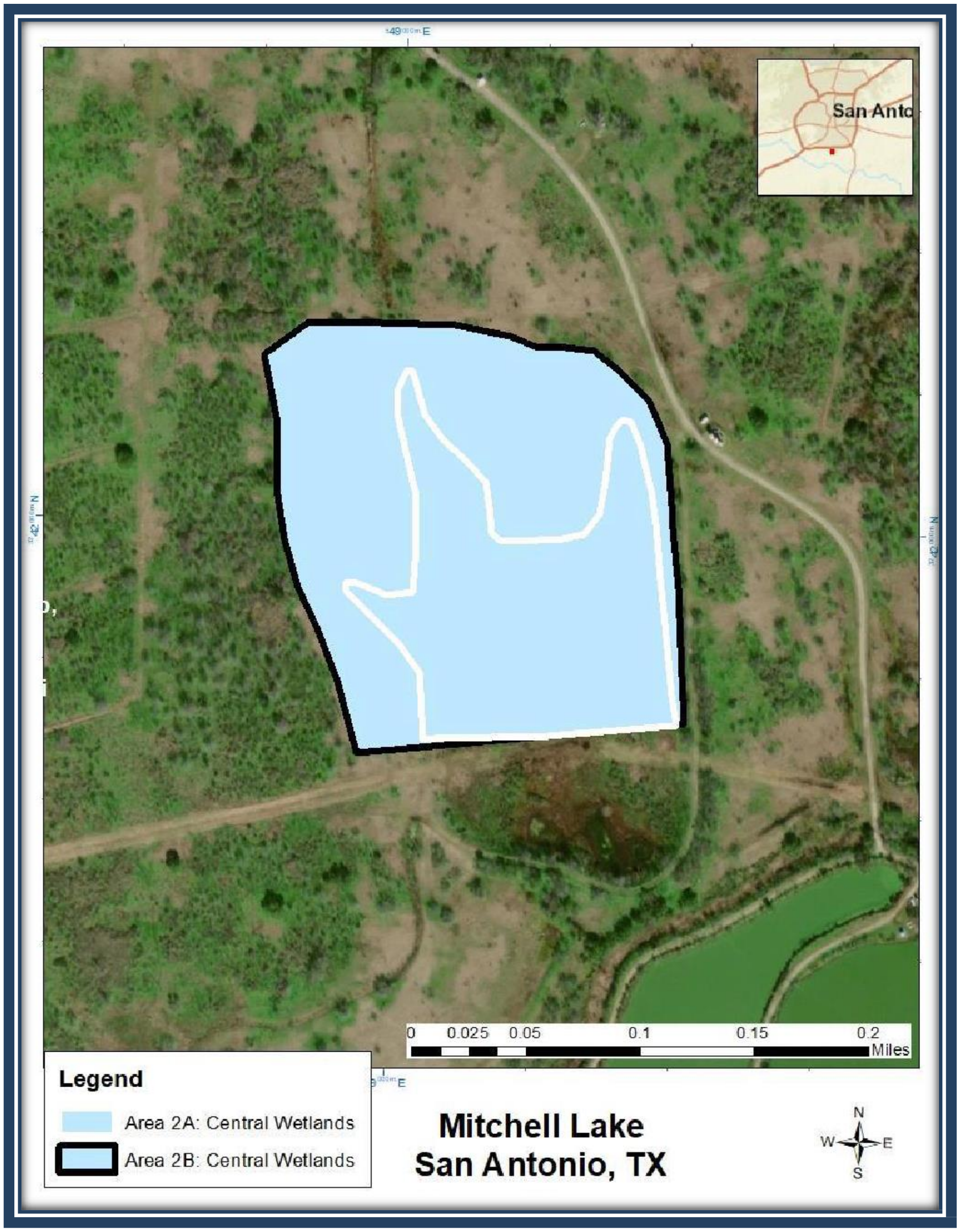

Figure 58. Area 2: Central Wetland (Alternatives 2A and 2B)

4.7.3 Area 3 – Skip's Pond

Like the alternatives described above, Area 3 – Skip's Pond, also known as Alternative 3 would incorporate the same measures and scales as described above in an existing 2.18-acre wetland (Figure 59 and Table 33), except for the Installation of the Pipeline measure. Skip's Pond would include the Native Submergent Wetland Plantings measure because of the likelihood of some shallow open water habitat due to ponding. Due to the location of the petroleum pipeline separating the Central Wetlands from Skip's Pond, there would not be enough room for the construction of a water pipeline outfall-structure dedicated to Area 3. Therefore, any Plans that include the restoration of wetlands in Skip's Pond are dependent on the inclusion of Central Wetlands in that Plan.

Figure 59 – Area 3: Skip's Pond (Alternative 3)

Table 33 - Alternative 3 Measures

Measure	Comments
Invasive Vegetation Management	Non-native and native (noxious) invasive species occur in the study area. Their removal will be necessary to ensure the sustainability of a diverse system
Clearing/Excavation	The excavation would increase the depth and diversity of the wetland bed topography to increase structural diversity in the wetland and create additional wetland habitat

Measure	Comments
Low Quality Vegetation Removal	Cattails and willow baccharis occur within Area 3 but are not dominant. Removal of these and other low-quality vegetation would be a minor component for this area.
Native Emergent Wetland Planting	The planting of native, site-specific plant emergent species is key to the establishment of a resilient, self-sustaining wetland habitat and is a key component of emergent wetland restoration.
Native Submergent Wetland Plantings	The establishment of submerged aquatic wetland vegetation to provide feeding, reproduction and protective cover habitats for fish, invertebrate and bird species.
Seasonal Pulses	Seasonal pulses would ensure the sustainability and extent of existing and excavated wetlands. Dependent upon Installation of Pipeline
Habitat Structure Augmentation	The area has limited large woody vegetation that could be used as fallen logs within the wetland or for brush piles adjacent to the wetland. Dependent upon Low Quality Habitat Removal and / or Clearing/Excavation
Installation of Bat/Nest Boxes	This simple measure can be enacted in any Area. The number of installed bat/nest boxes will be dependent on the size of the area and the species that frequent the area.
Installation of Pipeline	Installation of a pipeline to Area 3 would restore the wetland, ensure longer periods of inundation and provide resilience for the wetland.
Water Control Structure	Stop Logs will be used to control the depth of water by blocking or opening a water channel within the proposed areas.
Alternative 3	Restoring the footprint of the existing 2.18-acre wetland

4.7.4 Area 6 – Polders

From this point forward, Area 6 – Polders will also be referred as Alternative 6. The modification of 49.52 acres within the Polders/Basins to create essential mudflat habitat requires the implementation of two measures: Construction of Berms and Polder Operational Management (Table 34). Like the previous alternatives, the Installation of Bat/Nest Boxes is not required but provides significant cost-effective ecological benefits. The bat/nest boxes will be placed along the berms of the polders. Area 6 utilizes the existing polders of the old Mitchell Lake wastewater treatment facility. Currently, these polders are maintained as open water habitats to prevent the polder sediments from drying out and becoming airborne. Implementation of the proposed action would manipulate the water levels in the polders to create mudflats for migratory shorebird foraging habitat. The polder cells incorporated in Area 6 would be cycled to prevent the complete drying of the sediments and ensuring there is a water supply to inundate the drained polders. The improvement of overall water depths and availability and timing for water depths and availability improved the FWP in comparison to the FWOP.

Alternative 6 utilizes the existing polders of the old Mitchell Lake wastewater treatment facility. Currently, these polders are maintained as open water habitats to prevent the polder sediments from drying out and becoming airborne. The Polder Operational Management would manipulate the water levels in the polders to create mudflats for migratory shorebird foraging habitat. Seven inches of water is the preferred depth but should not be deeper from March to May and August to October. Because the East and West Polders are relatively large, the Construction of Berms measure would segment these polders to more manageable cells (Figure 60).

The Construction of Berms measure also includes the modification or construction of water control structures to allow both the filling and draining of the polders. Water supply for the operation of the polders is currently supplied by existing and back up pump stations. These pumps would continue to be utilized for the management of water in the polders. Despite the presence of wastewater sludge throughout the lake, there are not pollutants in Mitchell Lake and none are anticipated to be released from dry polders in excess of the FWOP conditions.

The polders will be segmented utilizing berms. This division is required to allow better management of water levels due to the significant size of the East and West polders compared to Basins 1-5 (40 acres vs. 7 acres). This adjustment will equalize water distribution.

Table 34 - Alternative 6 Measures

Measure	Comments
Polder Operational Management	Operational management of the polders is necessary to expose the mudflats and maintain the appropriate water levels to control encroachment of vegetation. Dependent upon Construction of Berms
Installation of Bat/Nest Boxes	Bat boxes and nesting boxes could be incorporated along the polder berms.
Construction of Berms	The addition of berms within existing polder cells will increase the management opportunities by allowing more refined water level control within the polder cells. An opportunity exists for using excavated material from wetland construction in other areas for use as source material. This opportunity is dependent on restoration plans involving the other wetlands to be incorporated in the same alternatives as polder restoration plan.
Installation of Pump	A temporary pump will be necessary to enact proper management of the polders. The pump will be utilized to move water between approximately two to three polders each spring and fall for shorebird migration season.
Alternative 6	**Management/Modification of Existing 49.52 Polders/Basins**

Figure 60 – Area 6: Polders (Alternative 6)

4.7.5 Area 7 – Fringe Wetlands / Coves 1 – 3

The limited and degraded fringe wetlands found in Area 7 are at risk of being eliminated and converted to upland/riparian habitats due to the proposed lowering the lake level elevation of 518.5' (NAVD88). From this point forward, Area 7 will also be referred to as Alternatives 7A – 7G because of the different restoration combinations possible for the three coves (Figure 61). Alternatives 7A – 7G entail creating a more diverse cove wetland complex at the new lake level that would be tolerant of the harsh water quality extremes of the lake. The applicable measures for Alternatives 7A – 7G are documented in Table 35.

Once SAWS implements the 518.5' (NAVD88) water surface elevation, the shoreline within the coves would be planted with native emergent and submergent plant species (Native Emergent Wetland Plantings and Native Submergent Wetland Plantings). With the migration of the shoreline resulting from the lake level modification away from the existing shoreline, there would be no riparian habitat along the new shoreline. Therefore, the alternatives include the Native Riparian Planting measure to establish shrub and tree canopies along the shoreline for shade, cover and the input of allochthonous material. Integral to these planting measures is the implementation of the Invasive Vegetation Management measure to ensure the establishment of the diverse vegetative habitats.

Three coves have been identified as part of the Fringe Wetland alternatives. They contain a scattered population of large trees adjacent to and within the existing wetland fringe habitats. A select number of these trees could be converted to standing snags for wildlife habitat. This Habitat Structure Augmentation measure would be extremely limited due to the scarcity of this resource. As with the previous areas, the Installation of Bat/Nest Boxes can be incorporated into Alternatives 7A-7G.

The Fringe Wetlands are separated into coves which can all be implemented as stand-alone alternatives or included in combination with each other. Cove 1 is ~53.68 acres on the northwest portion of Mitchell Lake. Cove 2 is ~11.84 acres on the northeast portion of Mitchell Lake. Cove 3 is on the southwest section of Mitchell Lake, within close proximity of the dam and is ~6.84 acres.

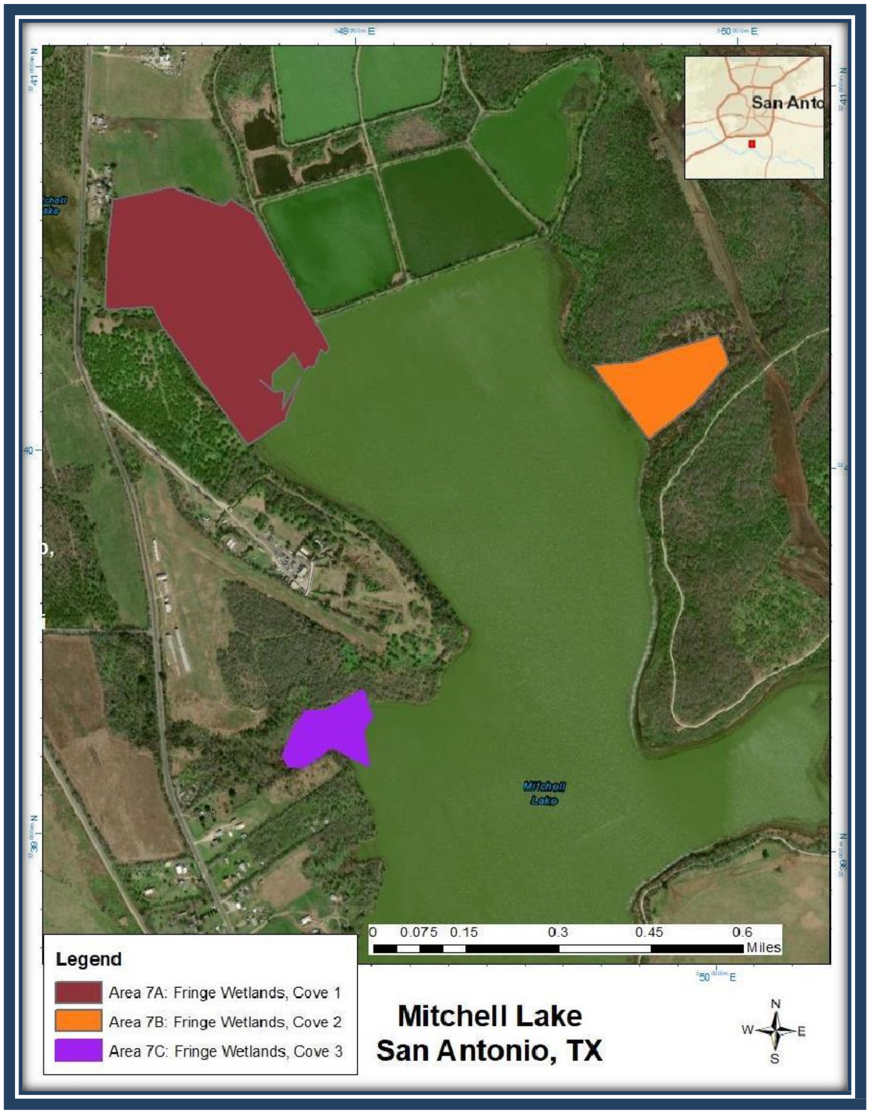

Figure 61. Area 7: Fringe Wetlands / Coves (Alternatives 7A through 7G)

Table 35 - Alternatives 7A - 7G Measures

Measure	Comments
Native Riparian Planting	SAWS plans on drawing down the water surface elevation of Mitchell Lake, which will increase exposed lakebed along the perimeter of the lake. The native riparian planting measure would decrease the time it would take for a natural riparian habitat to become established along the future lakeshore. This measure would be limited to the immediate shoreline to limit impacts to any emergent and submergent wetland plantings within the coves.
Invasive Vegetation Management	Non-native and native (noxious) invasive emergent and submergent species occur in the study area. Their removal will be necessary to ensure the sustainability of a diverse system

Native Emergent Wetland Planting	The planting of native, site-specific plant emergent species is key to the establishment of a resilient, self-sustaining emergent wetland habitat and is a key component of wetland restoration.
Native Submergent Wetland Plantings	The establishment of submerged aquatic vegetation to provide feeding, reproduction and protective cover habitats for fish, invertebrate and bird species
Habitat Structure Augmentation	Woody vegetation within the fringe wetland footprint is extremely scarce. This measure would be limited. Dependent upon Low Quality Habitat Removal and / or Clearing/Excavation
Installation of Bat/Nest Boxes	This simple measure can be enacted in any Area. The number of installed bat/nest boxes will be dependent on the size of the area and the species that frequent the area.
Scaled Alternatives	
Alternative 7A	Restoring 53.68-acre Cove 1 alone
Alternative 7B	Restoring 11.84-acre Cove 2 alone
Alternative 7C	Restoring 6.84-acre Cove 3 alone
Alternative 7D	Restoring 65.52 acres of Coves 1 & 2
Alternative 7E	Restoring 60.52 acres of Coves 1 & 3
Alternative 7F	Restoring 18.68 acres of Coves 2 & 3
Alternative 7G	Restoring 72.36 acres of Coves 1 – 3

4.7.6 Area 9: Dam Forested Wetlands

From this point forward, the alternatives for Area 9 – Dam Forested Wetlands, will be knows as Alternatives 9A or 9B. Measures appropriate for Area 9 (Figure 62 and Table 36) are the same measures identified for Areas 1 and 2 above (1A, 1B, 2A and 2B) with a few changes. The existing forested wetlands below the dam are dominated by hackberry, which provide limited wildlife habitat. The Low-Quality Vegetation Removal measure would entail the thinning of hackberry trees for use as structural habitat and the creation of standing snags to support the Habitat Structure Augmentation measure. The Area 9 alternatives would not require a pipeline for a reliable water source as the wetlands are fed by seepage from the Mitchell Lake Dam.

Table 36 - Alternatives 9A and 9B Measures

Measure	Comments
Native Riparian Planting	This area is the equivalent of a bottomland hardwood in the San Antonio region. Riparian plantings provide buffers and increase the habitat quality of the wetland complex.
Invasive Vegetation Management	Non-native and native (noxious) invasive species occur in the study area. Their removal will be necessary to ensure the sustainability of a diverse system
Clearing/Excavation	The excavation would increase the depth and diversity of the wetland bed topography to increase structural diversity in the wetland and create additional wetland habitat
Low Quality Vegetation Removal	The restoration area is dominated by hackberry essentially forming a forest monoculture with very little diversity.
Native Emergent Wetland Planting	The planting of native, site-specific plant emergent species is key to the establishment of a resilient, self-sustaining emergent wetland habitat and is a key component of wetland restoration.
Seasonal Pulses	Seasonal pulses would ensure the sustainability and extent of existing and excavated wetlands. Dependent upon Dam Modification
Habitat Structure Augmentation	Plenty of source material for brush piles, fallen logs, standing snags, etc. are found in Area 9 and can be used to create structural habitat for wildlife. Dependent upon Low Quality Vegetation Removal and / or Clearing/Excavation
Installation of Bat/Nest Boxes	This simple measure can be enacted in any Area. The number of installed bat/nest boxes will be dependent on the size of the area and the species that frequent the area.
Scaled Alternatives	
Alternative 9A	Restoration of the existing 2.55-acre wetland footprint
Alternative 9B	Expanding the existing wetland to form a 4.48-acre wetland

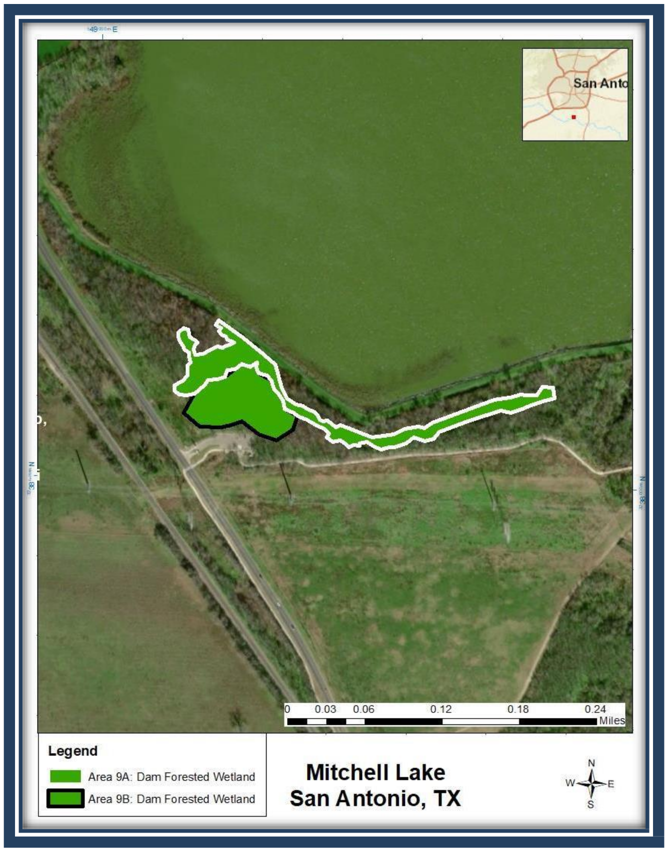

Figure 62. Area 9: Dam Forested Wetlands (Alternatives 9A and 9B)

4.7.7 Area 10 – Downstream Wetlands

The Downstream Wetlands (Figure 63 and Table 37) would be created utilizing the same measures identified for Alternatives 1A, 1B, 2A and 2B, except for the pipeline water supply. The water supply for the Downstream Wetlands would be provided by the outflow of SAWS treated wetlands. The Downstream Wetlands restoration plan entails the construction of a wetland complex adjacent to the proposed water quality treatment wetlands that would be constructed by SAWS. The Downstream 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 quality of water from the treatment wetlands.

Table 37 - Alternative 10 Measures

Measure	Comments
Clearing/Excavation	Large-scale excavation will be required to convert upland habitats to wetlands.
Native Emergent Wetland Plantings	Emergent wetland plantings are necessary for the success of this plan. This area will require new vegetation once the wetland cells are developed.

Measure	Comments
	Dependent upon Clearing/Excavation
Seasonal Pulses	Seasonal pulses would ensure the sustainability and extent of existing and excavated wetlands. Dependent upon Construction of Berms
Habitat Structure Augmentation	Source material from the upland clearing and excavation could be stockpiled and used to create habitat structures in the wetlands. Dependent upon Clearing/Excavation
Installation of Bat/Nest Boxes	This simple measure can be enacted in any Area. The number of installed bat/nest boxes will be dependent on the size of the area and the species that frequent the area.
Construction of Berms	Berms would be constructed in the Area 10 wetlands to facilitate water management and control the target wetland vegetation community. Dependent upon Clearing/Excavation
Water Control Structure	Stop Logs will be used to control the depth of water by blocking or opening a water channel within the proposed areas.
Alternative 10	Creation of 51.32 acres of wetlands

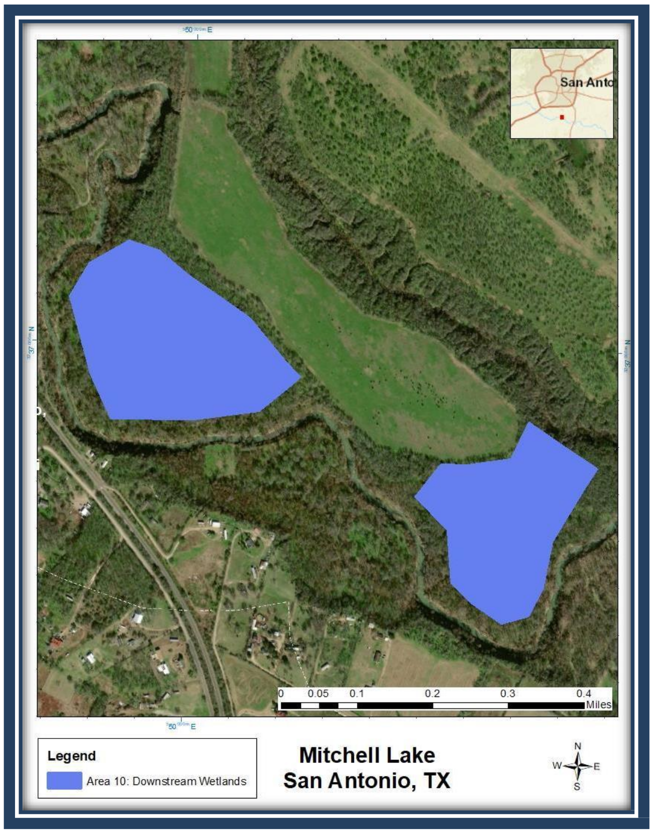

Figure 63 – Area 10: Downstream Wetlands (Alternative 10)

4.8 Evaluation and Comparison of Alternatives

The ecosystem restoration benefits and habitat modeling associated with the Mitchell Lake Aquatic ER Feasibility Study are described in detail in Appendix B – CE/ICA and Appendix C – Environmental Resources, Chapter 3. The Mitchell Lake study uses a measure of riparian and wetland species and wetland response as the ecological metric (criteria) to compare alternatives against their ability to address the ecosystem restoration objective. Riparian and wetland structure and function from pre-restoration conditions through completed restoration can be quantified by using an integrated assessment, comparing habitat and biological measures to measure the success of the ecosystem restoration objective. Therefore, restoration management measures are largely identified for their ability to restore the physical structures that contribute to food, cover and nesting sites of the ecosystem.

The Grey Squirrel Habitat Suitability Index (HSI) and Barred Owl HSI were used to evaluate the conditions of the historically riparian areas on either side of the San Antonio River. The Bullfrog and Marsh Wren (*Cistothorus palustris)* HSI allowed for the characterization of existing integrity of the existing wetlands within the project areas. The models have been approved for use in the San Antonio River Basin.

Similar studies and projects discussed in Chapter 1 were also evaluated and compared to determine whether restoration features would be effective and produce results yielding in high ecosystem restoration benefits. The product of HSIs and acres are utilized as a single unit of measure, average annual habitat units (AAHUs), which along with average annual cost (AAC) is used to compare and rank the numerous combinations of management measures.

Comparison and ranking ultimately provides an array of alternatives that, for their cost, provide the best return in ecological benefit. For the purpose of the Mitchell Lake study, the measured ecological benefit is the ability of the wetland and riparian restoration to provide the life requisites to a diverse community of riparian and aquatic (wetland) species.

NOTE: Much of the information in this Section has been updated in Section 4.12 RECOMMENDED PLAN at FINAL REPORT due to a change in plan selection after the DRAFT report was reviewed. The final recommended plan is the same as the TSP minus Area 10. Some information has been updated and numbers have been refined.

4.9 Comparison of the Scales / Sizes of Plans

NOTE: Much of the information in this Section has been updated in Section 4.12 RECOMMENDED PLAN at FINAL REPORT due to a change in plan selection after the DRAFT report was reviewed. The final recommended plan is the same as the TSP minus Area 10. Some information has been updated and numbers have been refined.

4.9.1 Costs

Total project economic costs were annualized using the annualizer tool in IWR Planning Suite II. A period of analysis of 50 years was used, along with a federal discount rate of 2.875% (per Economic Guidance Memorandum 19-01 dated 17 October 2018). Prices are expressed in October 2018 dollars.

Figure 64 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. 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.

Management Measure Area	First Cost	Real Estate	Constr. Duration (mos.)	IDC	Economic Cost	Annual Investment Cost	Annual OMRR&R	Total Annual Cost
Bird Pond 1A	$580,481	$38,040	6	$4,404	$622,925	$23,639	$6,340	$29,979
Bird Pond 1B	$648,528	$77,040	6	$5,166	$730,734	$27,730	$12,840	$40,570
Central Wetlands w/ Bird Pond 2A	$568,202	$125,520	1	$820	$694,542	$26,357	$20,920	$47,277
Central Wetlands w/o Bird Pond 2A	$842,092	$125,520	1	$1,144	$968,756	$36,762	$20,920	$57,682
Central Wetlands w/ Bird Pond 2B	$716,999	$220,440	1	$4,443	$941,882	$35,743	$36,740	$72,483
Central Wetlands w/o Bird Pond 2B	$893,744	$220,440	1	$5,281	$1,119,465	$42,482	$36,740	$79,222
Skip's Pond 3	$62,951	$6,540	0.75	$62	$69,553	$2,639	$4,360	$6,999
Polders 6	$144,780	$4,952	0.25	$44	$149,776	$5,684	$8,000	$13,684
Cove 1 7A	$1,503,040	$13,420	0.5	$897	$1,517,357	$57,581	$107,360	$164,941
Cove 2 7B	$331,520	$2,960	0.5	$198	$334,678	$12,700	$23,680	$36,380
Cove 3 7C	$191,520	$1,710	0.5	$114	$193,344	$7,337	$13,680	$21,017
Cove 1 & 2 7D	$1,834,560	$16,380	1	$2,189	$1,853,129	$70,323	$131,040	$201,363
Cove 1 & 3 7E	$1,694,560	$15,130	1	$2,022	$1,711,712	$64,956	$121,040	$185,996
Cove 2 & 3 7F	$523,040	$4,670	0.75	$468	$528,178	$20,043	$37,360	$57,403
Cove 1, 2, & 3 7G	$2,026,080	$18,090	1	$2,417	$2,046,587	$77,664	$144,720	$222,384
Dam Forested Wetland 9A	$606,339	$15,300	1.5	$1,103	$622,742	$23,632	$5,100	$28,732
Dam Forested Wetland 9B	$647,212	$26,880	1.5	$1,196	$675,288	$25,626	$8,960	$34,586
Constructed Wetlands 10	$1,515,669	$333,580	3	$6,568	$1,855,817	$70,425	$102,640	$173,065

Figure 64 - Cost Inputs for IWR Planning Suite CE/ICA Analysis

To arrive at the current costs for each of the alternative, the MII V 4.4 software and 2016 cost books (latest available versions) were used for plan formulation and then the final numbers for the Tentatively Selected Plan (TSP) were updated to the newer MII V 4.4.2 and 2016 cost books and escalated to current pricing. This is the most current version of the MCACES software. The remaining measures in the estimate are broken out based on the Civil Works Work Breakdown Structure (CWWBS).

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 option 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 Wetlands Alternatives or Central Wetland Alternatives was necessary in order to accurately conduct the CE/ICA (Appendix H – Cost).

4.9.2 Cost Effectiveness / 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 (Table 38).

This resulted in 1,728 Plans. CE/ICA analyses were based on preliminary cost estimates that were subsequently refined for the Recommended Plan.

Table 38 - Average Annual Benefits and Costs by Alternative

Project Area	Alternatives	Annual Benefits AAHU	Annual Cost ($1,000) October 2018 Prices
Area 1: Bird Pond Wetlands	1A: Restoration of Existing Wetlands	1.53	$29.98
	1B: Expansion/Restoration of Existing Wetlands and Creation of Additional Wetlands	3.85	$40.57
Area 2: Central Wetland	2A: Restoration of Existing Wetlands	5.03	$47.28
	2B: Expansion/Restoration of Existing Wetlands and Creation of Additional Wetlands	10.69	$72.48
Area 3: Skip's Pond	3: Restoration of Existing Wetlands	1.05	$6.90
Area 6: Polders	6: Management/Modification of Existing Polders/Basins	18.14	$13.68
Area 7: Fringe Wetlands	7A: Restoration of Cove 1 (Wetland/Riparian Plantings)	29.9	$164.94
	7B: Restoration of Cove 2 (Wetland/Riparian Plantings)	6.6	$36.38
	7C: Restoration of Cove 3 (Wetland/Riparian Plantings)	3.81	$21.02
	7D: Combination of Coves 1 & 2	36.5	$201.36
	7E: Combination of Coves 1 & 3	33.71	$186
	7F: Combination of Coves 2 & 3	10.41	$57.40
	7G: Combination of Coves 1, 2 & 3	40.31	$222.38
Area 9:	9A: Restoration of Existing Wet Riparian Habitat	0.47	$28.73

Project Area	Alternatives	Annual Benefits AAHU	Annual Cost ($1,000) October 2018 Prices
Dam Forested Wetlands	9B: Expansion/Restoration of Existing Wet Riparian Habitat and Creation of Additional Riparian Habitat	0.83	$34.59
Area 10: Downstream Wetlands	10: Creation of Wetlands Downstream of Mitchell Lake	14	$173.07

4.9.3 Cost Effective Plans

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 1,728 Plans (including various scales), 78 were identified as cost-effective Plans, including the No Action Plan (Figure 65).

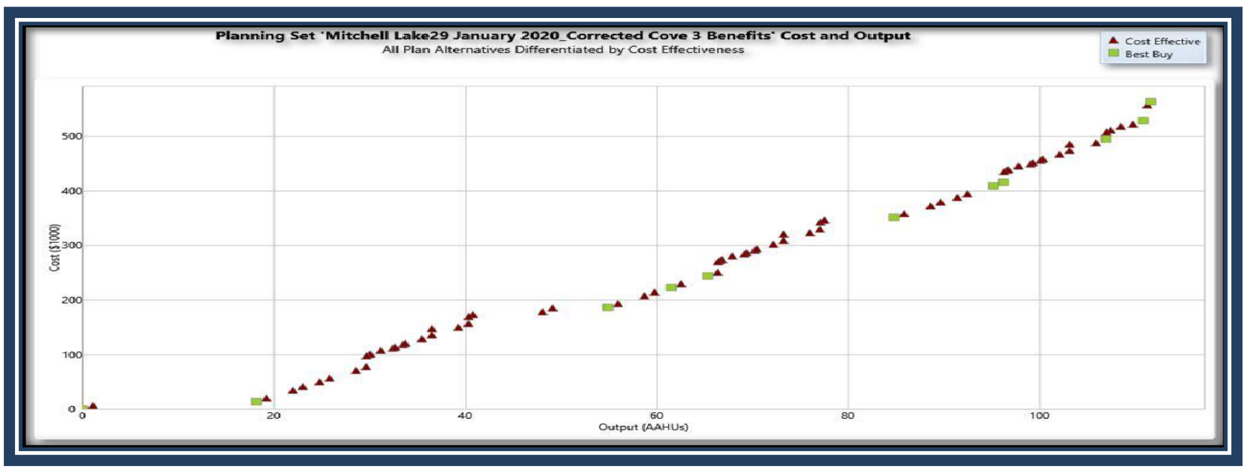

Figure 65 - Graph showing Cost Effective [red triangles] and Best Buy Plans [green squares]

4.9.4 Best Buy Plans

From the 78 cost effective Plans, eleven were identified as "Best Buy" Plans, including the No Action Plan. The result of the analysis is shown graphically in Figure 65, Figure 66 and Figure 67.

- Plan 1: No Action
- Plan 2: Polders
- Plan 3: Polders + Downstream Wetlands
- Plan 4: Polders + Downstream Wetlands + Cove 2
- Plan 5: Polders + Downstream Wetlands + Coves 2 and 3
- Plan 6: Polders + Downstream Wetlands + Cove 1
- Plan 7: Polders + Downstream Wetlands + Coves 1, 2 and 3
- Plan 8: Polders + Downstream Wetlands + Coves 1, 2 and 3 + Skip's Pond
- Plan 9: Polders + Downstream Wetlands + Coves 1, 2 and 3 + Skip's Pond + Central Wetlands (2B)
- Plan 10: Polders + Downstream Wetlands + Coves 1, 2 and 3 + Skip's Pond + Central Wetlands (2B) + Bird Pond Wetlands (1B)
- Plan 11: Polders + Downstream Wetlands + Coves 1, 2 and 3 + Skip's Pond + Central Wetlands (2B) + Bird Pond Wetlands (1B) + Dam Forested Wetlands (9B)

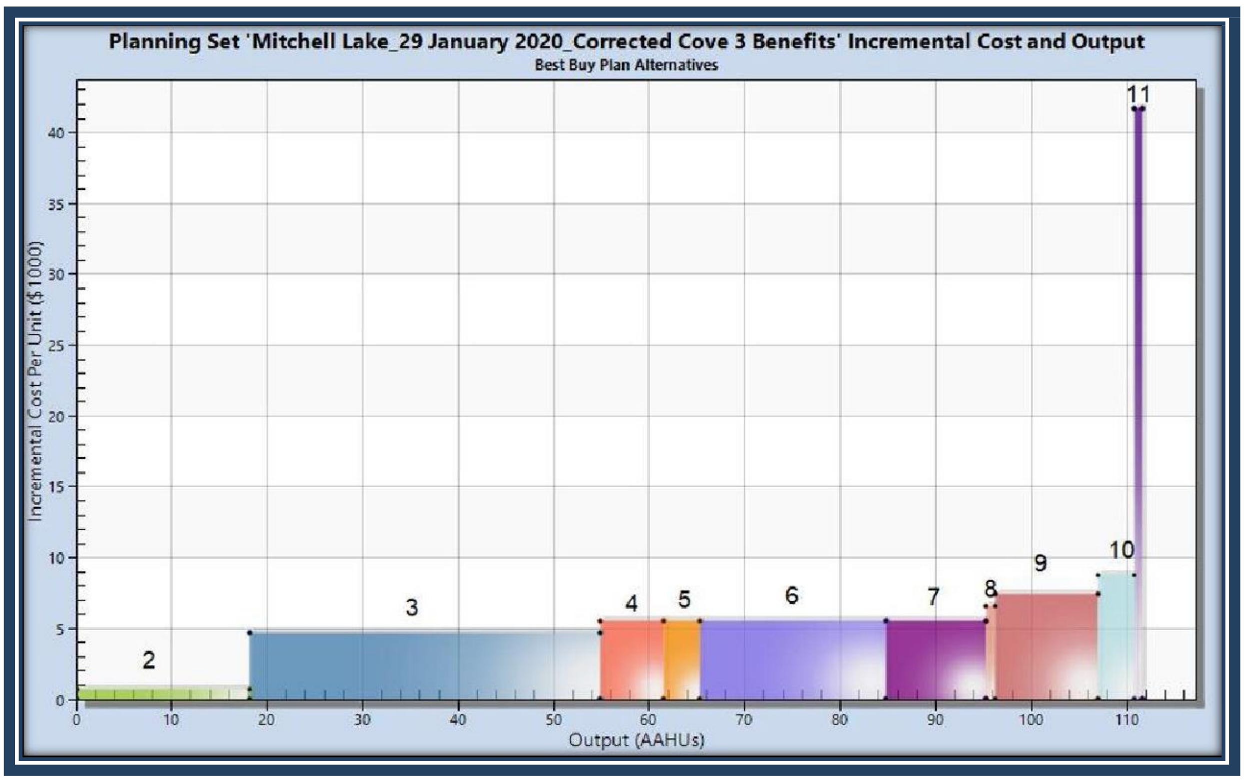

Figure 66 - Bar Chart comparing Best Buy Plans Benefits vs. Costs for Implementation

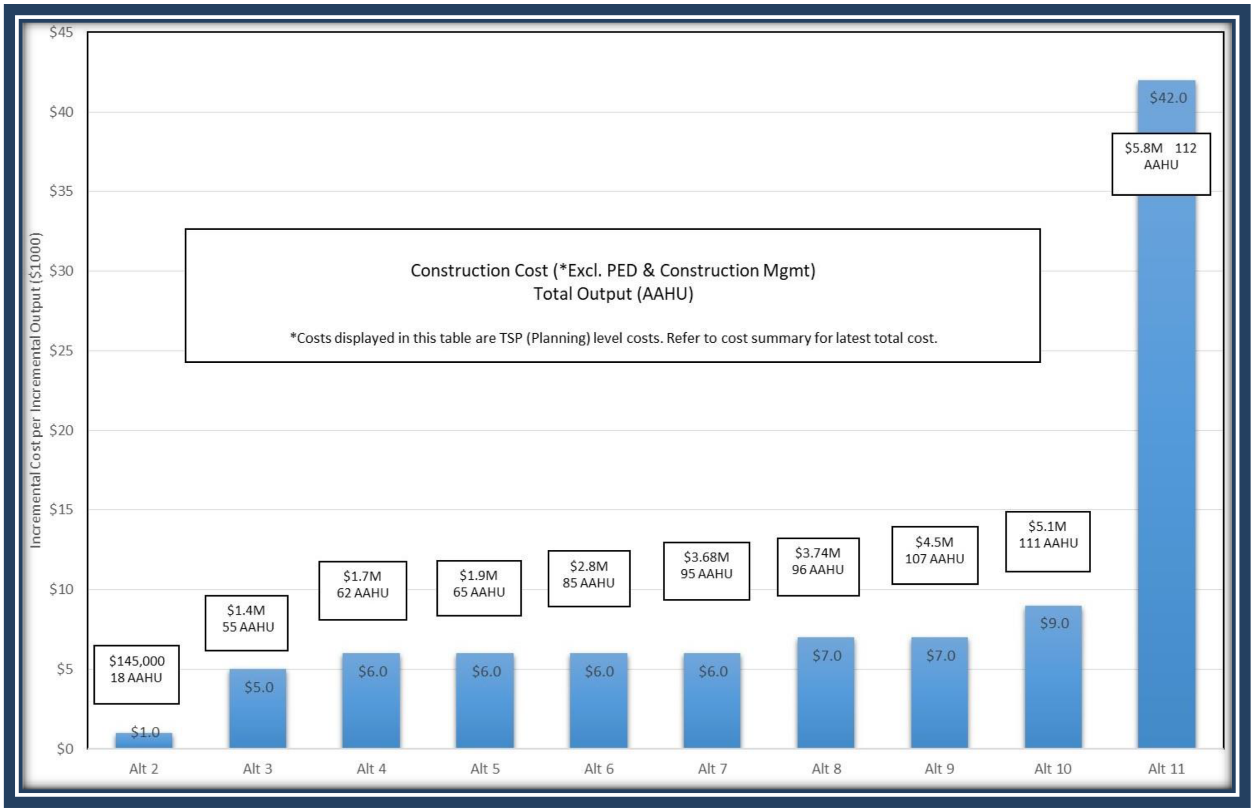

Figure 67 - Incremental Costs per Incremental Output for Best Buy Plans

4.9.5 Do the Best Buys Meet Study Objectives?

Specific Study Planning Objectives:

1. increase the areal extent and quality of fish and wildlife habitat in the study area for the 50-year Period of analysis
2. increase the floral and faunal species diversity and richness in the study area for the 50-year Period of analysis

First, each Plan was identified as either meeting a specific study objective (**Yes**) or failing to meet a specific planning objective (**No**) (Table 39). All but one Best Buy Plan met study objectives.

Table 39 – Screening of Plans with the Planning Objectives

Plan Name	Planning Objectives	
	1	2
Plan 1: No Action	No	No
Plan 2: Polders (Alternative 6 alone)	Yes	Yes
Plan 3: Polders + Downstream Wetlands	Yes	Yes
Plan 4: Polders + Downstream Wetlands + Cove 2	Yes	Yes
Plan 5: Polders + Downstream Wetlands + Coves 2 and 3	Yes	Yes
Plan 6: Polders + Downstream Wetlands + Cove 1	Yes	Yes
Plan 7: Polders + Downstream Wetlands + Coves 1, 2 and 3	Yes	Yes
Plan 8: Polders + Downstream Wetlands + Coves 1, 2 and 3 + Skip’s Pond	Yes	Yes
Plan 9: Polders + Downstream Wetlands + Coves 1, 2 and 3 + Skip's Pond + Central Wetlands (2B)	Yes	Yes
Plan 10: Polders + Downstream Wetlands + Coves 1, 2 and 3 + Skip's Pond + Central Wetlands (2B) + Bird Pond Wetlands (1B)	Yes	Yes
Plan 11: Polders + Downstream Wetlands + Coves 1, 2 and 3 + Skip's Pond + Central Wetlands (2B) + Bird Pond Wetlands (1B) + Dam Forested Wetlands (9B)	Yes	Yes

4.9.6 Is it Worth It? Analysis of the Best Buy Plans

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 US. 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 many 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 alternative to improve habitat for the nationally significant migratory bird populations at Mitchell Lake.

Plan 2: Polders (Alternative 6 alone)

Plan 2 (Figure 68) 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.

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 18.1 AAHU for migratory shorebirds with an incremental cost per incremental output of $750. The Plan has a first cost of $144,780 and an incremental cost of $13,680. 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, Plan 2 is worth the Federal and local investment.

Figure 68 - Plan 2 (Alternative 6 Alone)

Plan 3 (Polders and Downstream Wetlands)

Plan 3 (Figure 69) includes the mudflat restoration defined in Plan 2 and adds the restoration of 51.32 acres of emergent wetlands located downstream of the Mitchell Lake Dam in Area 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 3 adds 36.7 AAHUs of emergent wetland habitat to the 18.1 AAHU of mudflat 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 3 would provide a total of 54.9 AAHUs; this comprises 49% of the output of that captured by the largest Plan (Plan 11). The incremental cost per incremental output of Plan 3 is $4,712 with a first cost of $1,370,889. Plan 3 would restore 49% of the total area identified for restoration under this study.

Plan 3 includes the restoration of shorebird habitat attributed to the polders and adds the emergent wetlands benefit for waterbirds and temperate and neotropical migrant songbirds. Because Plan 3 increases the habitat value for another group of migratory bird species with a relatively minor incremental cost to incremental output ratio, the selection of this Plan as a Federal and local investment is justified.

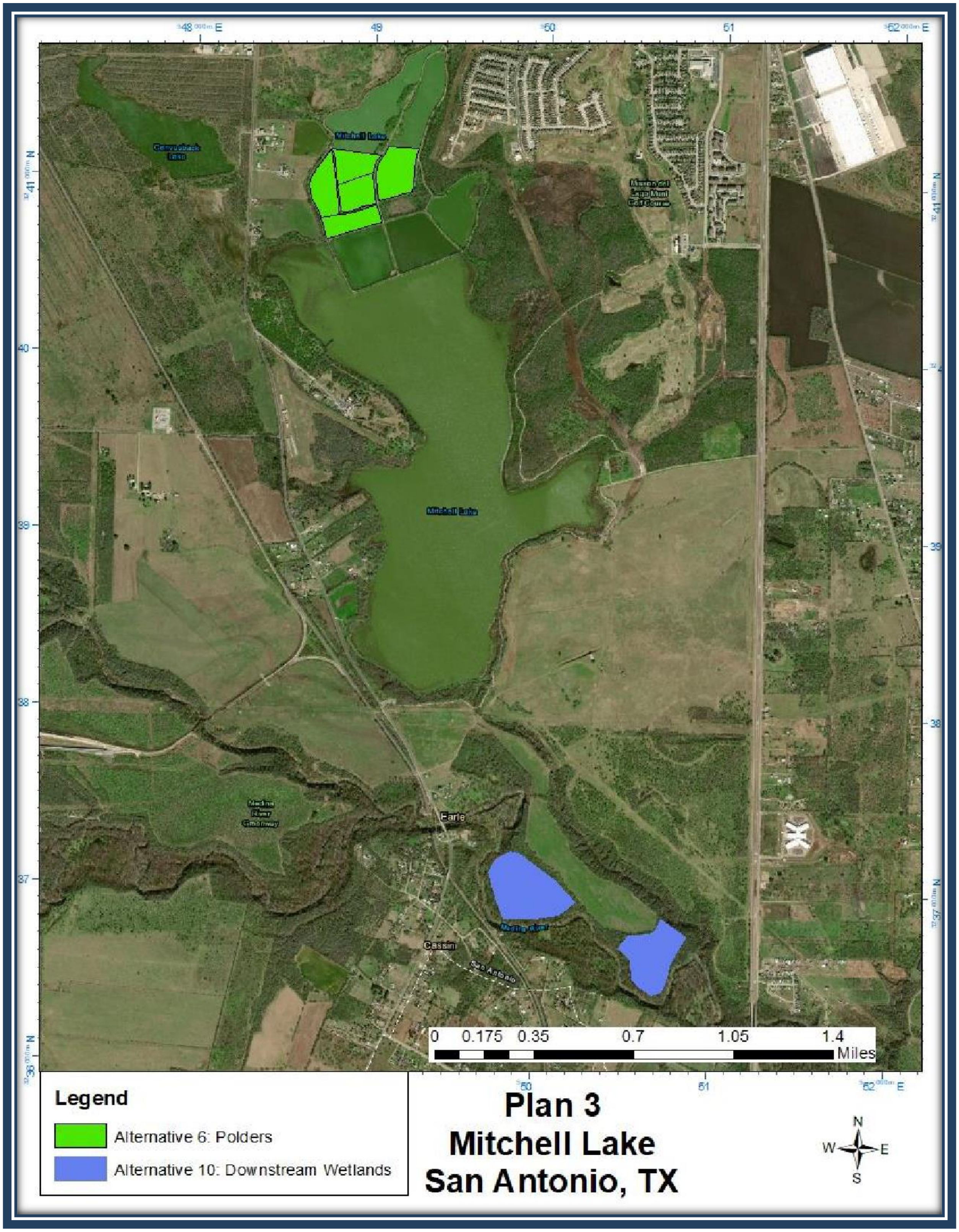

Figure 69. Plan 3 (Alternatives 6 and 10)

Plan 4 (Polders, Cove 2 and the Downstream Wetlands)

Plan 4 (Figure 70) includes the restoration of the mud flats and emergent wetlands that were defined in Plan 3 and adds the restoration of 11.84 acres of a combination of emergent/submergent wetland and unmeasured riparian habitat for buffering in Cove 2.

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. Details of the ecological benefits of the emergent/submergent wetland habitats are provided in Chapter 6 of the Main Report.

Plan 4 adds 6.6 AAHUs of emergent/submergent wetland habitat with an unmeasured ecological benefit of a riparian habitat buffer to the 18.1 AAHU of mudflat and 36.73 AAHUs of emergent wetland habitats. Keeping the caveat identified above regarding combination of AAHUs from different habitat types quantified using different habitat models model in mind, Plan 4 would result in a total 61.5 AAHUs or 55% of the total potential AAHUs available for the study. The incremental cost per incremental output for Plan 4 is $5,512 with a first cost of $1,702,409. Plan 4 would restore 55% of the total area identified for restoration under this study.

The addition of Cove 2 associated with Plan 4 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, the emergent/submergent wetlands benefit waterfowl and waterbirds and the emergent wetlands benefit waterbirds and temperate and neotropical migrant songbirds. Cove 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 4 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

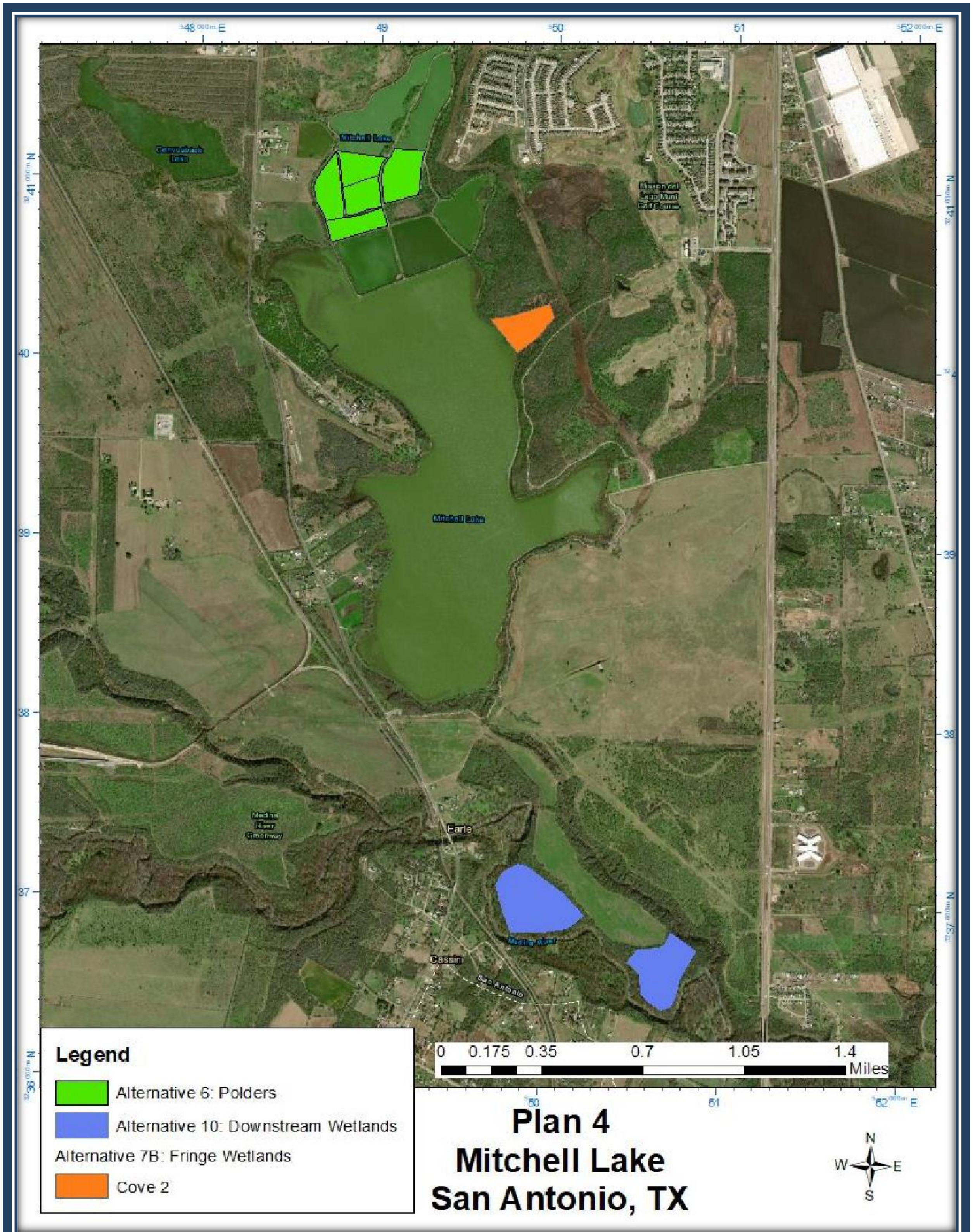

Figure 70. Plan 4 (Alternatives 6, 10 and 7C)

Plan 5 (Polders; Coves 2 and 3 and the Downstream Wetlands)

Plan 5 (Figure 71) adds the restoration of emergent and submergent wetlands and a small riparian buffer in Cove 3 from Alternative 7F to those restoration features included in Plan 4. In addition to the restoration of 49.52 acres of mudflats associated with the polders, 11.84 acres of emergent/submergent wetlands with a riparian buffer associated with Cove 2 and 51.32 acres of emergent wetlands associated with the downstream wetlands, Plan 5 adds emergent/submergent wetland habitat restoration in an additional cove of Mitchell Lake. Restoration would include 6.84 acres of restoration in Cove 3 located at the southwest end of the lake and 11.84 acres of restoration in a cove at the eastern edge of the lake. The additional 6.84 acres of emergent/submergent wetland provided by Plan 5 would result in a total of 18.68 total acres of restoration in the coves of Mitchell Lake.

Plan 5 adds 3.8 AAHUs of emergent/submergent wetland habitat to the previous 6.6 AAHUs of emergent/submergent wetlands, 18.1 AAHUs of mudflat and 36.7 AAHUs of emergent wetland habitats. The 65.3 total AAHUs captured by this Plan can be broken down for each habitat type:

- 49.52 acres and 18.1 AAHUs of mudflat habitat
- 18.68 acres and 10.4 AAHUs of emergent/submergent wetland habitat
- 51.32 acres and 36.7 AAHUs of emergent wetland habitat

The incremental cost per incremental output for Plan 5 is $5,517 with a first cost of $1,893,929. Plan 5 would restore 58% of the total area identified for restoration under this study.

Plan 5 would increase the area of emergent/submergent wetlands restored by 6.84 acres. 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 the downstream wetlands, Cove 2 and the polders. The incremental cost per incremental output of including the Cove 2 wetlands into Plan 4 was $5,512 compared to the $5,517 incremental cost per incremental output for the Cove 2 and Cove 3 wetlands. Because of the value of these wetlands, the expenditure of the additional incremental cost per incremental output is worth the Federal and local investment.

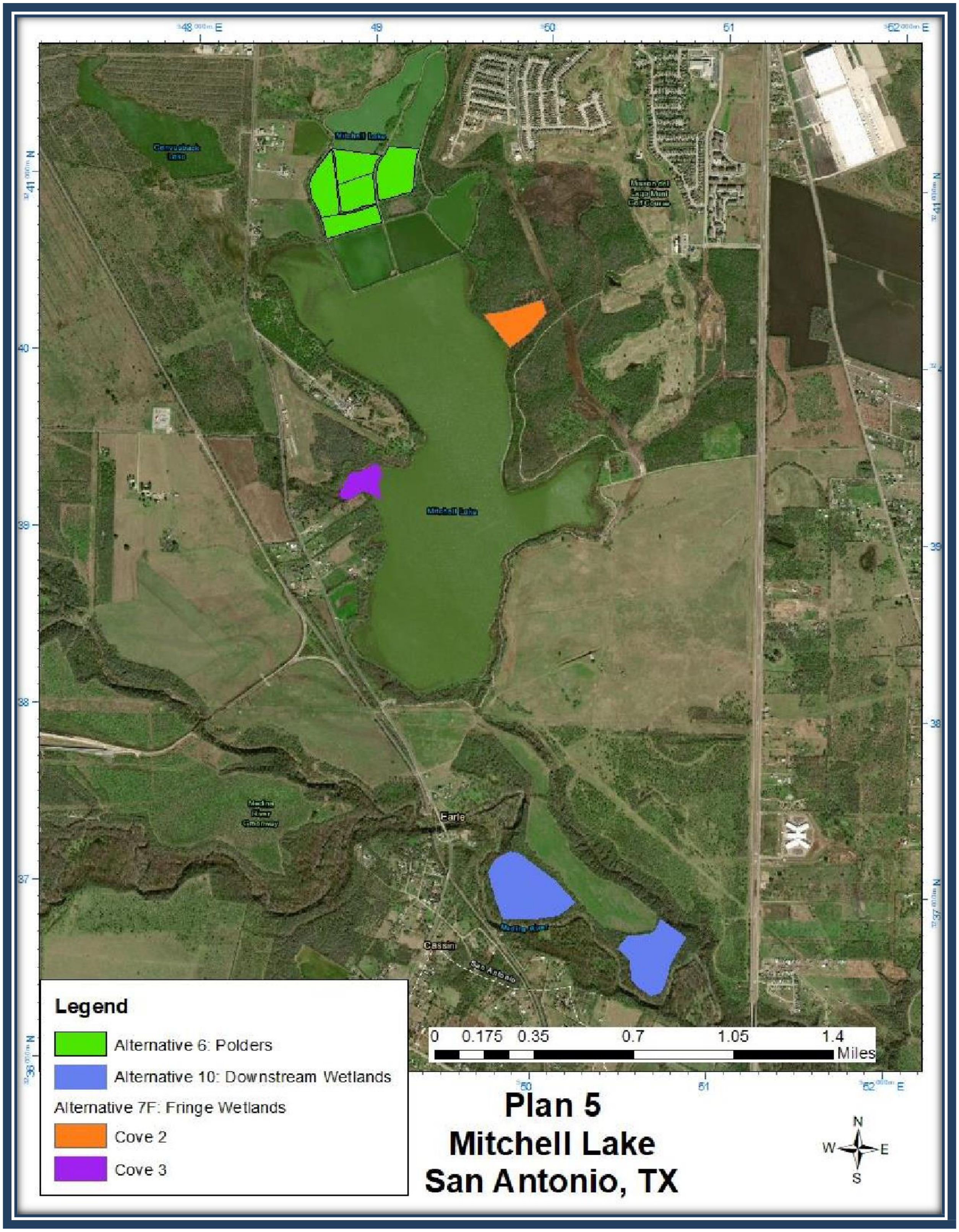

Figure 71. Plan 5 (Alternatives 6, 7F and 10)

Plan 6 (Polders, Cove 1 and Downstream Wetlands)

Plan 6 (Figure 72) adds the restoration of emergent and submergent wetlands in Cove 1 from Alternative 7A to those restoration features included in Plan 5, but removes Cove 2 and 3. Plan 6 includes the restoration of 49.52 acres of mudflats associated with the polders, 53.68 acres of emergent/submergent wetlands associated with Cove 1 and 51.32 acres of emergent wetlands associated with the downstream wetlands. The 53.68 acres of emergent/submergent wetland provided by Plan 6 would result in restoration of the northernmost cove of Mitchell Lake.

Plan 6 adds 29.9 AAHUs of emergent/submergent wetland habitat, 18.1 AAHUs of mudflat and 36.7 AAHUs of emergent wetland habitats. The 84.8 total AAHUs captured by this Plan can be broken down for each habitat type:

- 49.52 acres and 18.1 AAHUs of mudflat habitat
- 53.68 acres and 29.9 AAHUs of emergent/submergent wetland habitat
- 51.32 acres and 36.7 AAHUs of emergent wetland habitat

The incremental cost per incremental output for Plan 6 is $5,518 with a first cost of $2,873,929. Plan 6 would restore 76% of the total area identified for restoration under this study.

Cove 1 is large and characterized by shallow water throughout. It is connected to the rest of the study area through a drainage channel northwest of the polders. The incremental cost per incremental output of including the Cove 1 wetlands into Plan 6 is $5,518. Compared to the incremental cost per incremental output of $5,517 for Plan 5 there is an extremely minor increase in cost to include a larger cove area. Because of the value of these wetlands, the expenditure of the additional incremental cost per incremental output is worth the Federal and local investment.

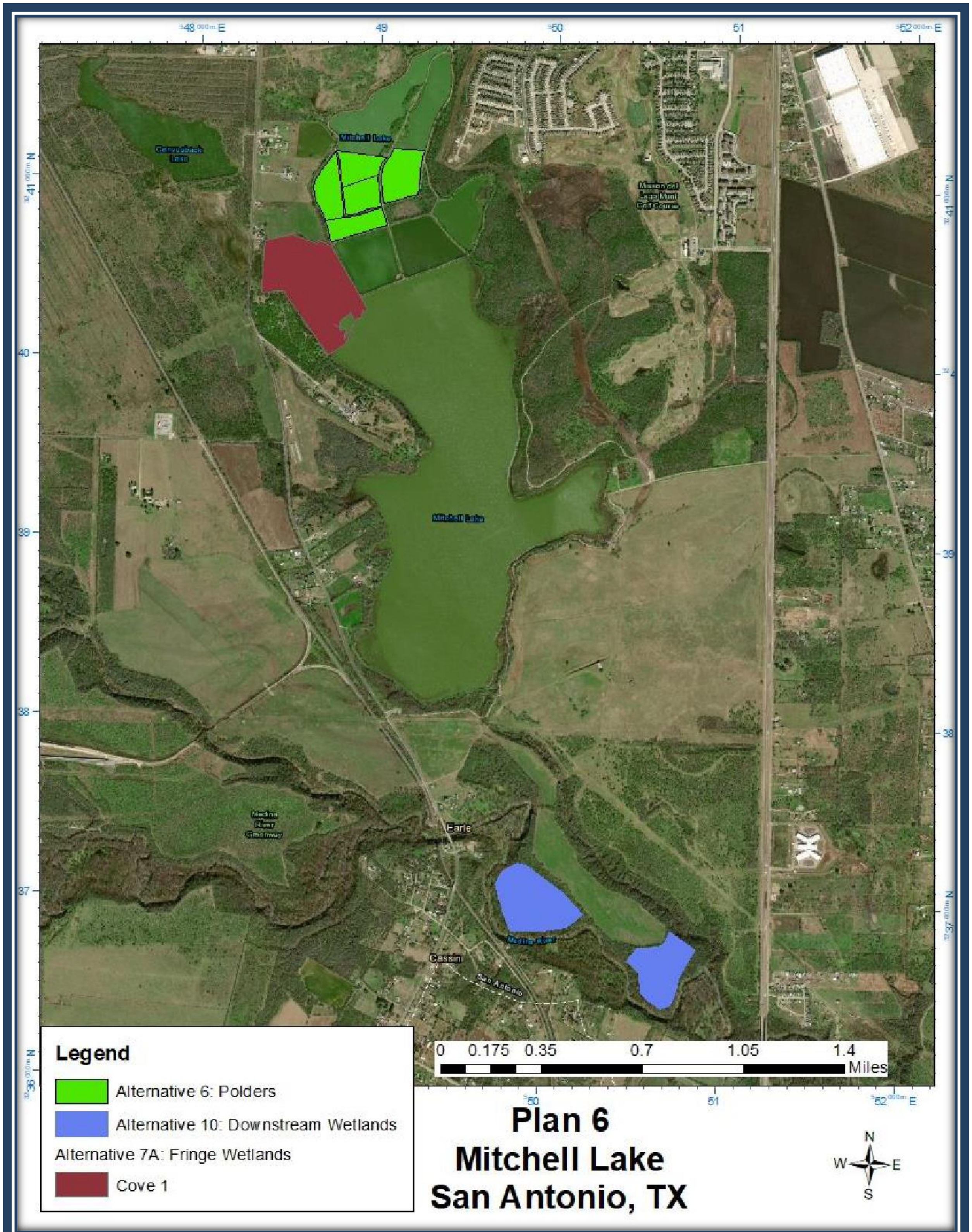

Figure 72. Plan 6 (Alternatives 6, 7A and 10)

Plan 7 (Polders, Downstream Wetlands, Coves 1, 2 and 3)

Plan 7 (Figure 73) adds the restoration of emergent and submergent wetlands in Cove 1 from Alternative 7A to those restoration features included in Plan 5. In addition to the restoration of 49.52 acres of mudflats associated with the polders, 53.68 acres of emergent/submergent wetlands associated with Cove 1 and 51.32 acres of emergent wetlands associated with the downstream wetlands (Table 37), Plan 7 adds emergent/submergent wetland habitat restoration of Coves 2 and 3, along with a small native riparian buffer around the shoreline of each cove. Restoration would include 6.84 acres of restoration in Cove 3 located at the southwest end of the lake and 11.84 acres of restoration in a cove at the eastern edge of the lake. The additional 18.68 acres of emergent/submergent wetland provided by Plan 7 would result in a total of 72.36 total acres of restoration in the coves of Mitchell Lake.

Plan 7 adds 10.4 AAHUs of emergent/submergent wetland habitat to the previous 29.9 AAHUs of emergent/submergent wetlands, 18.1 AAHUs of mudflat and 36.7 AAHUs of emergent wetland habitats. The 95.2 total AAHUs captured by this Plan can be broken down for each habitat type:

- 49.52 acres and 18.1 AAHUs of mudflat habitat
- 72.36 acres and 40.3 AAHUs of emergent/submergent wetland habitat
- 51.32 acres and 36.7 AAHUs of emergent wetland habitat

The incremental cost per incremental output for Plan 7 is $5,518 with a first cost of $3,686,529. Plan 7 would restore 85% of the total area identified for restoration under this study.

Plan 7 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 addition of two larger 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 the two larger coves 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.

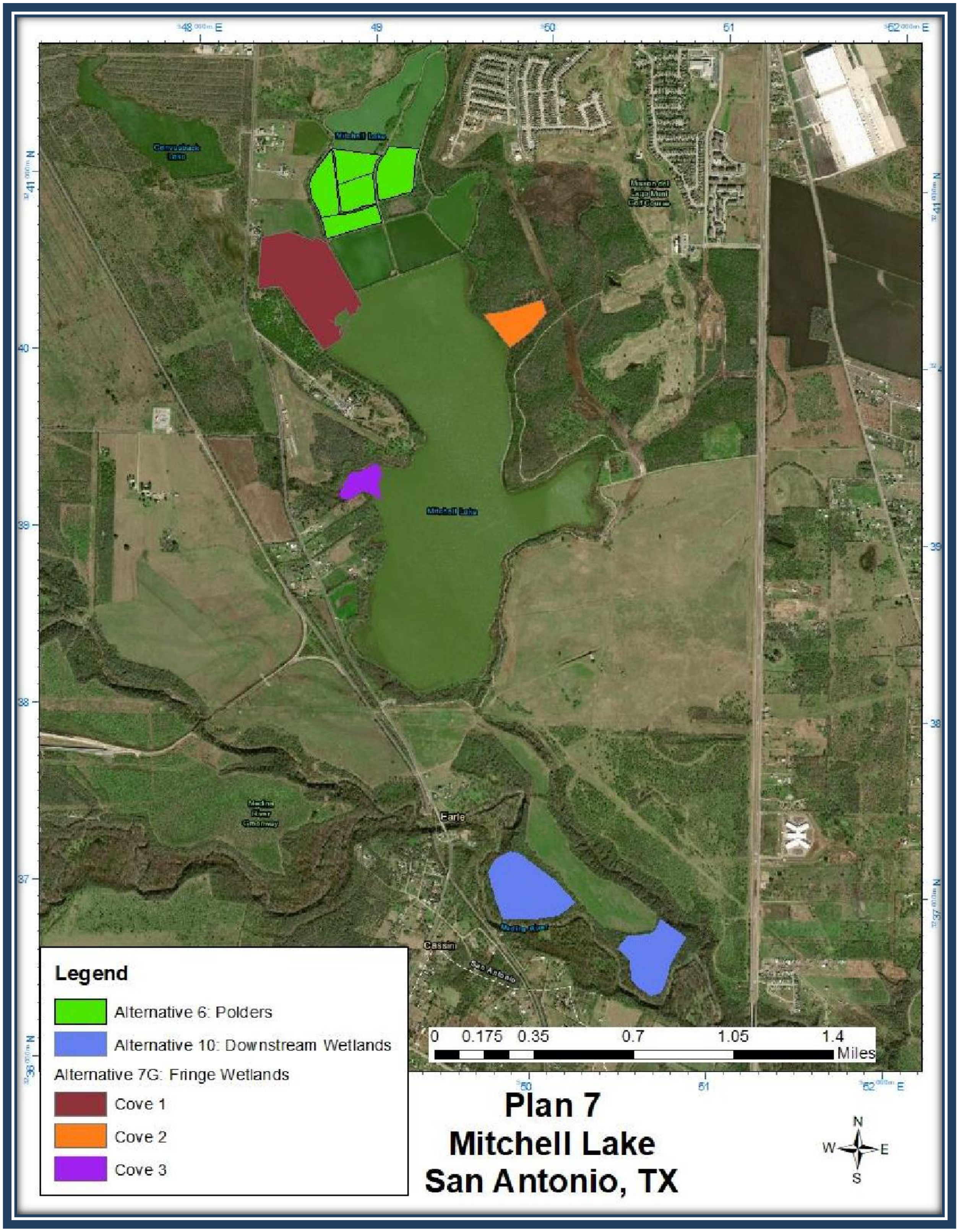

Figure 73. Plan 7 (Alternatives 6, 7G and 10)

Plan 8 (Polders; Coves 1, 2 and 3, the Downstream Wetlands and Skip's Pond)

In addition to the restoration features included in Plan 7, Plan 8 (Figure 74) adds restoration measures to improve the habitat quality of Skip's Pond from Alternative 3. Skip's Pond is an existing submergent/emergent wetland with areas of open water. The restoration would increase the topographic diversity of the pond, create emergent vegetation on the margins of the pond, add additional submergent vegetation within open water areas, and control non-native, invasive species. The Skip's Pond restoration would add 2.18 acres of submergent/emergent wetlands and 1.1 AAHUs to the previous Plan.

A total of 96.2 AAHUs are provided by Plan 8; the allocation of the AAHUs are provide below:

- 49.52 acres and 18.1 AAHUs of mudflat habitat
- 74.54 acres and 41.3 AAHUs of emergent/submergent wetland habitat
- 51.32 acres and 36.7 AAHUs of emergent wetland habitat

The incremental cost per incremental output for Plan 8 is $6,571 with a first cost of $3,749,480, a first cost increase of approximately $63,000 over Plan 7. Plan 8 would restore 85.7% of the total area identified for restoration under this study.

Although Skip's Pond adds submergent/emergent wetland habitat to the proposed restoration and increases the total acreage of submergent/emergent for this Plan to 74.54 acres, 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 distinct habitat that has not necessarily 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 Plan 7 to Plan 8 and the marginal increase in the first cost, Plan 8 is worth the Federal and local investment.

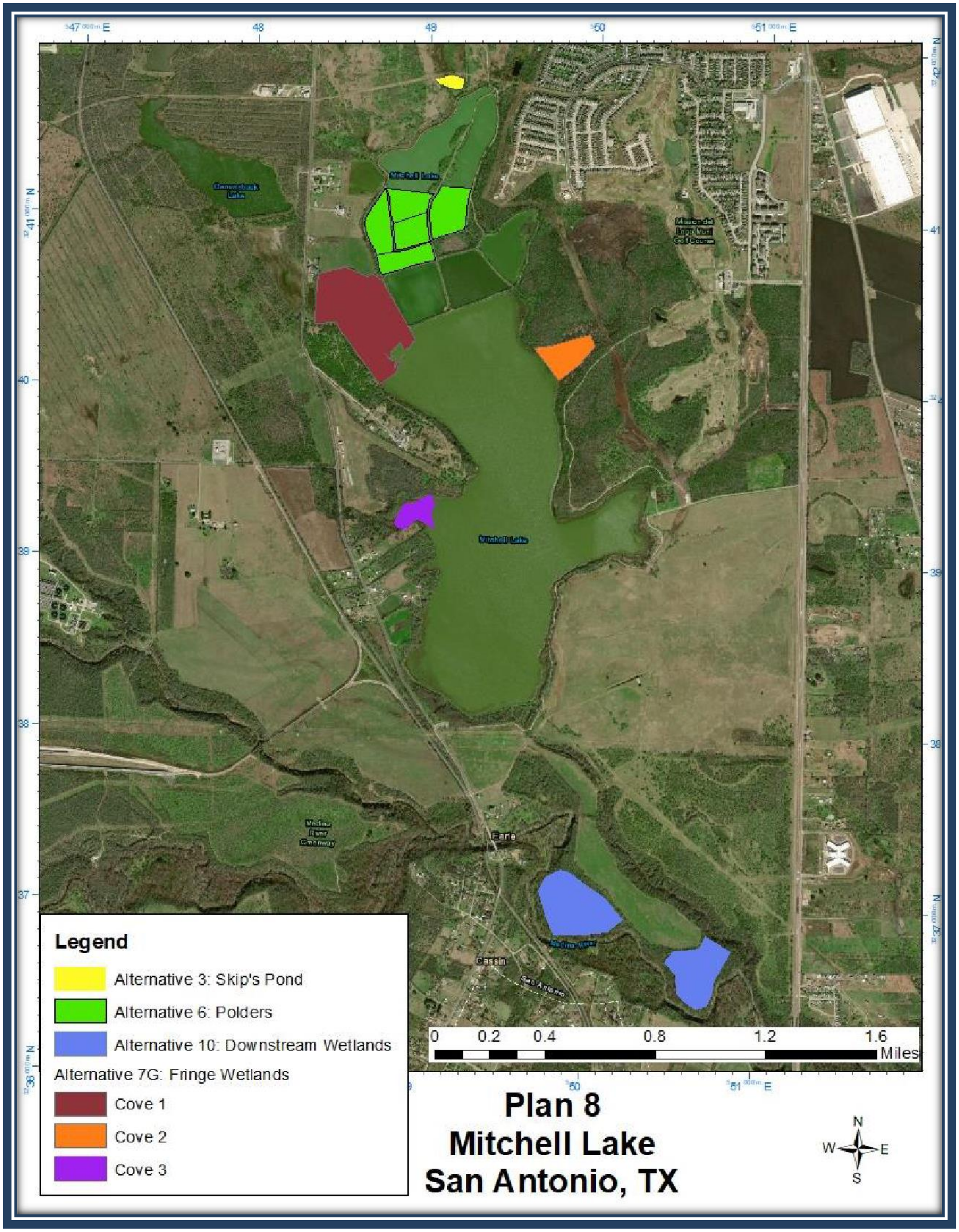

Figure 74. Plan 8 (Alternatives 3, 6, 7G and 10)

Plan 9 (Polders; Coves 1, 2 and 3, the Downstream Wetlands, Skip's Pond and the Central Wetlands)

Plan 9 (Figure 75 and Figure 76) includes the restoration features included in Plan 8 and adds the restoration the expansion of the Central Wetlands from Alternative 2B. 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. The Central Wetland restoration would add 18.37 acres of emergent wetlands and 10.7 AAHUs to the previous Plan.

A total of 106.9 AAHUs are provided by Plan 9; the allocation of the AAHUs are provided below:

- 49.52 acres and 18.1 AAHUs of mudflat habitat
- 74.54 acres and 41.4 AAHUs of emergent/submergent wetland habitat
- 69.69 acres and 47.4 AAHUs of emergent wetland habitat

The incremental cost per incremental output for Plan 9 is $7,411 with a first cost of $4,446,479, a first cost increase of approximately $717,000 over Plan 8. Plan 9 would restore 94.6% of the total area identified for restoration under this study.

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 9 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 existing pump station at the southwest corner of 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. 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' through the linear wetland and Cove 1 of Mitchell Lake.

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 the Downstream Wetlands would be excavated from an upland area, the transitional areas between the resultant wetland and upland would be more severe and constrained. Although the captured benefits more than justifies each of these emergent wetland areas, the cumulative captured and uncaptured benefits of the Central Wetlands is significantly higher than the Downstream Wetlands.

Because of the connectivity the Central Wetlands provide to Skip's Pond, the linear wetlands 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 Plan 8 to Plan 9 and the marginal increase in the first cost, Plan 9 is worth the Federal and local investment.

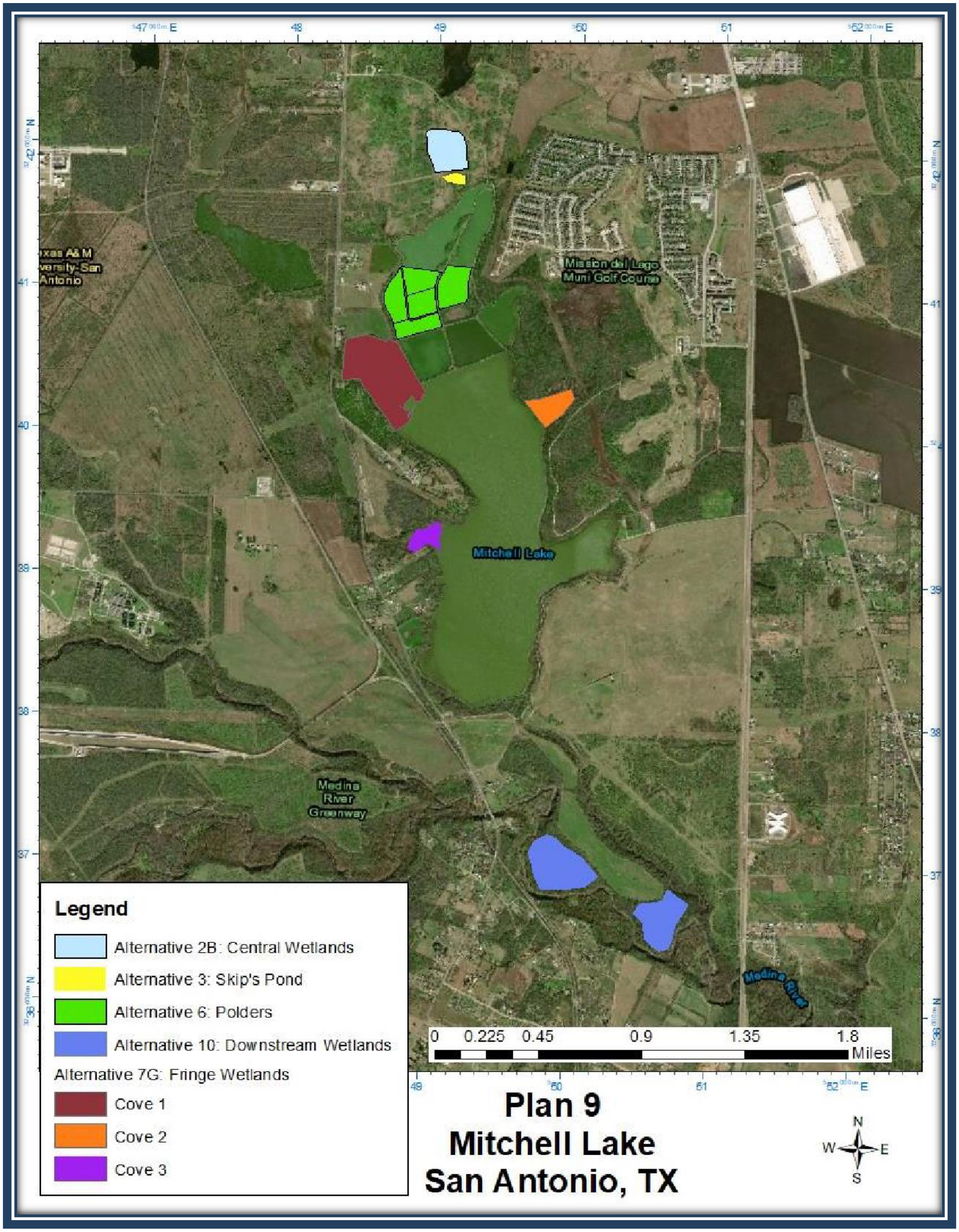

Figure 75. Plan 9 (Alternatives 2B, 3, 6, 7G and 10)

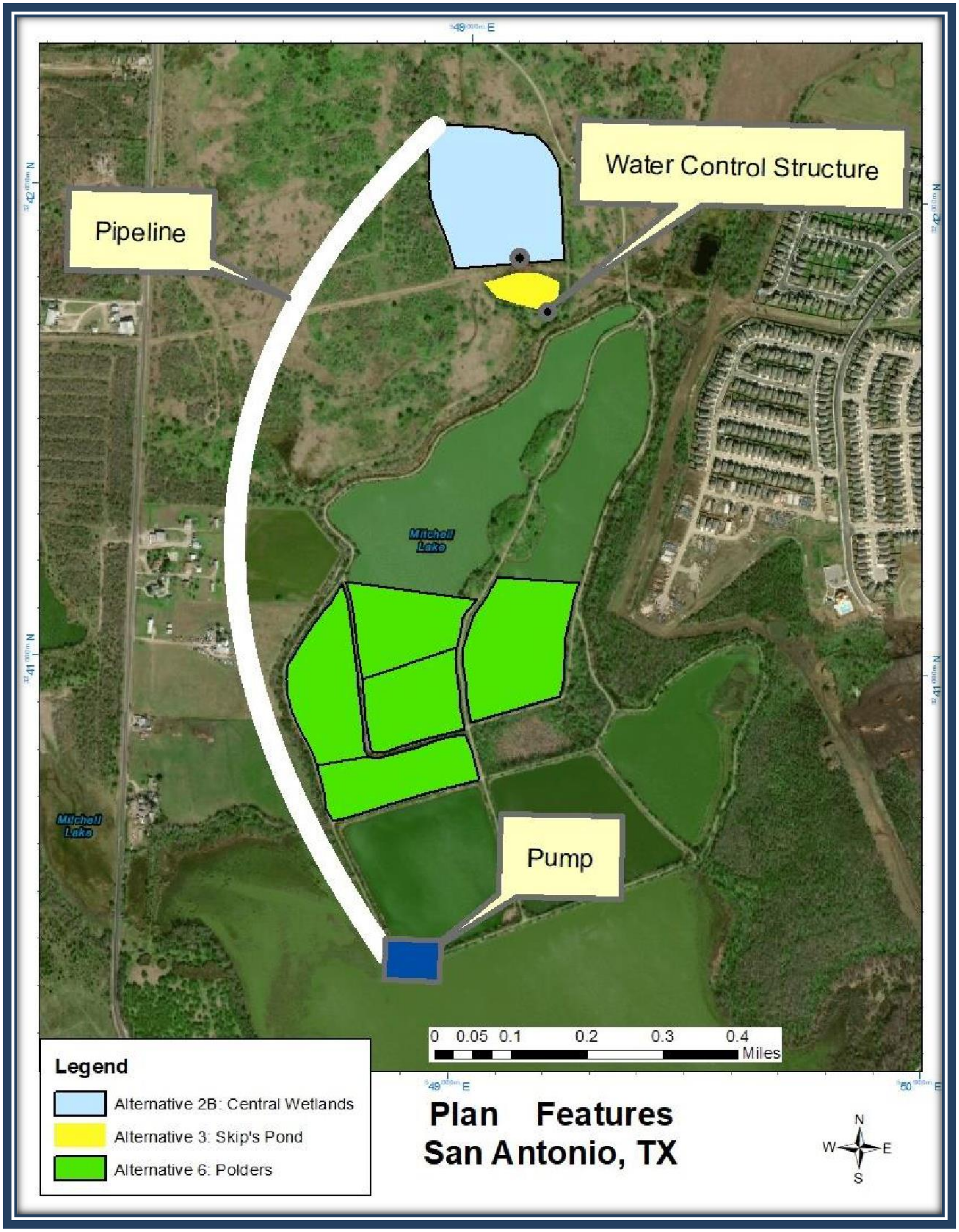

Figure 76. Plan 9 Restoration Features

Plan 10 (Polders; Coves 1, 2 and 3, the Downstream Wetlands, Skip's Pond, the Central Wetlands and the Bird Pond Wetlands)

Plan 10 (Figure 77 and Figure 78) includes the restoration features included in Plan 9 and adds the restoration and expansion of the Bird Pond Wetlands from Alternative 1B. The Bird Pond Wetlands is an existing wetland located east of Bird Pond and upslope 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 9), the pipeline would be moved to the north end of the Bird Pond Wetlands. The restoration measures would improve the plant diversity and expand the wetland complex. The Bird Pond Wetlands restoration would add 6.42 acres of emergent wetlands and 3.9 AAHUs to the previous Plan.

A total of 110.8 AAHUs are provided by Plan 10; the allocation of the AAHUs are provide below:

- 49.52 acres and 18.1 AAHUs of mudflat habitat
- 74.54 acres and 41.4 AAHUs of emergent/submergent wetland habitat
- 76.11 acres and 51.3 AAHUs of emergent wetland habitat

The incremental cost per incremental output for Plan 10 is $8,787 with a preliminary first cost of $5,115,007, a first cost increase of approximately $648,000 over Plan 9. Plan 10 would restore 97.8% of the total area identified for restoration under this study.

Plan 10 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 Downstream 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 Wetlands also provides optional foraging opportunities for pond dependent species utilizing the Bird Pond habitats such as egrets and herons.

Although the incremental cost per incremental output for restoring the Bird Pond Wetlands is slightly higher than the incremental ratio of the Central Wetlands, the Bird Pond Wetlands 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 Wetlands 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 9 to Plan 10, Plan 10 is worth the Federal and local investment.

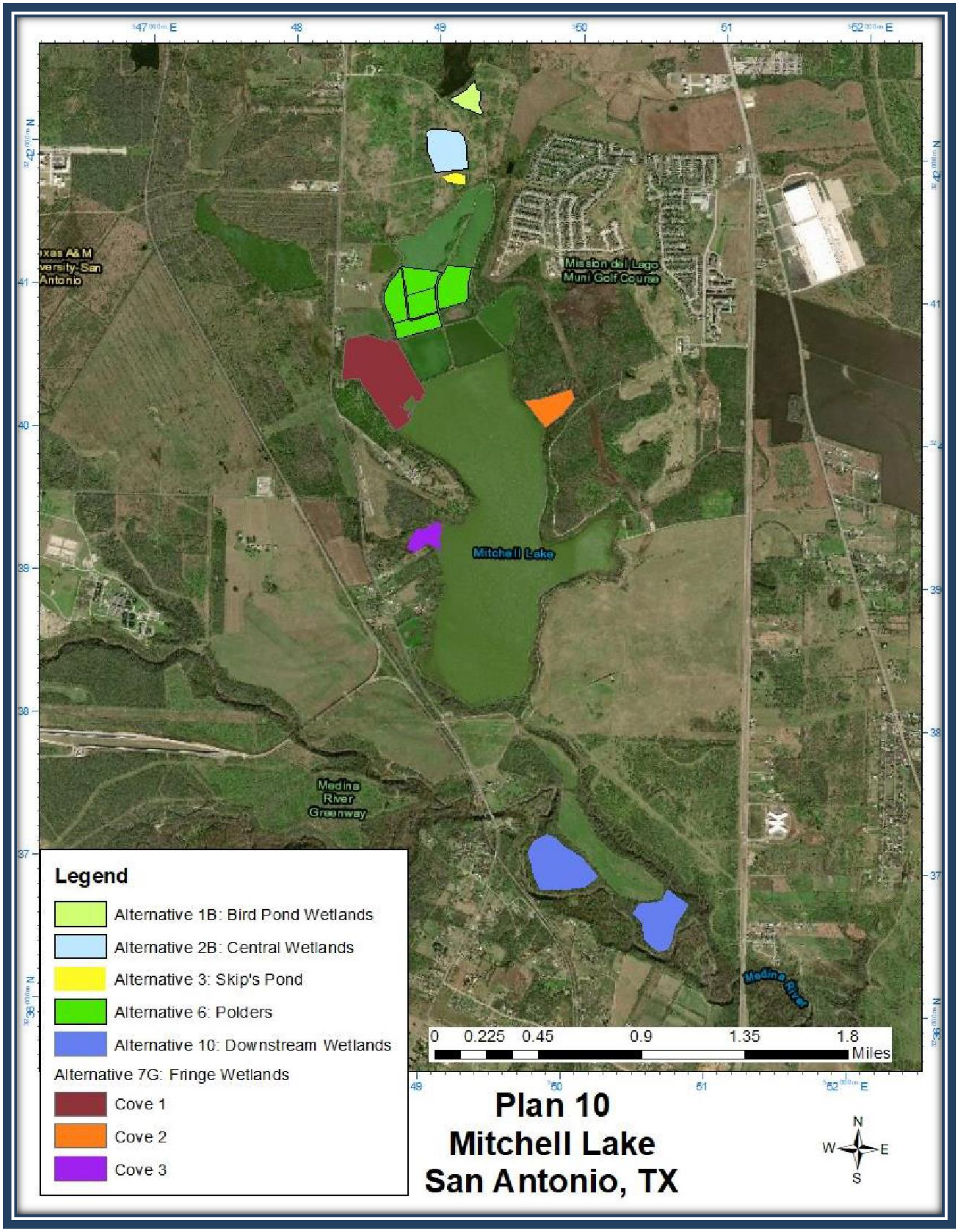

Figure 77. Plan 10 (Alternatives, 1B, 2B, 3, 6, 7G and 10)

Figure 78. Plan 10 Restoration Features

Plan 11 (Polders; Coves 1, 2 and 3, the Downstream Wetlands, Skip's Pond, the Central Wetlands, the Bird Pond Wetlands and the Dam Forested Wetlands)

Plan 11 (Figure 79) includes the restoration features included in Plan 10 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 0.8 AAHUs 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 111.6 AAHUs are provided by Plan 11; the allocation of the AAHUs are provided below:

- 49.52 acres and 18.1 AAHUs of mudflat habitat
- 74.54 acres and 41.4 AAHUs of emergent/submergent wetland habitat
- 76.11 acres and 51.3 AAHUs of emergent wetland habitat
- 4.48 acres and 0.8 AAHUs of forested wetland habitat

The incremental cost per incremental output for Plan 11 is $41,675 with a first cost of $5,762,219, a first cost increase of approximately $647,000 over Plan 10. Plan 11 would restore all areas identified for restoration under this study.

Plan 11 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. Despite the ecological value that the addition of the Dam Forested Wetlands provides 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 11 is not justified.

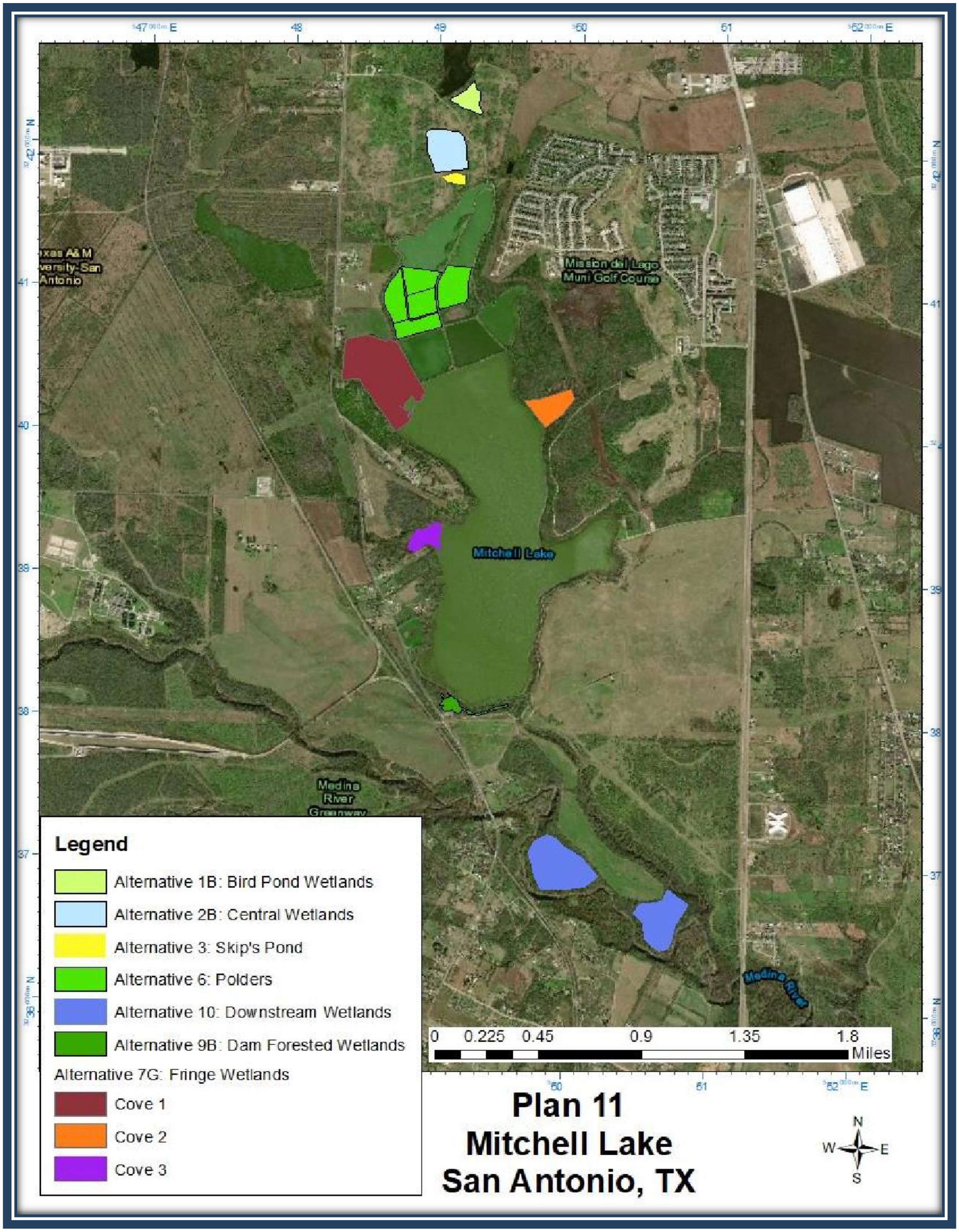

Figure 79. Plan 11 (Alternatives 1B, 2B, 3, 6, 7G, 9B and 10)

4.10 Selection of the Tentatively Selected Plan at the DRAFT REPORT

4.10.1 Plan 10: Bird Pond Wetlands (1B) + Plan 9 (Alternatives 1B + 2B + 3 + 6 + 7G + 10)

Best Buy Plan 10 (Figure 77 and Figure 78) increases the synergistic water quality benefits of the previous Plans by adding the nutrient filtering function of the Bird Pond Wetlands with the channel to the Central Wetland/Skip's Pond/Linear Wetland/Cove 3 system (Figure 75 and Figure 76). Plan 10 is worth the Federal and local investment because of:

1. increased diversity of bird species benefiting from the restoration
2. increased water quality function resulting from adding the Bird Pond Wetlands to the Plan
3. relatively small increase in incremental cost to incremental output ratio
4. increase in first cost resulting from moving from Plan 9 to Plan 10

The increased cost is worth the investment due to a combination of relatively low increase in cost and because of the valuable and rare habitat that will be restored/created during this project. The plans incrementally add bird species diversity and stopover habitat for migrating birds that will utilize the area after project completion. The diversity of habitats within each area will increase the diversity of faunal species that can utilize those habitats.

4.10.2 NER 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 10 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
- creation of a complex of wetlands that can be managed to improve water quality as an ancillary benefit
- restoration of 97.8% of the proposed restoration areas
- incremental cost per incremental output of $8,787 over Plan 9
- approximate first cost of $7.13 million (including Pre-Construction Engineering and Design, Construction Management and Contingency)

4.10.3 NER Plan and the Four Criteria

As part of Federal guidelines for water resources projects, there are general feasibility criteria that must be met. According to the USACE ER 1105-2-100 for planning, any the USACE project must be analyzed regarding the following four criteria (Table 40):

1. **Completeness –** Does the Plan provide and account for all necessary investments or other actions to ensure the realization of the planned effects?
    a. Plan 10, in conjunction with SAWS planned water treatment wetlands downstream of the dam, will provide and account for all necessary investments and actions to ensure ecosystem restoration effects. Should SAWS fail to construct their downstream wetlands, then Plan 10 will not be complete.
2. **Effectiveness** – Does the Plan alleviate the specified problems and achieve the specified opportunities?
    a. Plan 10 will alleviate the specified problems, achieve the specified opportunities and violates no constraint. Plan 10 will:
        i. reduce the loss of fish and wildlife habitat quality and diversity, particularly for migratory birds
        ii. improve aquatic connectivity between the upstream and downstream habitats
        iii. decrease nutrient loads in Mitchell Lake and Cottonmouth Creek
        iv. remove invasive species within the project footprint for at least 10 years
        v. reduce daily variation in pH and O_2 levels in the water that flows through the upper wetlands and back into Mitchell Lake, in the restored coves and in Cottonmouth Creek below this project
        vi. reconnect the upstream and downstream hydrologies
        vii. improve water quality as an incidental benefit
        viii. provide additional recreation and ecotourism benefits to the community
3. **Efficiency –** Is the Plan the most cost-effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment?
    a. Plan 10 is the NER plan and the most cost-effective means of achieving the objectives of all this study's alternatives, plans and scales of plans.
4. **Acceptability** – Is the Plan workable and viable with respect to acceptance by State and local entities and the public? Is the Plan compatible with existing laws, regulations and public policies?
    a. Plan 10 is both workable and viable per the Abbreviated Risk Analysis. It is acceptable to the State and local entities and the public. The Plan received substantial review feedback, no negative comments but has instead received letters of support from the Audubon Society and TPWD. The Plan is compatible with all known applicable laws, regulations and public policies.

b. While Plan 10 does improve water quality within the project area as an ancillary benefit, Plan 10 does NOT principally result in treating, or otherwise abating pollution, or meeting SAWS requirement to comply with EPA water quality standards for water entering the Medina River. SAWS alone is legally responsible for the remediation and compliance with the 2019 EPA AO.

Table 40 - Principles and Guidelines Four Criteria Evaluation

	Complete?	Effective?	Efficient?	Acceptable?
Plan 10	YES	YES	YES	YES

4.11 Description of the TENTATIVELY SELECTED PLAN

Analyses indicate that Plan 10 is the NER Plan and the TSP. It is the plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective.

4.11.1 Civil Engineering

Area 1: Bird Pond Wetlands (Alternative 1B)

Bird Pond contains an existing perimeter ~3.17 acres that can restored to a wetland feature. To increase the perimeter to a larger wetland area then the perimeter can be expanded to 6.42 acres. Water Supply would be pumped through a pipeline system from the southwest pump station (or new/modified pump) from the waters of Mitchell Lake to the north edge of Birds Pond Wetland. The pipeline would need to cross-existing petrochemical pipeline right-of-way, but the petrochemical pipeline would not have to be relocated. The outfall from the Bird Pond Wetlands should be designed with a drainage ditch to merge into the existing creek below Bird Pond. A culvert would be needed to cross the road between Bird Pond Wetlands and the Bird Pond creek.

Wetland excavation criteria and limits

The conditions for native vegetative species will be improved through light grading, invasive species management and native emergent species plantings. Wetlands perimeter area should be excavated to establish average depth grading of 6” to 2’ throughout. In addition to the bottom grading of the wetlands there should be deeper pockets four feet in depth with an approximate bottom radius of 4’, sloped to meet back up with a 2’ depth. The deeper pockets should be located 65’ from the shoreline and no closer than 65’ from each other around the perimeter of each wetland. The remaining acreage of shrubland/upland habitat will also be graded/excavated to ensure the areas are level with the existing wetlands. All the excavated material can be disposed onsite at Area 6 – Polders berms and Area 10 – Downstream Wetlands berms.

- wetland Cell Excavation: 1,570 cubic yards (cy)

Construction of a water control structure

Stop log type structures (Figure 80) will be used to maintain water depths for the Bird Pond and Central Wetlands. Logs may be added or removed in increments for desired water depths (Appendix G – Civil Engineering).

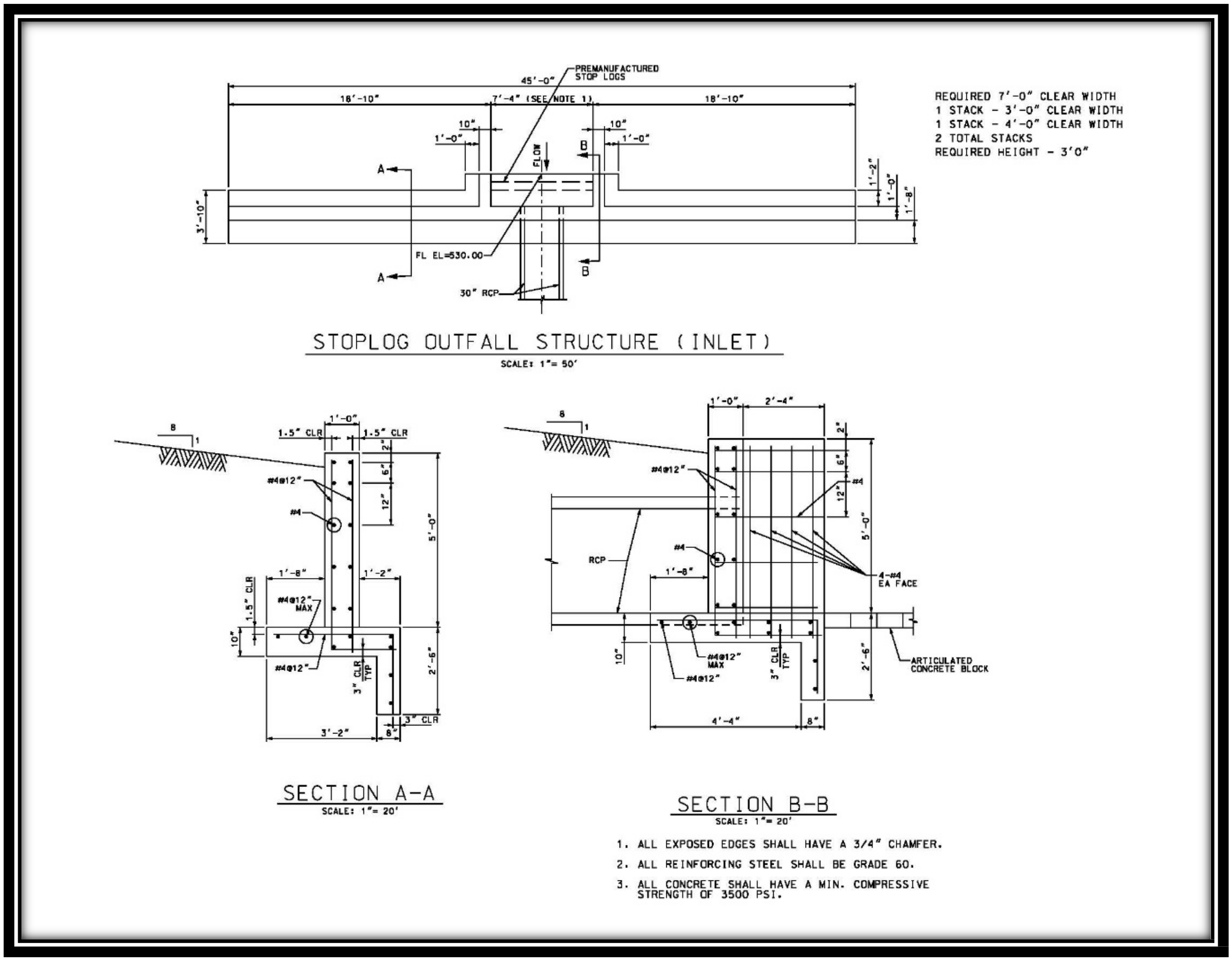

Figure 80 - Example Stop Log Structure

Area 2: Central Wetland (Alternative 2B)

The Central Wetland area contains an existing perimeter ~10.46 acres that can restored to a wetland feature. To increase the perimeter to a larger wetland area then the perimeter can be expanded to 18.37 acres.

Water supply to this wetland can provided from two sources depending on the restoration features upstream. If Bird Pond is included in the restoration project, then the flows from the drainage ditch and existing creek will provide the water supply. If nothing were restored upstream, then water supply would be pumped through a pipeline system from the southwest pump station (or new/modified pump) to the north edge of the Central Wetland. The pipeline would need to cross petrochemical pipeline rights-of-way, but the petrochemical pipeline would not have to be relocated. The outfall from the Central Wetland would be a drainage ditch along an existing creek to drain into the next wetland cell at Skip's Pond.

Wetland excavation criteria and limits

Wetlands perimeter area should be excavated to establish average depth grading of 6” to 2’ throughout. In addition to the bottom grading of the emergent wetlands there should be deeper pockets four feet in depth with an approximate bottom radius of 4’, sloped to meet back up with a 2’ depth. The deeper pockets should be located 65’ from the shoreline and no closer than 65’ from each other around the perimeter of each wetland. All the excavated material can be disposed onsite at Area 6 – Polders berms and Area 10 - Downstream Wetlands berms.

- Wetland Cell Excavation: 4,826 cy

Construction of a water control structure

Stop log type water control structure (Figure 80) should be place such that allows water levels to be controlled to maintain 6” to 4’ depths with appropriate freeboard. The wetland shall be drained to 2’ so that the deeper holes retain water to maintain maximum depths during spring and fall months, allowed to draw down up to one foot during the summer and drain during the winter months to control and promote diverse vegetation.

The upper chain of wetlands of the proposed Mitchell Lake Ecosystem Restoration study require a supplemental water supply in order to maintain the target aquatic habitat and facilitate the management of the wetlands. The supplemental water would be provided by Mitchell Lake and transported to the upper wetland (Bird Wetland) via a pump and water line. A series of water control structures would be constructed to manage water levels of each wetland and manage flows from the Bird Wetlands to the Central Wetlands to Skip’s Pond and ultimately back into Mitchell Lake.

Historically, Mitchell Lake supported tule (bulrush) dominated emergent wetlands and the restoration is designed around creating a novel ecosystem that mimics the form and function of the historical wetlands. The conceptual design of the restored wetlands consists of optimizing emergent wetland habitat for stopover migration and nesting habitat for migratory birds by letting the water levels seasonally fluctuate. The target depths of water in the wetlands would increase during the spring and be allowed to dry out over the summer months. The water management strategy for the Bird and Central Wetlands are provided in Table 41.

Table 41 - Wetland Water Level Management for Bird Pond and Central Wetlands

Month	Target Depth (in.)	Management Actions
January	0	No pumping, leave dry
February	12	Prescribed burn mid-February, begin pumping
March	36	Pump until 36”
April	36	Pump to maintain depth
May	33[1]	No pumping, let water level decrease
June	30	No pumping, let water level decrease
July	26	No pumping, let water level decrease
August	21	No pumping, let water level decrease
September	19	No pumping, let water level decrease

Month	Target Depth (in.)	Management Actions
October	18	No pumping, drain wetlands third or fourth week of the month
November	0	No pumping, leave dry
December	0	No pumping, leave dry

[1]Estimated depth based on evapotranspiration and precipitation

In many emergent wetlands, southern cattails (*Typha domingensis*) are considered noxious and can completely dominate the wetlands creating a monoculture. The reduction of diversity within the cattail monoculture corresponds to a lack of diversity for wildlife species as well (Anderson et al., 2019; Kostecke et al., 2005; Murkin et al., 1982). Because the restoration goals are to maximize wildlife value, particularly avian species and create a diverse emergent wetland complex, the management of cattails is an integral part of the operations and maintenance of the wetlands. An effective way to manage for cattails in emergent wetlands is through seasonal water management and prescribed burning (Apfelbaum et al., 1985; Ball, 1990; Sojda and Solberg, 1993). As presented in Table 41, the water management in the chain of wetlands is designed so that the wetlands dry over the winter allowing the cattail rhizomes to potentially freeze. Prior to refilling the wetlands in the spring, the wetlands would be burned utilizing approved prescribed burning techniques to further minimize the growth of cattails and other noxious woody vegetation. The burns could potentially be integrated into the prescribed burning program that the Audubon Center uses to manage the prairie habitats adjacent to the wetlands. An average water depth of 36” would be maintained in the wetlands through the first months of the growing season which would prohibit the establishment and growth of cattails in most of the wetlands. The water levels would be allowed to drop beginning in the late spring and the wetlands would be drained in mid to late October.

In order to determine the amount of water that would be needed to fill and manage the wetlands, we need to determine the supplemental water needs balanced against gains from precipitation and losses from evaporation and the transpiration of the wetland vegetation. Because wetland hydrology currently exists at the three wetlands, the assumption is that no additional supplemental water would be required to saturate the wetland soils before they would start to fill up. Therefore, a simple water balance equation was used to calculate the supplemental water needs (water deficit) to maintain the desired seasonal depths:

$$WD = P_m - ETo_m - SS_i$$

Where WD = the water deficit for maintaining a target water level,

P_m = Monthly precipitation

ETo_m = Monthly evapotranspiration rate

and, SS_i = Water required for the initial saturation of wetland soils (for the Bird and Central Wetlands, this value is 0).

The evapotranspiration rate is the sum of the evaporation rate (ETo) of the water surface and the water demand of the wetland vegetation for photosynthesis. Monthly ETo rates and precipitation rates for San Antonio, TX were used to calculate the monthly changes in water depths or deficits without the addition of supplemental water (Table 42).

Table 42 - Water balance variables for San Antonio, TX

Month	ETo Rate (in.) [1]	Precipitation (in.)[2]	Water Deficit (in.)
January	2.42	1.96	-0.66
February	2.90	1.79	-1.11
March	4.42	2.31	-2.11
April	5.47	2.10	-3.37
May	6.47	4.01	-2.46
June	6.97	4.14	-2.83
July	7.31	2.74	-4.57
August	6.99	2.09	-4.90
September	5.64	3.03	-2.61
October	4.44	4.11	-0.33
November	2.85	2.28	-0.57
December	2.36	1.91	-0.45

[1]Texas A&M AgriLife Extension (2020)
[2]National Weather Service (2020)

In order to calculate the volume of water required to maintain the target depths of Bird and the Central Wetlands, the area of the wetlands (6.42 and 18.37 acres respectively) were multiplied by the water deficit for the months requiring supplemental water (February through April). Skip's Pond was not included in the calculations as the pond is perennially inundated and is on the downstream end of the wetland complex. The monthly water volumes required to maintain seasonal target depths are provided in Table 43.

Table 43 - Supplemental Water Requirements for Bird Pond and Central Wetlands

Month	Target Depth	Supplemental Water Required to Maintain Depth (in.)	Bird Wetlands Water Required (ac-ft)	Central Wetlands Water Required (ac-ft)	Total Water Required (ac-ft)
January	0.00	0.00	0.00	0.00	0.00
February	12.00	13.11	7.01	20.07	27.08
March	36.00	26.11	13.97	39.97	53.94
April	36.00	3.37	1.80	5.16	6.96
May[1]	33.54	0.00	0.00	0.00	0.00
June	30.71	0.00	0.00	0.00	0.00
July	26.14	0.00	0.00	0.00	0.00

Month	Target Depth	Supplemental Water Required to Maintain Depth (in.)	Bird Wetlands Water Required (ac-ft)	Central Wetlands Water Required (ac-ft)	Total Water Required (ac-ft)
August	21.63	0.00	0.00	0.00	0.00
September	18.63	0.00	0.00	0.00	0.00
October[2]	18.30/0.00	0.00	0.00	0.00	0.00
November	0.00	0.00	0.00	0.00	0.00
December	0.00	0.00	0.00	0.00	0.00
		Total	**22.79**	**65.20**	**87.98**

[1]No supplemental water added, therefore, decrease in depth is attributable to the water deficit
[2]Water depth is reported as before draining/after draining

In order to manage the Mitchell Lake chain of wetlands for temperate and Neotropical migratory birds and waterfowl and sustain a native tule wetland habitat, approximately 88 acre-feet of supplemental water would be required during an average year. Supplemental water demand would be higher during periods of drought; however, if water is not available during those times, the plant species included in the design of the wetlands are site specific and drought tolerant. Therefore, the wetland habitats would be expected to recover once normal precipitation events return.

Area 3: Skip's Pond Alternative (Alternative 3)

The Skip's Pond perimeter area to be part of the restored emergent/submergent wetland feature is 2.18 acres. The water supply would be from the discharge ditch coming out of the Central Wetland cells.

Excavation at Skip's Pond would be limited to 30% of the perimeter area for the feature to the same criteria and limits as described above for the Central Wetland and would only include one 4' deep pocket with the dimensions describe above.

Modification of one existing water control structure or construction of a new one (Figure 80) if needed to maintain water levels as described above.

- Wetland Cell Excavation: 432 cy

Area 6: Polder Alternative (Alternative 6)

The perimeter area for the mudflats area consists of 49.52 acres. The mudflats complex consists of two long cells divided as East and West and five basin cells. All the cells are divided by perimeter berms that have a top of berm elevation at ~527. In order to facilitate an operation to lower the water levels at different stages and times additional berms would be added to the following mudflat cells from excavated materials of the constructed wetland cells:

1. construction of two berms at the south end of the West Polder
2. construction of one berm at the south end of the East Polder

3. construction of one berm at the southwest corner of Basin 1

Water Control Structures

Modification/replacement of existing water control structures to drop the invert to a level that would allow the draining of the polder cells. Existing water control structures and pipes that cannot be modified to meet project objectives will be removed or fully grouted with flowable fill.

Installation of new water control structures (Figure 80) to facilitate transfer of water across the new berms in the West Polder, East Polder and Basin 1

Another potential option would be the construction of a controlled outfall structure on the west side of Basin 1 to facilitate releasing water to filter through the northwest end of Mitchell Lake if the Mitchell Lake emergent wetland Area 7 Option would be implemented.

- Berm Fill Material: 3,309 cy

Area 7: Fringe Wetlands / Coves 1 - 3 (Alternative 7G)

No excavation or grading of existing area will be done as a structural measure of improvement to meet the planting of diverse tree, shrub and / or herbaceous species (**Error! Reference source not found.**).

Area 10: Downstream Wetlands Alternative (Alternative 10)

Approximately 3,000’ downstream of the existing dam along Cottonmouth Creek two new wetlands can be created totaling an area of 51.32 acres. Adjacent to these wetland cells the non-federal sponsor will construct two wetland cells. The non-federal sponsor’s wetland will be supplied with water from a gravity-fed conduit. The Downstream Wetlands will be dependent upon the water supply provided by the non-federal sponsor wetlands. This will require a connection between the Downstream Wetlands and the non-federal sponsor’s wetlands to ensure native species plantings are adequately wetted (Figure 54).

Wetland excavation criteria and limits

Wetlands perimeter area should be excavated to establish average depth grading of 6” to 2’ throughout. In addition to the bottom grading of the wetlands there should be deeper pockets four feet in depth with an approximate bottom radius of 4’, sloped to meet back up with a 2’ depth. The deeper pockets should be located 65’ from the shoreline and no closer than 65’ from each other around the perimeter of each wetland. All the excavated material can be disposed onsite if the options for Area 6 – Polders and Area – Island Habitat are implemented.

- Wetland Cell Excavation: 7,907 cy

Construction of a water control structure

Stop log type water control structures should be placed such that they allow water levels to be controlled to maintain 6” to 4’ depths with appropriate freeboard. The wetland shall be drained to 2’ so that the deeper holes retain water to maintain maximum depths during spring and fall months, allowed to draw down up to one foot during the summer and drain during the winter months to control and promote diverse vegetation.

The Recommended Plan is dependent upon the completion of the SAWS constructed wetland that will be located downstream of Mitchell Lake. The Recommended Plan will implement Alternative 10, which includes the construction of wetlands cells within shrubland/upland habitat adjacent to the SAWS constructed wetlands in order to promote habitat quality and wildlife diversity.

Alternative 10 does not fulfill the water quality requirements set forth by the EPA AO. Alternative 10 compliments the actions adopted by SAWS in order to satisfy the EPA AO. The USACE is not authorized to formulate for water quality; however, implementation of Alternative 10 will result in improved water quality as an ancillary benefit to habitat quality.

4.11.2 Recreation

Existing recreation features and access roads, parking areas and other associated public use facilities, will remain open and available to all on equal terms. There are several recreation features that will be incorporated with project implementation. Discussions with the NFS and Mitchell Lake Audubon Center facility (Figure 10 and Figure 11) staff led to the development and locations for these features (Figure 81 and Figure 82). Several picnic tables, approximately eight, can be placed throughout the study area near points of interest such as the Polders and Skip's Pond. Approximately six bird blinds should be located throughout the study area near the Polders and the northern chain of restored / created wetlands. Availability of these recreation features should improve birding opportunities for recreationalists. Additional trails, about 4' wide, will be built leading from the Bird Pond Wetlands to Skip's Pond for approximately two miles. A trailhead can be located at the beginning of the natural trail near the Bird Pond Wetlands. These newly incorporated features should provide ease of access to the ecosystem restoration areas, while also providing additional educational and wildlife viewing opportunities

Recreation features that will be implemented around the Downstream Wetlands will be dependent upon the NFS. There is a desire to include public access and recreation features around the treatment wetlands that are currently being designed by SAWS. Once construction has been completed, recreation features will most likely be implemented to incorporate the city of San Antonio's hike and bike trails. USACE may implement trailheads, a one mile long by 4' wide trail, bird blinds and picnic tables once SAWS establishes public access into this area.

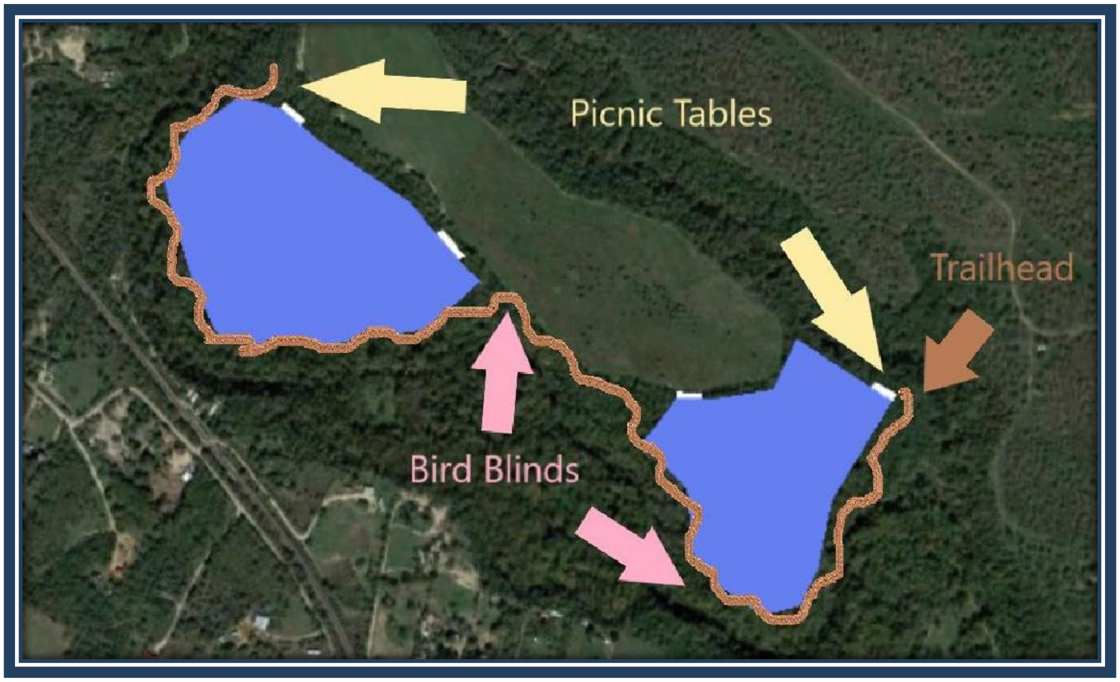

Figure 81 - Recreation Opportunities Southern Mitchell Lake

Figure 82 - Recreation Opportunities Northern Mitchell Lake

4.11.3 Adaptive Management and Monitoring

To ensure the success of the proposed action, the restoration measures implemented will be periodically surveyed to provide feedback on the response of the ecosystem and its resources to the management measures taken. By connecting the ecosystem response to the restoration as well as the management measures, potential beneficial adaptations and adjustments to the project or management plan can be identified to ensure continued success of the project. This is especially true of the plantings that will have to be frequently monitored from their initial planting until reasonable stabilization is achieved. To accomplish this goal, periodic monitoring of the restoration measures will be conducted over a three-year period beginning after the completion of the construction of project features and the initial plantings (Appendix C – Environmental Resources, Attachment K).

4.11.4 Operation and Maintenance

SAWS is the owner of the property and is responsible for its operation, inspection, maintenance and repair.

4.11.4.1 Inspections

A representative of SAWS shall perform routine inspections to ensure timely identification of potential problems. Inspections will be performed as indicated and preferably, before and/or after the typical rainy seasons for the area. Inspection schedules should be monitored and adjusted based on the conditions observed and the age of the project. Three types of inspections are required to ensure that the proposed project functions as designed.

1. Annual inspections of access roads and gate structures will be accomplished by SAWS personnel to determine if the roads are safe, passable and operable.
2. Annual inspections of all proposed and existing culverts, gate and drainage structures shall be inspected for functionality, operability, sediment, debris and corrosion.
3. Annual inspections of all pumps will be completed by trained SAWS personnel. Pumps will be evaluated for performance, operation, corrosion, power connections, piping connections and safety. All hoses for the portable pump will be inspected for wear, holes, corrosion and operable connectors.
4. Annual inspection of the earthen berms between the polders and within the downstream wetlands to include visual inspections for slope failure, erosion and invasive plant growth.
5. Annual inspection of all bat and bird nest boxes to determine if structures remain in good condition and are habitable.

4.11.4.2 Preventative Maintenance

Preventive maintenance will be performed on the access roads, pumps, drainage structures, earthen berms and habitat structures. The list below is a preliminary list of maintenance items known at this point of the study.

1. **Access Roads** – Fill any ruts or minor depressions with similar soil and compact it to surrounding grade. Inspect the access gates for operation and make repairs as needed to keep them operational and safe to operate. Paint any observed areas where the metal is exposed, or corrosion is occurring. Properly prep the metal surface prior to painting. Inspect gate posts and verify condition, replace if they show signs of possible failure. Verify that all vegetation is clear for proper operation of the gates.
2. **Culverts, Gates and Drainage Structures –** Remove all debris and vegetation at the inlet and outlet side of all culverts, gates and drainage structures. Restore corroded metal to original condition by replacing or welding on new metal and painting to prevent corrosion. Inspect entire culvert interior either manually or by camera depending on accessibility and repair as needed. Replace boards with similar as needed for stop log structures.
3. **Pumps, Piping and Hoses –** Inspect pump controls for proper operation and connectivity. Replace or repair any loose or worn electrical connections. Inspect all pumps by switching them on, verifying that they are operational. Note any unusual noises or vibrations during operation. Inspect pump for corrosion or exposed metal and repair/repaint surface to prevent further corrosion or rust. Inspect the pump connections to the piping or hoses, verify the connections are operational and in good working order. Verify that all connection points are tight and relatively leak proof. Repair connections as required. Remove pump, inspect and maintain in accordance with the manufacturer's operation and maintenance manual. For engine driven pumps, inspect and maintain the motor for the pump in accordance with the manufacturer's operations and maintenance manual. Inspect hoses for pump for holes and wear points. Repair or replace the hoses as necessary. Inspect all pump inlet piping and screens, removing all debris and foreign matter. Replace all damaged screens as required. Inspect concrete structures for spalling and cracking. Repair and seal any leaking cracks.
4. **Earthen Berms** – Inspect the berms for signs of ruts, minor depressions, or erosion. Fill any ruts, minor depressions, or eroded areas with similar soil and compact it to surrounding grade.
5. **Bat and Bird Nest Boxes** –Verify structure is not rotted or corroded, if so, replace sections of structure with new parts (wood panels, screws, nails, metal siding, etc.). Repair or reinstall base of structure if damaged.

4.11.4.3 Operation

SAWS will be responsible for the operation of the project features and systems including pumps and water control structures. At their discretion, they will manage the water levels and flows and adapt their operations to observed field conditions to provide the desired habitat conditions. All pumps and water control structures will be manually operated.

<u>NON-STRUCTURAL / NON-MECHANICAL ELEMENTS</u>

Per Implementation Guidance for Section 1161 of the WRDA 2016, Completion of Ecosystem Restoration Projects, "Ten years after ecological success has been determined pursuant to paragraph 7.c, the responsibility of a non-federal sponsor to conduct O&M activities on nonstructural and non-mechanical elements of an ecosystem restoration project (or component of a project) will cease. Operation, maintenance, repair, replacement and rehabilitation of structural and mechanical elements of an ecosystem restoration project (or component of a project) will continue as outlined in the operations manual for the project."

Non-Structural / Non-Mechanical Elements of Plan 10 include:

- clearing and excavation
- habitat structure augmentation
- invasive species management
- low quality vegetation removal
- native submergent wetland plantings
- native riparian plantings
- native emergent wetland plantings

WHAT IF ANALYSIS

It is assumed that if the non-federal sponsor does not pursue operations and maintenance of non-structural / non-mechanical measures beyond the 10-year period after the date on which the Secretary makes a determination of success, some ecological benefits of the non-structural measures: invasive vegetation management, native submergent wetland plantings, native riparian plantings and native emergent wetland plantings could be negatively impacted.

Invasive vegetative species are prevalent within the study area, however; focused management on the establishment of native vegetative species should diminish the likelihood of the reestablishment of invasive species within the specified project areas. Native species, once established, should be able to maintain influence and deter the spread of invasive species around Mitchell Lake.

Unforeseen circumstances, such as significant storm events, can cause disturbances to the ecosystem. Disturbed areas, lacking enough native vegetative cover, are more likely to become inhabited by fast-growing invasive species. The non-federal sponsor should remain vigilant and enact management where possible and if it is still within their means to do so within the 50-year life of the project. Coordination with the Mitchell Lake Audubon Society regarding success of native species would help support the success of the Mitchell Lake Aquatic Ecosystem Restoration.

Depending on the level of disturbance, reestablishment of invasive species could occur within a single growing season. However, full-scale establishment, negatively affecting wildlife habitat, may take up to several years depending on the species. If invasive species come back into the project area and are left unrestricted over a 50-year period, then the full FWP ecosystem benefits may not be realized.

4.12 RECOMMENDED PLAN at FINAL REPORT

The TSP was the Recommended Plan. During the ATR of the Final Report, it was discovered that the excavation quantities necessary to provide the ecosystem restoration benefits for Area 10 were undercounted (Table 44).

Excavation Quantities Area 10

Two concepts were developed; one provided the maximized the footprint with minimal earthwork; the second concept maximized the footprint and ties into an adjacent project by the non-federal sponsor. These concepts varied in size from 14.00 to 19.10 acres; as the footprint grows larger, the required earthwork grows significantly from 419,000 CY of cut to 794,000 CY of cut. Most of this excess material would have to be disposed of offsite.

Wetlands perimeter area should be excavated to establish average depth grading of 6” to 2’ throughout. In addition to the bottom grading of the wetlands there should be deeper pockets four feet in depth with an approximate bottom radius of 4’, sloped to meet back up with a 2’ depth. The deeper pockets should be located 65’ from the shoreline and no closer than 65’ from each other around the perimeter of each wetland.

Table 44 - Updated Excavation Quantities for Area 10 Post-ATR

Area 10 Downstream Wetland	Acres	Estimated Quantities (CY)
Minimal Grading	14.0	419,000
Tie into Sponsor Wetland	19.1	794,000

After review by civil engineering, quantities and costs were updated. IWR Suite was rerun to determine cost effective and Best Buy Plans.

4.12.1 National Ecosystem Restoration Plan – Plan 6

The NER Plan and Recommended Plan is Plan 6. It is the same as the TSP, Plan 10 at the draft report, prior to final ATR minus the restoration measures of Area 10. It is the plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective.

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, 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 NER 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
- creation of a complex of wetlands that can be managed to improve water quality as an ancillary benefit
- restoration of 86% of the proposed restoration areas
- incremental cost per incremental output of $8,208
- approximate first cost of $8.1 million (rounded)

Table 45 – Average Annual Habitat Benefits of Plan 6

Project Area	Alternative	FWOP AAHU	FWP AAHU	Annual Benefits AAHU	FWP Acres
Area 1: Bird Pond Wetlands	1B: Expansion/Restoration of Existing Wetlands and Restoration of Additional Wetlands	0.86	4.71	3.85	6.42
Area 2: Central Wetlands	2B: Expansion/Restoration of Existing Wetlands and Restoration of Additional Wetlands	2.85	13.54	10.69	18.37
Area 3: Skip's Pond	3: Restoration of Existing Wetlands	0.59	1.64	1.05	2.18
Area 6: Polders	6: Management/Modification of Existing Polders/Basins	30.21	48.35	18.14	49.52
Area 7: Fringe Wetlands	7G: Combination of Coves 1, 2 & 3	18.1	58.41	40.31	72.36

Table 46 - Average Annual Benefits and Costs of Plan 6

Project Area	Alternatives	Annual Benefits AAHU	Annual Cost ($1,000) October 2020 Prices
Area 1: Bird Pond Wetlands	1B: Expansion/Restoration of Existing Wetlands and Creation of Additional Wetlands	3.85	$40.17
Area 2: Central Wetlands	2B: Expansion/Restoration of Existing Wetlands and Creation of Additional Wetlands w/Area 1	10.69	$37.74
Area 3: Skip's Pond	3: Restoration of Existing Wetlands	1.05	$8.53
Area 6: Polders	6: Management/Modification of Existing Polders/Basins	18.14	$14.19
Area 7: Fringe Wetlands	7G: Combination of Coves 1, 2 & 3	40.31	$83.4

4.12.1.1 Output Significance of Plan 6

Resource significance is determined by the importance of non-monetary value of the resource based on institutional, public and technical recognition in the study area. The criteria are defined in the Main Report, Chapter 2.

Institutional

The creation, restoration and augmentation of wetlands at Mitchell Lake contributes to the conservation and protection of migratory birds (Appendix C – Environmental Resources, Chapter 2). In addition, red knot, piping plover and least tern are shorebirds that may utilize Mitchell Lake as stopover habitat during their migration. It is anticipated that the Recommended Plan ecosystem restoration measures and alternatives, such as mudflat habitat creation and invasive species management would greatly benefit these species. As shown in Final Coordination Act Report, USFWS is in support of the ecosystem restoration alternatives. This project satisfies the requirements of EO 11990 Protection of Wetlands and of WRDA 1990 in that it will increase the quality of American wetlands as defined by acreage and function. The wetlands will provide food source, nesting and roosting for migratory and year-round bird species (Main Report, Chapter 2).

Public

The proposed Mitchell Lake 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 SARA and the Mitchell Lake Audubon Society facility (Figure 10 and Figure 11). Each have made commitments to improving habitat across the San Antonio River watershed, approximately two to five miles from Mitchell Lake (Main Report, Chapter 2).

Technical

Additional discussion regarding the Technical Significance of the Recommended Plan can be found in Appendix C – Environmental Resources, Chapter 2.

Scarcity: Nationally, the loss of wetland and riparian habitats is widely recognized. Over a period of 200 years, the lower 48 states lost an estimated 53-percent of their original wetlands (USGS, 2016).

Representativeness: Mitchell Lake is a unique area, abundant with birding and environmental education opportunities. The history of this area is similar to other wetlands in the U.S.; however, Mitchell Lake continues to provide resources for migrating birds and other types of wildlife while maintaining its degraded and low quality features.

Status and Trends: The success of the Recommended Plan is much higher compared to other projects due to the lack of residential or commercial development within the project areas but it may become sensitive to future development if left unchecked.

Connectivity: The establishment of native woody, herbaceous, emergent and submergent wetland species through the Recommended Plan would provide significant benefit to the movement of Neotropical migratory birds, waterfowl and waterbirds throughout the study area and would play a role in providing adequate food, water and shelter to replenish the energy and strength of migrators.

Limiting Habitat: The USFWS estimates that up to 43% of North America's threatened or endangered species depend on wetlands for survival. Although the Mitchell Lake study area does not have sustainable critical core habitat for federally threatened or endangered species, the implementation of the project will improve the resources required for Neotropical migratory bird stopover habitat.

Biodiversity: The Recommended Plan would improve biodiversity through native wetland and riparian species plantings and invasive species management.

4.12.2 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.

Figure 83 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.

[5] https://www.aswm.org/pdf_lib/state_summaries/texas_state_wetland_program_summary_083115.pdf

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

Figure 83 - Cost Inputs for IWR Planning Suite CE/ICA Analysis

In the table above, the description “Central Wetlands w/o Bird Pond 2A” and “Central Wetlands w/o Bird Pond 2B” appear to be a cheaper option 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.

4.12.3 Cost Effectiveness / Incremental Cost Analysis

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.

In the table below (Table 47), 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.

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. The relationships are listed below.

<u>Combinability:</u>

- 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)

<u>Dependency:</u>

- 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 (Appendix B – CE/ICA Chapter 3).

Table 47 - Annual Benefits and Annual Costs for Each Alternative

Project Area	Alternatives	Annual Benefits AAHU	Annual Cost ($1,000) October 2020 Prices
Area 1: Bird Pond Wetlands	1A: Restoration of Existing Wetlands	1.53	$30.43
	1B: Expansion/Restoration of Existing Wetlands and Creation of Additional Wetlands	3.85	$40.17
Area 2: Central Wetland	2A: Restoration of Existing Wetlands w/Area 1	5.03	$28.73
	2A1: Restoration of Existing Wetlands w/out Area 1	5.03	$37.74
	2B: Expansion/Restoration of Existing Wetlands and Creation of Additional Wetlands w/Area 1	10.69	$46.62
	2B1: Expansion/Restoration of Existing Wetlands and Creation of Additional Wetlands w/out Area 1	10.69	$55.19
Area 3: Skip's Pond	3: Restoration of Existing Wetlands	1.05	$8.53
Area 6: Polders	6: Management/Modification of Existing Polders/Basins	18.14	$14.19
Area 7: Fringe Wetlands	7A: Restoration of Cove 1 (Wetland/Riparian Plantings)	29.90	$61.86
	7B: Restoration of Cove 2 (Wetland/Riparian Plantings)	6.60	$13.69
	7C: Restoration of Cove 3 (Wetland/Riparian Plantings)	3.81	$7.93
	7D: Combination of Coves 1 & 2	36.50	$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	$83.40
Area 9: Dam Forested Wetlands	9A: Restoration of Existing Wet Riparian Habitat	0.47	$23.58
	9B: Expansion/Restoration of Existing Wet Riparian Habitat and Creation of Additional Riparian Habitat	0.83	$26.67

Project Area	Alternatives	Annual Benefits AAHU	Annual Cost ($1,000) October 2020 Prices
Area 10: Downstream Wetlands	10: Creation of Wetlands Downstream of Mitchell Lake	13.60	$402.95

4.12.4 Cost Effective Plans

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) (Figure 84) (Appendix B – CE/ICA Chapter 3).

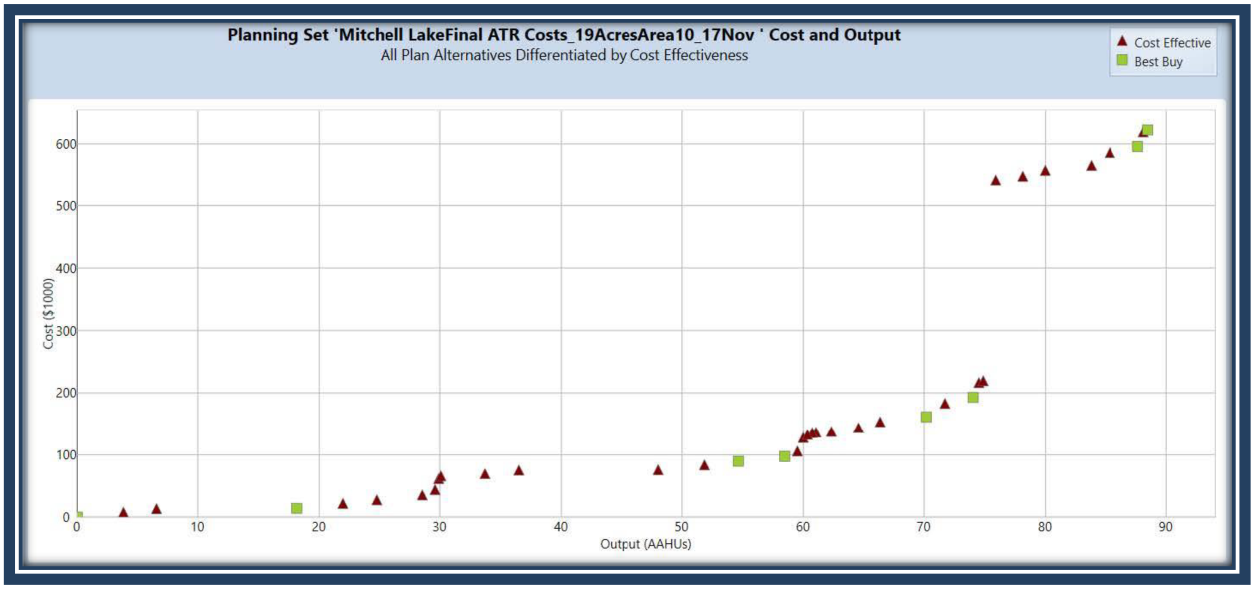

Figure 84 - Graph showing Cost Effective [red triangles] and Best Buy Plans [green squares]

4.12.5 Best Buy Plans

From the cost-effective alternatives, nine were identified as "Best Buy" plans (including the no action plan). The result of the analysis is shown graphically in Figure 84, Figure 85 and Figure 86 (Appendix B – CE/ICA Chapter 3).

- Plan 1: No Action
- Plan 2: Polders Alone
- 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)

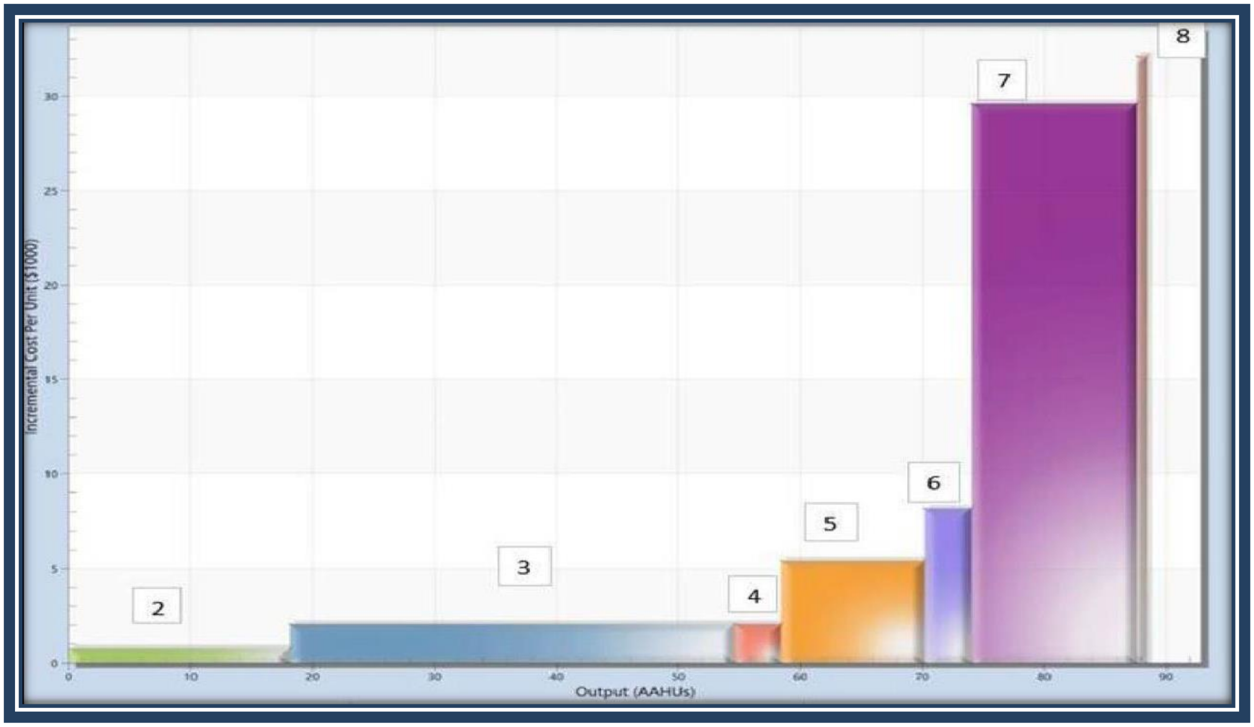

Figure 85 - Bar Chart comparing Best Buy Plans Benefits vs. Costs for Implementation

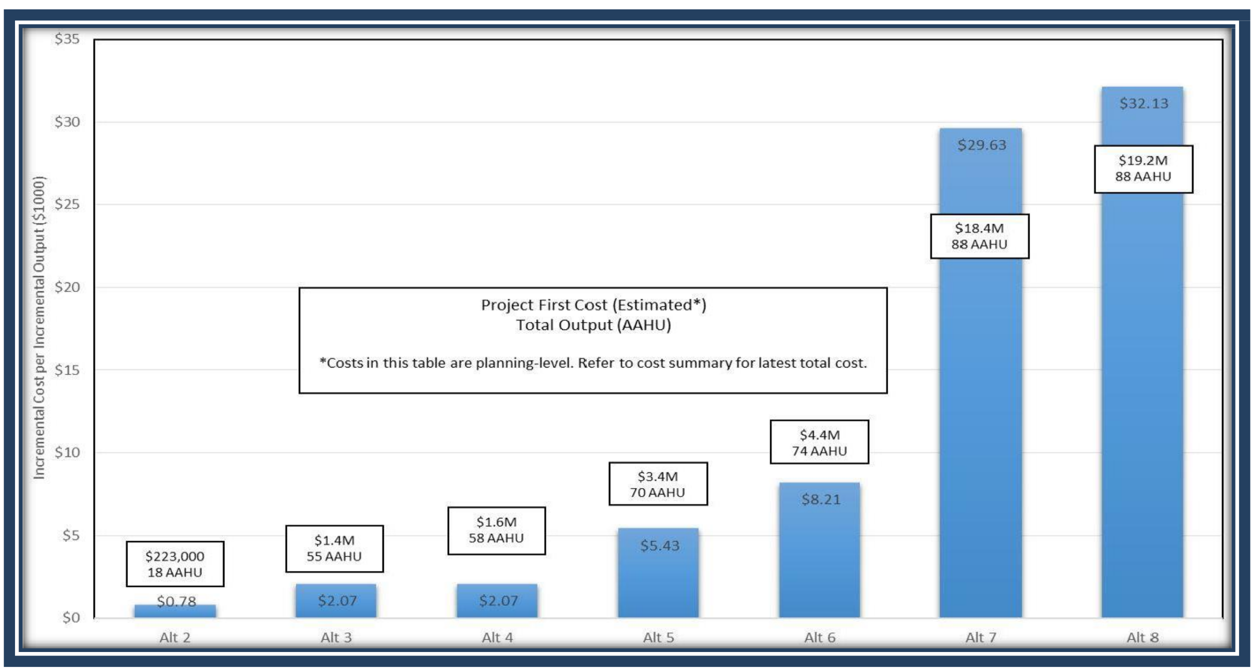

Figure 86 - Incremental Costs per Incremental Output for Best Buy Plans

4.12.6 Do the Best Buys Meet Study Objectives?

Specific Study Planning Objectives:

1. increase the areal extent and quality of fish and wildlife habitat in the study area for the 50-year Period of analysis
2. increase the floral and faunal species diversity and richness in the study area for the 50-year Period of analysis

First, each Plan was identified as either meeting a specific study objective (**Yes**) or failing to meet a specific planning objective (**No**) (Table 48). All but one Best Buy Plan met study objectives.

Table 48 – Screening of Plans with the Planning Objectives

Plan Name	Planning Objectives	
	1	2
Plan 1: No Action	**No**	**No**
Plan 2: Polders (Alternative 6 alone)	**Yes**	**Yes**
Plan 3: Polders + Coves 1 & 2	**Yes**	**Yes**
Plan 4: Polders + Coves 1, 2 & 3	**Yes**	**Yes**
Plan 5: Polders + Coves 1, 2 & 3 + Central Wetlands (2B) + Skip's Pond	**Yes**	**Yes**
Plan 6: Polders + Coves 1, 2 & 3 + Central Wetlands (2B) + Skip's Pond + Bird Pond (1B)	**Yes**	**Yes**
Plan 7: Polders + Coves 1, 2 & 3 + Central Wetlands (2B) + Skip’s Pond + Bird Pond (1B) + Downstream Wetlands	**Yes**	**Yes**
Plan 8: Polders + Coves 1, 2 & 3 + Central Wetlands (2B) + Skip’s Pond + Bird Pond (1B) + Downstream Wetlands + Dam Forested Wetlands (9B)	**Yes**	**Yes**

4.12.7 Is It Worth It? Analysis of the Best Buy Plans

Plan 1: No Action

There is no change from the TSP (Appendix B – CE/ICA, Chapter 4).

Plan 2: Polders (Alternative 6 alone)

There is no change from the TSP (Appendix B – CE/ICA, Chapter 4).

Plan 3: Polders + Coves 1 & 2

Plan 3 includes the restoration of the mud flats adds the restoration of 65.52 acres of emergent/submergent wetland habitat (Figure 87). 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. Details of the ecological benefits of the emergent/submergent wetland habitats are provided in Chapter 6.

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.

Figure 87 - Plan 3: Polders + Coves 1 & 2

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) (Appendix B – CE/ICA, Chapter 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 (Figure 88). Restoration would include 6.84 acres of restoration in Cove 3 located at the southwest end of the lake and 66 acres of restoration in the coves at the northeastern and western edges of the lake. The additional 7.84 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 (Appendix B – CE/ICA, Chapter 4).

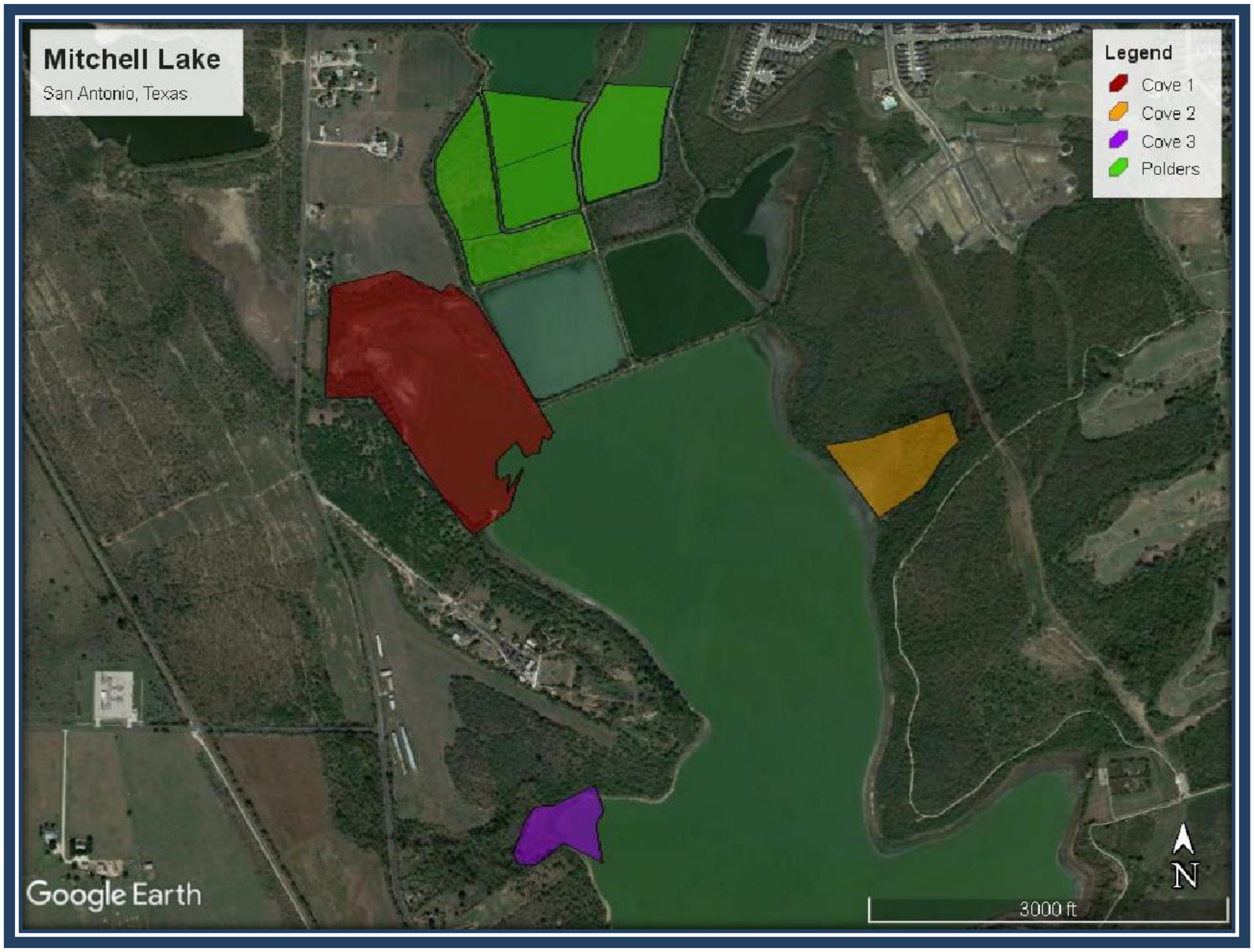

Figure 88 - Plan 4: Polders + Coves 1, 2 & 3

Plan 5: Polders + Coves 1, 2 & 3 + Central Wetlands (2B) + 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 (Figure 89). The Central Wetlands is a low quality 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 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 wetland 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 Plan 4; therefore, Plan 5 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' 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, the linear wetlands 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 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 (Appendix B – CE/ICA, Chapter 4).

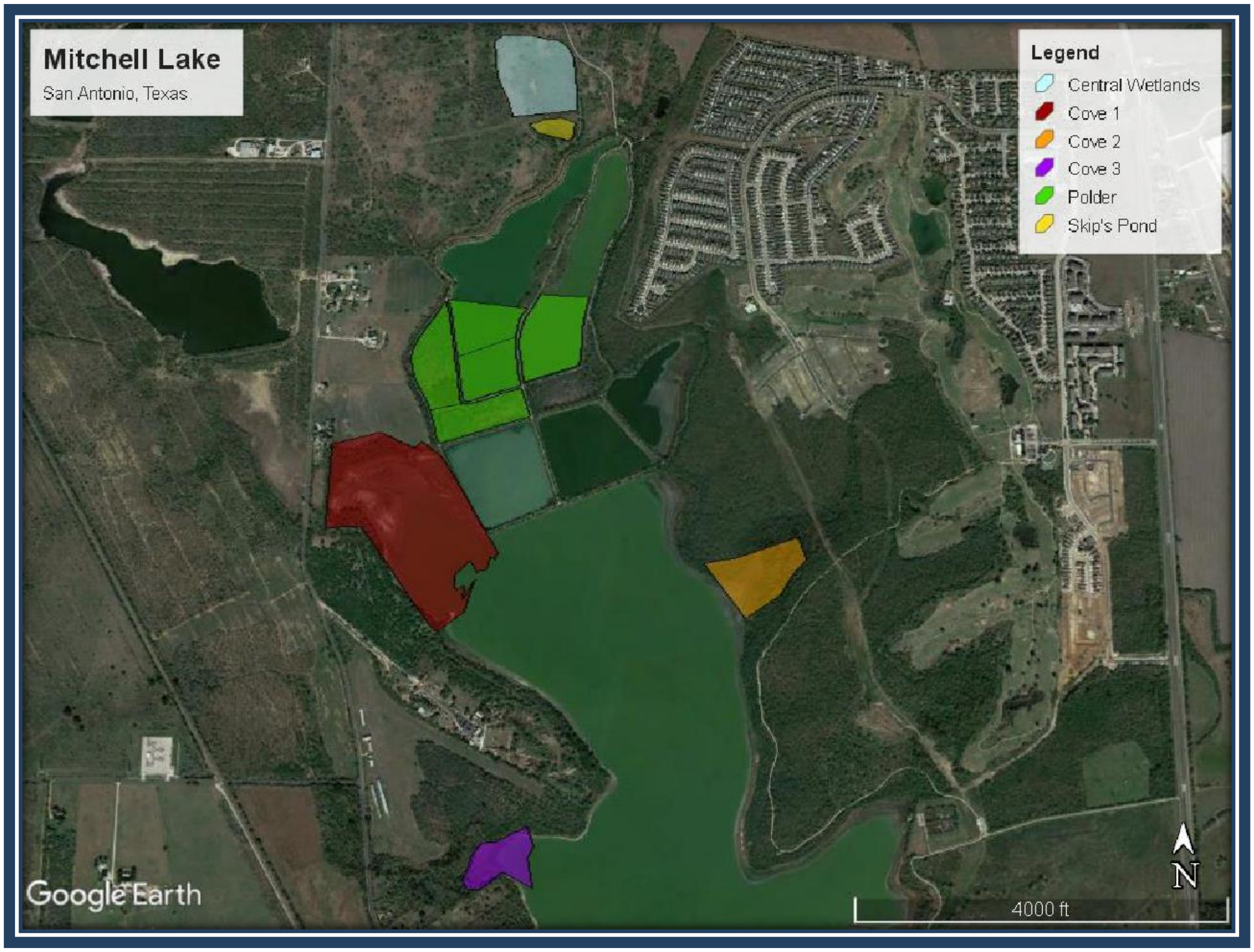

Figure 89 - Plan 5: Polders + Coves 1, 2 & 3 + 2B + 3

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

Plan 6 (Figure 90) 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 project first cost of $8.1 million.

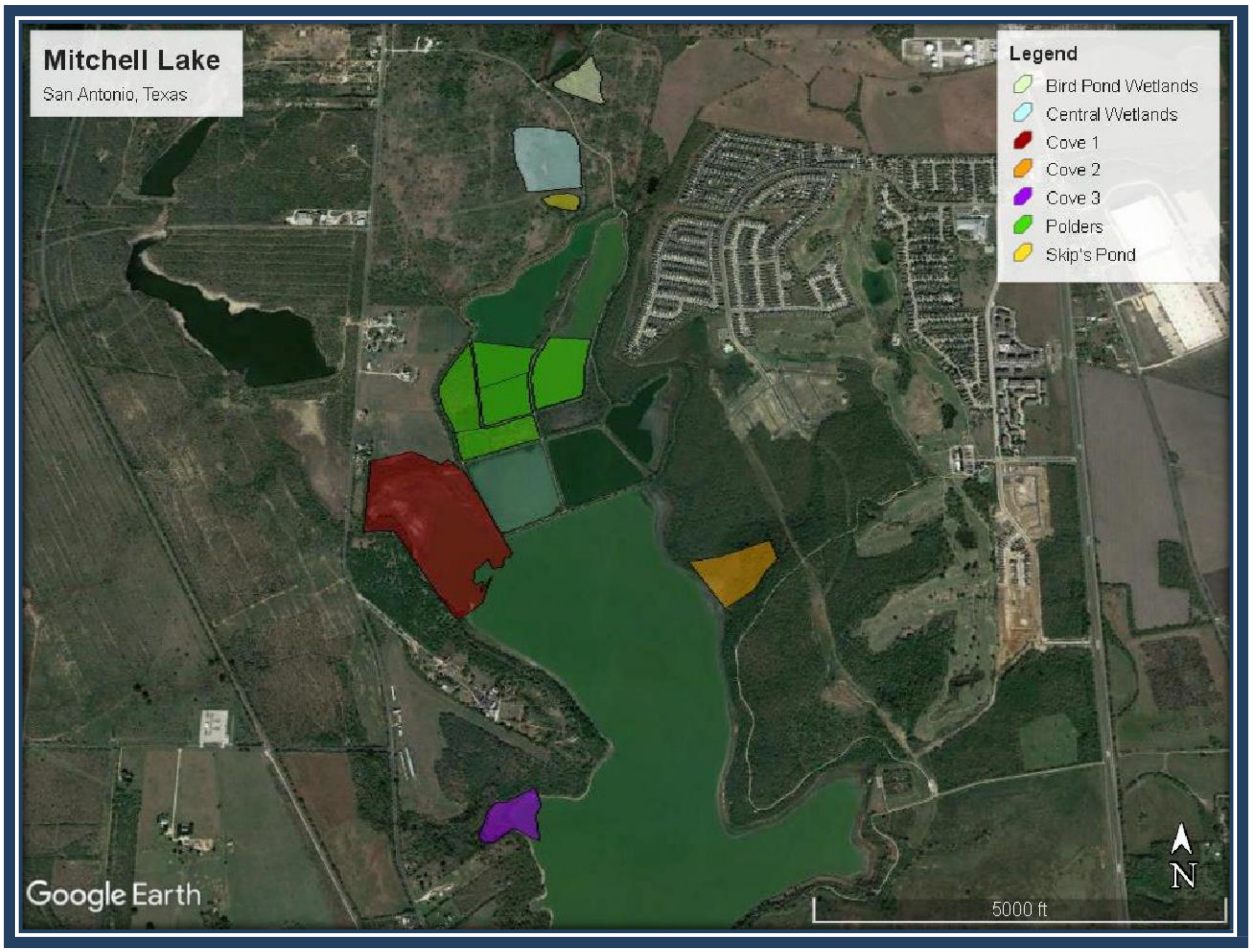

Figure 90 - Plan 6: Polders + Coves 1, 2 & 3 + 2B + 3 + 1B

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 (Appendix B – CE/ICA, Chapter 4).

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

Plan 7 (Figure 91) 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.

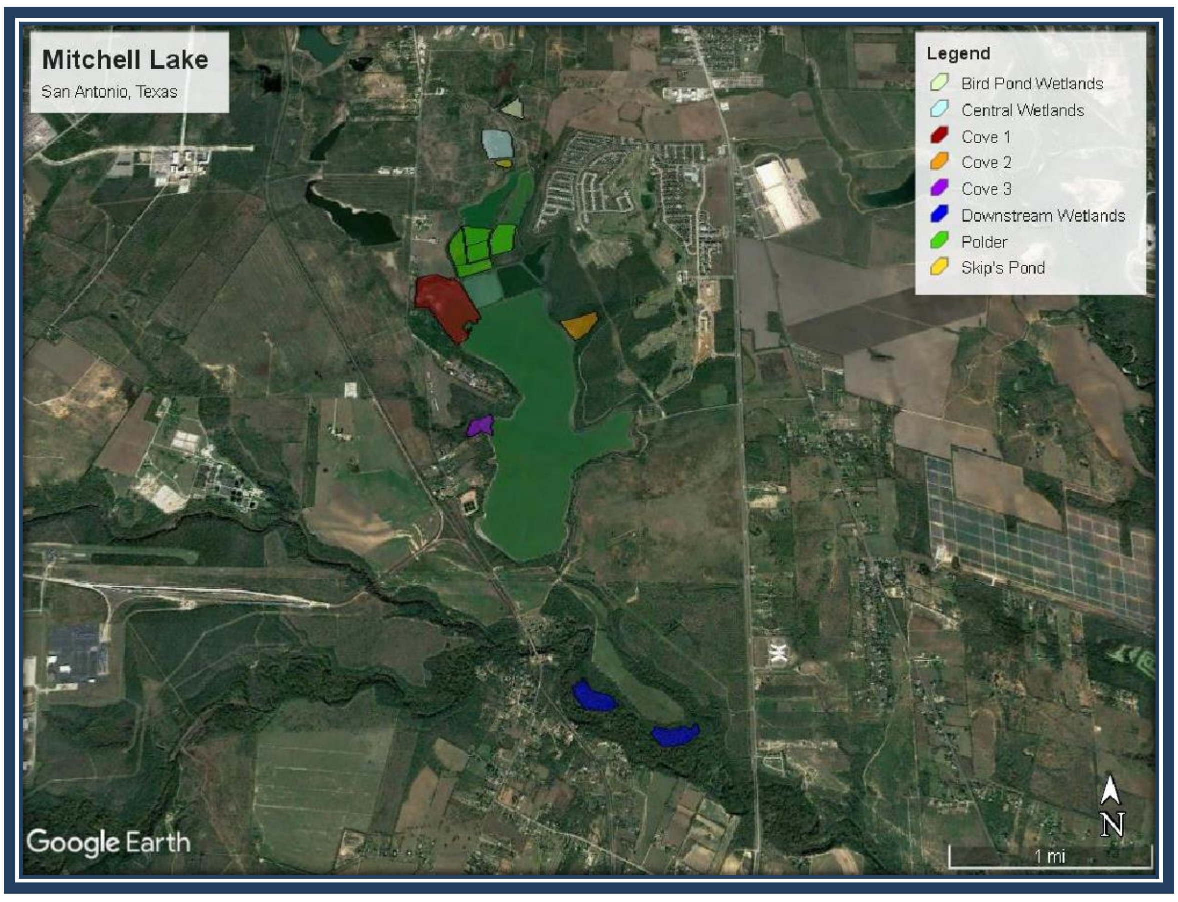

Figure 91 - Plan 7: Polders + Coves 1, 2 & 3 + 2B + 3 + 1B + 10

Plan 7 adds 14 AAHUs of emergent wetland habitat to the 74 AAHUs of mudflat, emergent, and emergentsubmergent 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 (Appendix B – CE/ICA, Chapter 4).

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

Plan 8 (Figure 92) 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 (Appendix B – CE/ICA, Chapter 4).

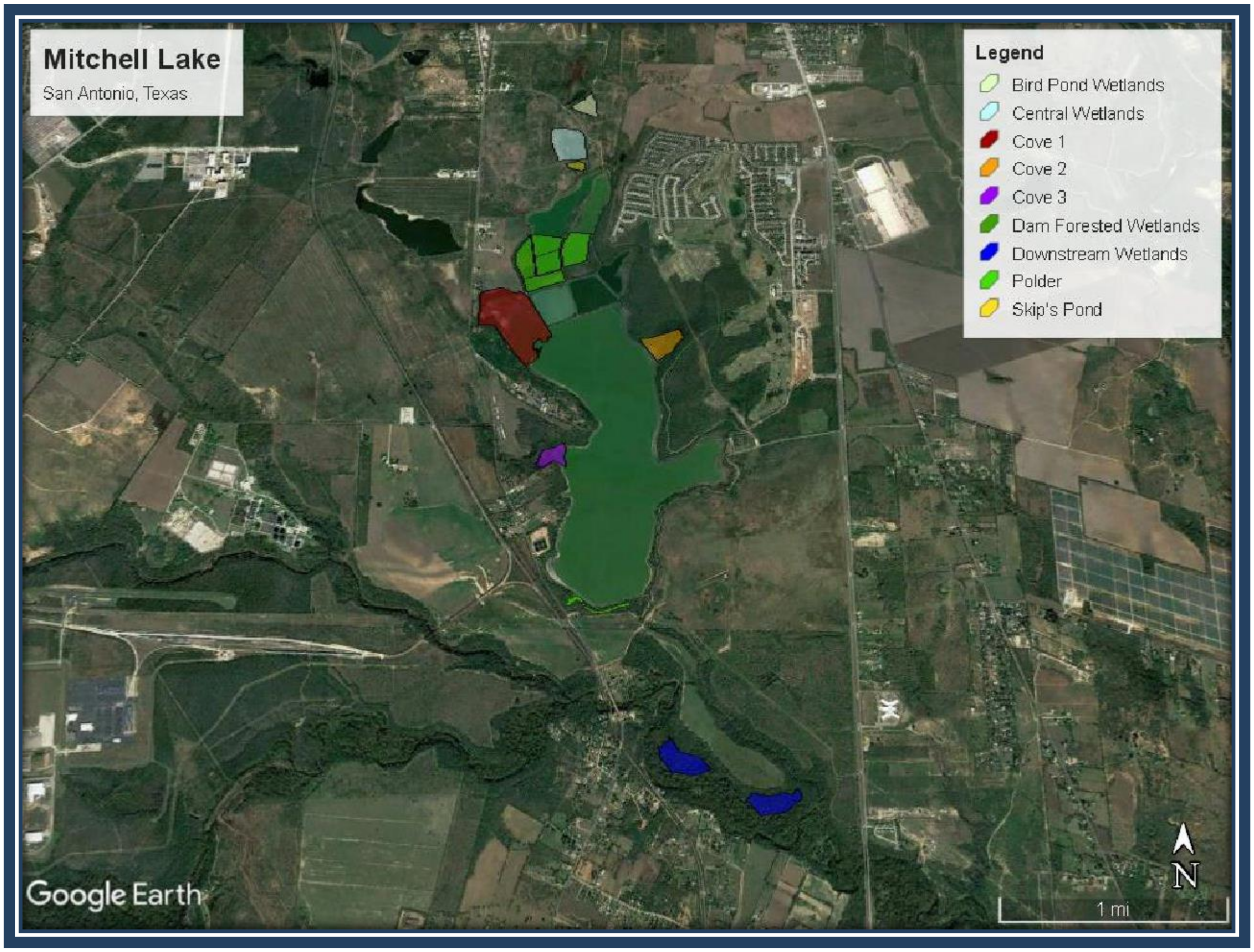

Figure 92 - Plan 8: Polders + Coves 1, 2 & 3 + 2B + 3 + 1B + 10 + 9B

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 provides 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 (Appendix B – CE/ICA, Chapter 4).

4.12.8 NER Plan and the Four Criteria

As part of Federal guidelines for water resources projects, there are general feasibility criteria that must be met. According to the USACE ER 1105-2-100 for planning, any the USACE project must be analyzed regarding the following four criteria:

1. **Completeness –** Does the Plan provide and account for all necessary investments or other actions to ensure the realization of the planned effects?

   a. Plan 6, in conjunction with SAWS planned water treatment wetlands downstream of the dam, will provide and account for all necessary investments and actions to ensure ecosystem restoration effects. This Plan does not address SAWS' water quality, but instead provides an incidental benefit to water quality through the use of emergent and submergent wetland vegetation upstream and within Mitchell Lake. This Plan is complete to restore the aquatic ecosystem within the study area and is the most practicable alternative.

2. **Effectiveness** – Does the Plan alleviate the specified problems and achieve the specified opportunities?
   a. Plan 6 will alleviate the specified problems, achieve the specified opportunities and violates no constraint. Plan 6 will:
      i. reduce the loss of fish and wildlife habitat quality and diversity, particularly for migratory birds
      ii. improve aquatic connectivity between the upstream and downstream habitats
      iii. decrease nutrient loads in Mitchell Lake and Cottonmouth Creek
      iv. remove invasive species within the project footprint for at least 10 years
      v. reduce daily variation in pH and O_2 levels in the water that flows through the upper wetlands and back into Mitchell Lake, in the restored coves which will flow into Cottonmouth Creek
      vi. reconnect the upstream and downstream hydrologies between Bird Pond and Mitchell Lake
      vii. improve water quality as an incidental benefit
      viii. provide additional recreation and ecotourism benefits to the community
3. **Efficiency** – Is the Plan the most cost-effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment?
   a. Plan 6 is the NER plan and the most cost-effective means of achieving the objectives of all this study's alternatives, plans and scales of plans.
4. **Acceptability** – Is the Plan workable and viable with respect to acceptance by State and local entities and the public? Is the Plan compatible with existing laws, regulations and public policies?
   a. Plan 6 is both workable and viable per the Abbreviated Risk Analysis. It is acceptable to the State and local entities and the public. The Plan received substantial review feedback, no negative comments but has instead received letters of support from the Audubon Society and TPWD. The Plan is compatible with all known applicable laws, regulations and public policies.

While Plan 6 does improve water quality within the project area as an ancillary benefit, Plan 6 does NOT principally result in treating, or otherwise abating pollution, or meeting SAWS requirement to comply with EPA water quality standards for water entering the Medina River. SAWS alone is legally responsible for the remediation and compliance with the 2019 EPA AO.

4.12.9 Comprehensive Benefit Description

The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) and ER 1105-2-100, Planning Guidance Notebook (PGN) states that for ecosystem restoration projects, a plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, shall be selected. This plan is referred to as the NER plan. In addition, the P&G identifies four accounts for consideration: National Economic Development (NED), Regional Economic Development (RED), Environmental Quality (EQ) and Other Social Effects (OSE). The following provides a description of these accounts and the potential effects of the Recommended Plan.

National Economic Development. Though the benefits of the Recommended (NER) Plan are not quantified in terms of NED benefits, the ancillary recreation features provide recreation (NED) benefits that have been quantified using the UDV method. The plan for recreation would provide approximately two miles of natural trails. In addition to trails, other components include (1) trailhead, (2) picnic tables and (4) bird blinds. The first cost for recreational facilities is approximately $481,311. This translates to an annual recreation benefit of $59,300 and an annualized cost of $17,075, resulting in approximately $42,000 in annual NED benefits.

Regional Economic Development. This account considers the changes in the distribution of regional economic activity that could result from the plan. The U.S. Army Corps of Engineers (USACE) Institute for Water Resources, Louis Berger and Michigan State University have developed a regional economic impact modeling tool, RECONS (Regional Economic System), that provides estimates of jobs and other economic measures such as labor income, value added and sales that are supported by USACE programs, projects and activities.

A generic RECONS report for the San Antonio-New Braunfels area was run to obtain an estimate of the effect of approximately $7 million in expenditures related to this project. In summary, this expenditure would support a total of 121.9 full-time equivalent jobs, $6,874,642 in labor income, $7,570,161 in the gross regional product and $13,205,858 in economic output in the local impact area. More broadly, these expenditures support 156.6 full-time equivalent jobs, $10,027,847 in labor income, $12,200,293 in the gross regional product and $21,274,831 in economic output in the nation.

Environmental Quality. This account considers effects of significant natural and cultural resources. EQ at Mitchell Lake would be improved by restoring a more natural wetland system as well as by the community response to the restoration and recreation opportunities. The Recommended Plan is expected to generate renewed pride and social connectivity in Mitchell Lake, increasing interest in local programs to improve the environmental quality of Mitchell Lake for additional recreation opportunities in the future. In addition, the Recommended Plan would contribute to 74 AAHUs and 148.85 acres of wetland and some minor riparian restoration into the Mitchell Lake study area.

Other Social Effects. This account registers plan effects that are relevant to the planning process, but not reflected in the other accounts. Residents of San Antonio share tales where Mitchell Lake was a bustling wildlife sanctuary with a plethora of hunting opportunities. The Recommended Plan provides facilities to support new interest in birding opportunities in a way that minimizes the risk to the restored environment. The combined recreation and ecosystem restoration features of the Recommended Plan provide opportunities for improved physical and psychological health for the community.

4.12.10 Recreation

There are several recreation opportunities that can be incorporated alongside the ecosystem restoration project surrounding Mitchell Lake (Figure 93). 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 improve 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.

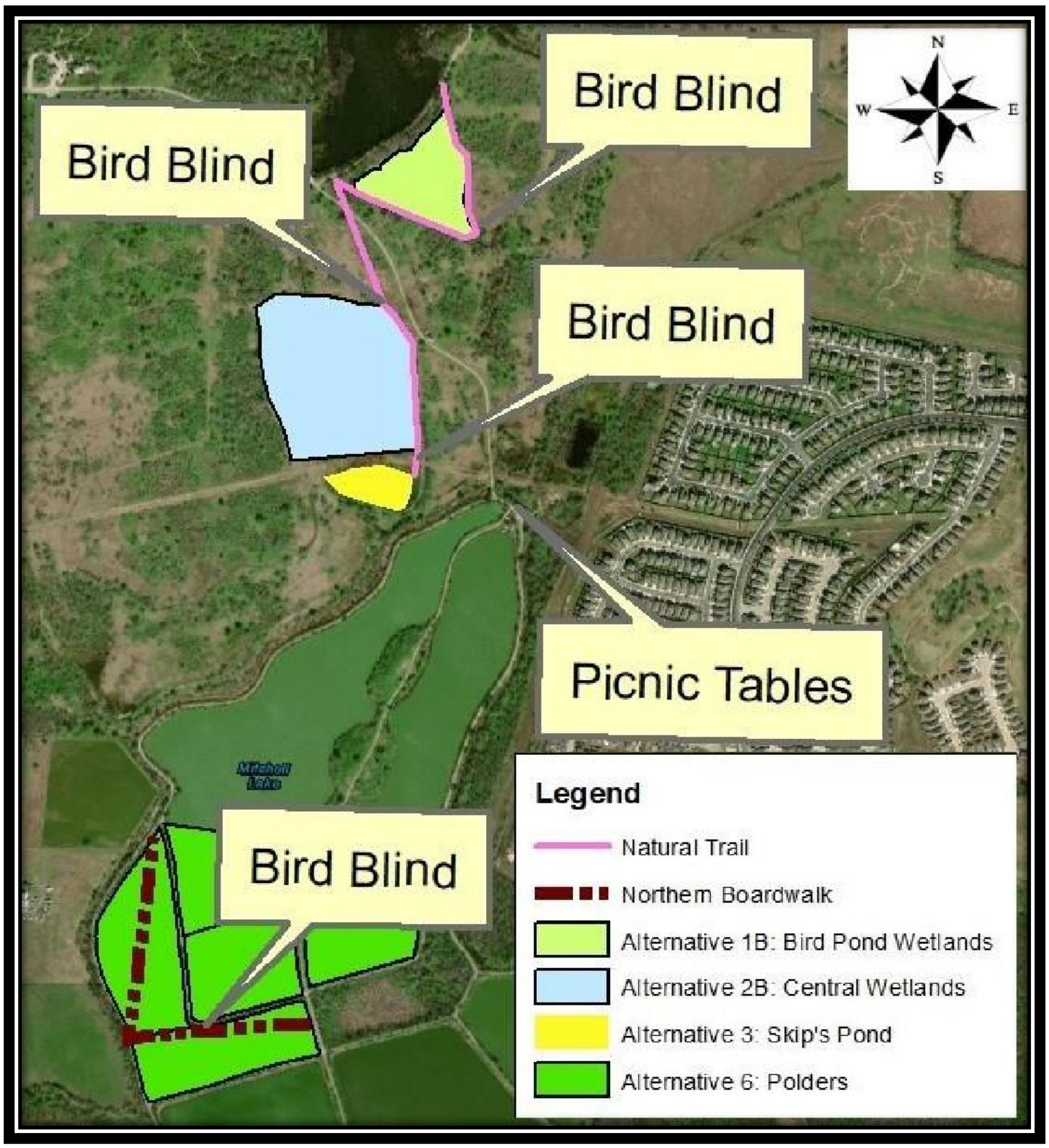

Figure 93 - Recreation Opportunities Northern Mitchell Lake

Plans to improve 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 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

4.12.10.1 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:
   a. expanded bike and trail network (and park connectivity); respondents supported the creation of hiking, biking and walking trails
   b. 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:
   a. increase trail network (biking, walking)
   b. expand opportunities for exercise and play (biking, walking)
   c. improve safety
   d. provide innovative, updated programs and facilities
   e. 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 (Appendix B – CE/ICA Chapter 7).

4.12.10.2 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 (Appendix B – CE/ICA Chapter 7).

4.12.10.3 Unit Day Value

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 improve 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 Appendix B – CE/ICA Chapter 7).

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 49.

Table 49 - 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

4.12.10.4 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 (Table

50). Using the annual recreation benefit of $59,300, the BCR is 3.5 to 1 (Appendix B – CE/ICAChapter 7).

Table 50 - Recreation Benefit-Cost Ratio ($1,000s)

Estimated First Cost	$327
PED and CM (Recreation)	$154
Annual Interest Rate	2.5%
Period of Analysis	50 years
Construction Period	6 months
Annual Recreation Benefits	$59
Recreation AAEQ Cost	$17
Recreation BCR	3.5:1
NOTE: Based on FY21 price level and interest rate	

4.12.11 Project First Costs

Table 51 - Project First Costs Allocation (rounded)

FEATURE	FEDERAL	NON-FEDERAL	TOTAL
Ecosystem Restoration (65/35)			
01 Lands and Damages	$0	$525	$525
06 Fish and Wildlife Facilities	$4,715	$0	$4,715
30 Engineering & Design	$1,542	$0	$1,542
31 Construction Management	$1,040	$0	$1,040
Unadjusted ER	$7,297	$525	$7,822
Adjustment for 65/35	**($2,213)**	**$2,213**	
Subtotal for ER	**$5,084**	**$2,738**	**$7,822**
Recreation (50/50)			
14 Recreation Facilities	$164	$163	$327
Project First Costs	**$5,248**	**$2,901**	**$8,149**
October 2020 Price Levels ($1,000s)			

Costs were taken from Appendix H – Cost Engineering Total Project Cost Summary.

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5 Expected Future With-Project Condition for the Recommended Plan

This chapter describes what can be reasonably expected to happen in the project area. This forecast extends from the base year (the year when the proposed project is expected to be operational) to the end of the period of analysis (2024 – 2073).

The same important resources described in the existing and FWOP conditions (Chapters 2 and 3) are described for the FWP condition in order to identify differences between the two futures.

The DPR-EA has been prepared pursuant to Section 102 of the National Environmental Policy Act (NEPA) of 1969 as implemented by the regulations promulgated by the Council on Environmental Quality (CEQ) 40 Code for Federal Regulation (CFR) 1500-1508 and Engineering Regulation (ER) 200-2-2. The objectives of NEPA are to ensure consideration of the environmental aspects of the Proposed Action in Federal decision-making processes and to disclose environmental information to the public and collect their input before decisions are made and actions are taken. The DPR-EA provides enough evidence for determining whether to prepare an Environmental Impact Statement (EIS) or Finding of No Significant Impact (FONSI). This report evaluates the potential environmental impacts of the alternatives associated with eight Plans, including the No Action Plan. The scope of the plans analyzed are limited to the boundaries of the Mitchell Lake study area.

The Proposed Action is a combination of the Polders; Coves 1, 2 and 3; Skip's Pond; Central Wetlands; and the Bird Pond Wetlands.

5.1 Hydrology, Hydraulics and Climate

Although the Recommended Plan would change the water management of the polders, the polders are a contained system; therefore, the management of the polders to create mudflat habitats would not have any impact on the watershed hydrology or hydraulics of the surrounding aquatic systems (Appendix A – Hydrology, Hydraulics and Climate, Chapter 4)

The planting of emergent and submergent vegetation associated with Coves 1, 2 and 3 and small riparian buffers would not alter the hydrology or hydraulics of the watershed.

The restoration of Skip's Pond entails the excavation of deeper water within the pond to serve as a refugia for fish and wildlife during times of drought and the planting of native emergent and submergent vegetation. The creation of deeper pockets within the pond is not expected to alter the watershed hydrology or affect the hydraulics of the pond inflows and outflows.

From a watershed perspective, wetland habitats essentially function as "sponges". Wetlands slow floodwaters allowing the water to better infiltrate into the ground, decreasing a portion of the runoff from the watershed. The Recommended Plan increases the wetlands size to 99.33 acres. The increase in wetland size also increases the hydrologic effect on the watershed.

The Recommended Plan also includes the construction of a water control structure at the downstream end of Skip's Pond and the Bird Pond Wetlands. The water control structure allows for management of the Central Wetland's and Bird Pond Wetlands' water levels to mimic seasonal fluctuations in precipitation and maintain a diverse and healthy wetland. The impacts to the hydraulics resulting from the water control structure would also affect Skip's Pond.

The hydraulics of the Bird Pond Wetlands, Central Wetlands, Skip's Pond and the linear wetlands bordering the northern and western edges of the polders would change as water would be pumped to the upstream portion of the Bird Pond Wetlands to maintain water levels in the wetlands. However, the increased flows that would result from the pumping would occur in a closed system as the water would be pumped from Mitchell Lake and allowed to flow back to the lake relatively close to the pump intake. Although the internal hydrology and hydraulics of the Bird Pond Wetlands, Central Wetlands and Skip's Pond may be modified, the impacts outside of that closed system would be negligible.

5.1.1 Floodplains

Although the Proposed Action is located partially within the 100-year floodplain, the primary design consideration of the Proposed Action is to ensure that the combination of all ecosystem restoration measures proposed would maintain hydraulic neutrality, i.e. not result in a decrease in floodplain capacity or an increase in flood risk within the study area. For plans that would require the excavation of materials, appropriate disposal site of materials not utilized for berms would be in an upland area outside of both the 100- and 500-year floodplains. The Proposed Action would comply with EO 11988 (see Environmental Compliance Section of this Chapter).

5.1.2 Climate and Climate Change

5.1.2.1 Vulnerability Assessment to Climate Change Impacts

The USACE Watershed Climate Vulnerability Assessment Tool was used to compare the relative vulnerability of the HUC 121003, Texas Gulf Region, to climate change to the other watersheds across the continental United States. The tool facilitates a screening level, comparative assessment of how vulnerable a given watershed is to the impacts of climate change. The Climate Vulnerability Assessment Tool is used to assess the vulnerability of the Texas Gulf Region for the USACE Ecosystem Restoration business line to projected climate change impacts relative to the effects that climate change might have on the USACE ecosystem restoration business line in the other watersheds in the continental United States. The tool uses the Weighted Order Weighted Average (WOWA) method to represent a composite index of how vulnerable a given HUC-4 watershed (Vulnerability Score) is to climate change specific to a given business line. The USACE Climate Vulnerability Assessment Tool makes an assessment for two 30-year epochs of time centered at 2050 and 2085. These two periods were selected to be consistent with many of the other national and international analyses. The tool assesses how vulnerable a given watershed is to the impacts of climate change for a given business line. The top 50% of the traces is called the "wet" subset of traces and the bottom 50% of the traces is called the "dry" subset of traces. There is a combination of four epoch subset combinations, which provide for an indication of the variability/uncertainty in the outputs. Results of the analysis are shown in Figure 94 through Figure 99. Figure 94 shows that relative to the other HUC-4 watersheds in SWD, the watershed is relatively more vulnerable to the impacts of climate change on ecosystem restoration the Central Texas Coastal area in both the wet and dry scenarios (Appendix A – Hydrology, Hydraulics and Climate, Chapter 5).

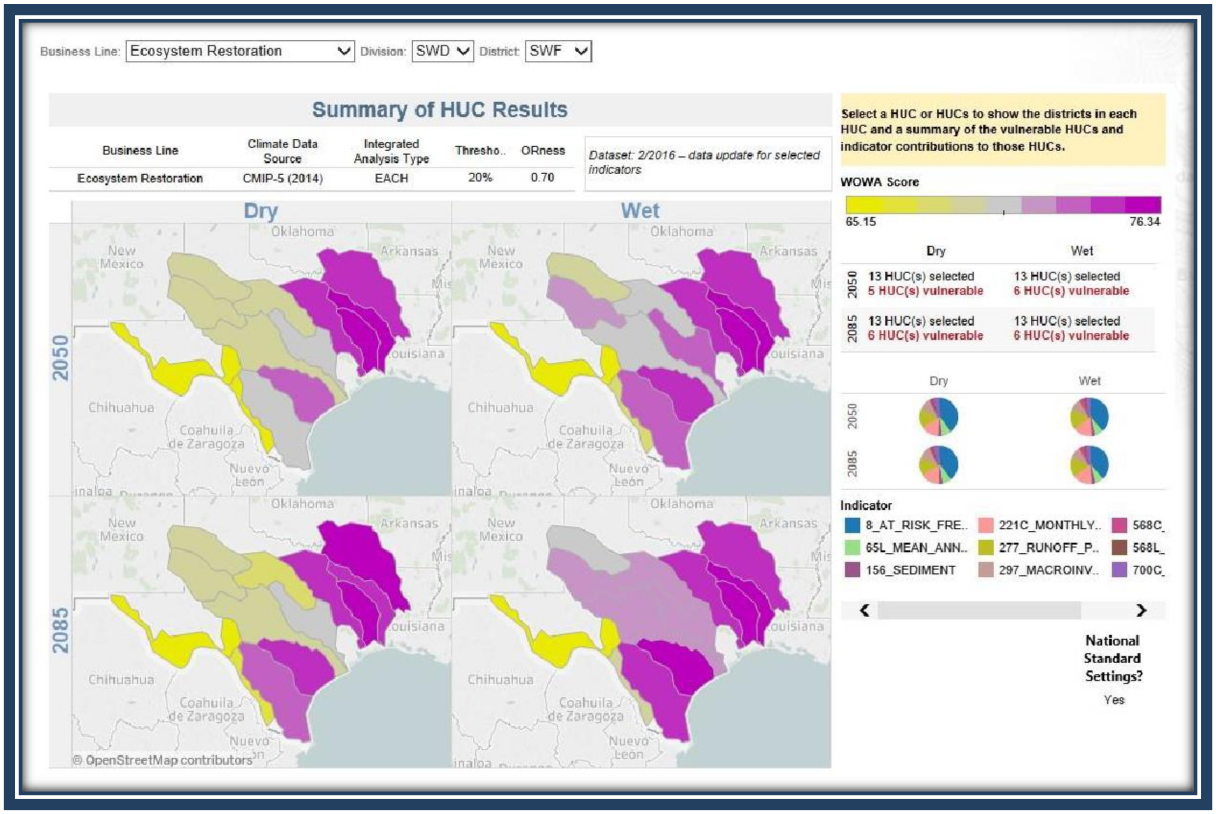

Figure 94 - Vulnerability Assessment Results

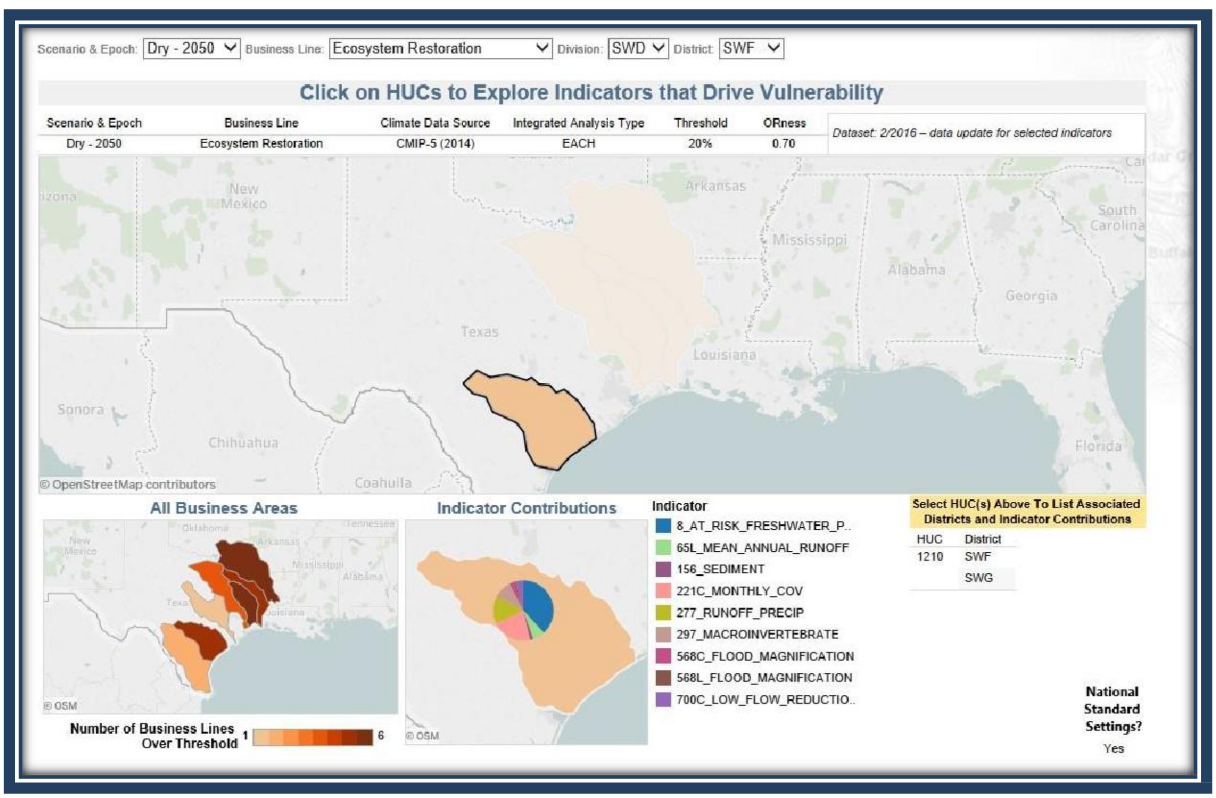

Figure 95 - Vulnerability Assessment Results2

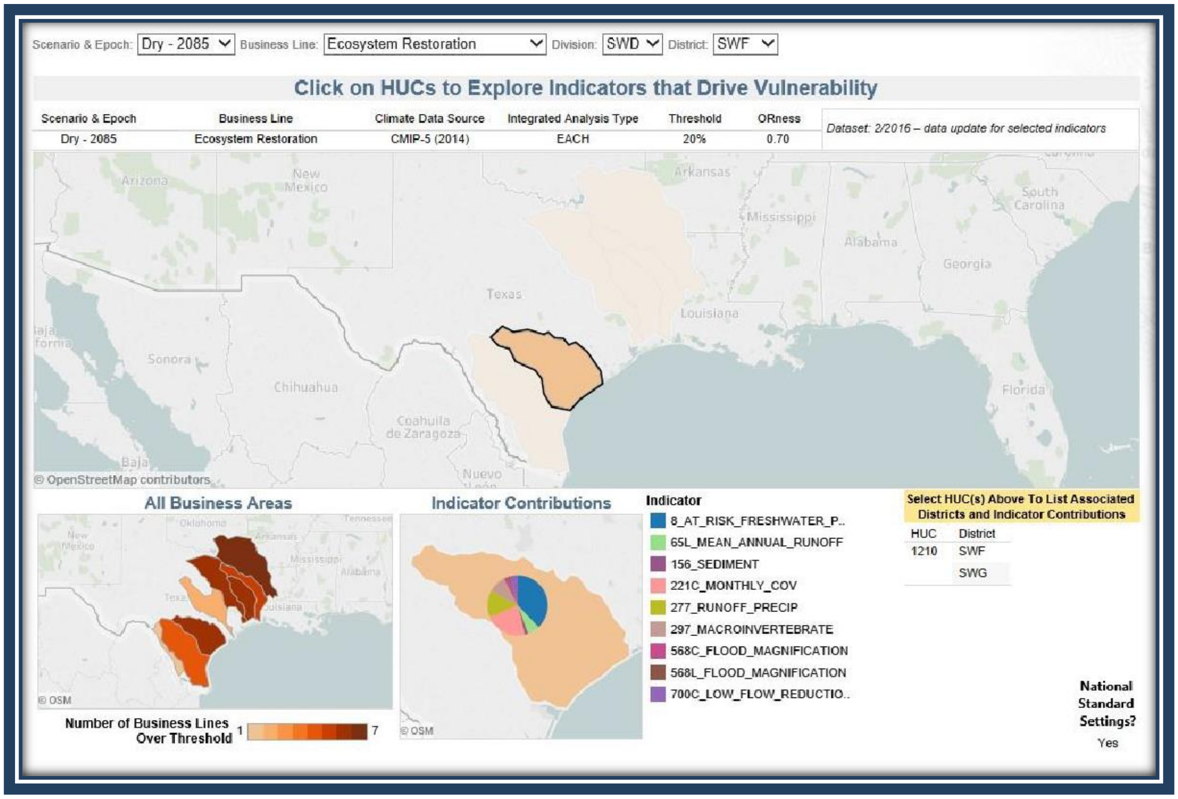

Figure 96 - Vulnerability Assessment Results3

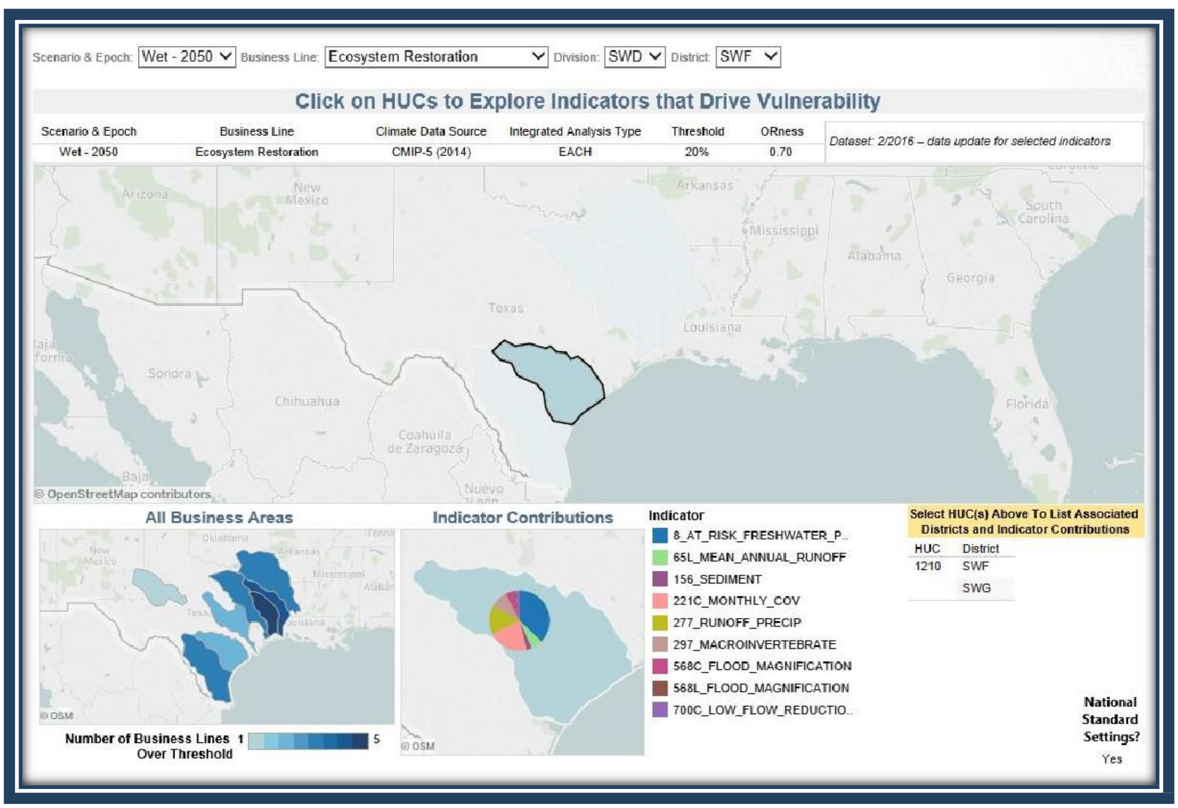

Figure 97 - Vulnerability Assessment Results2

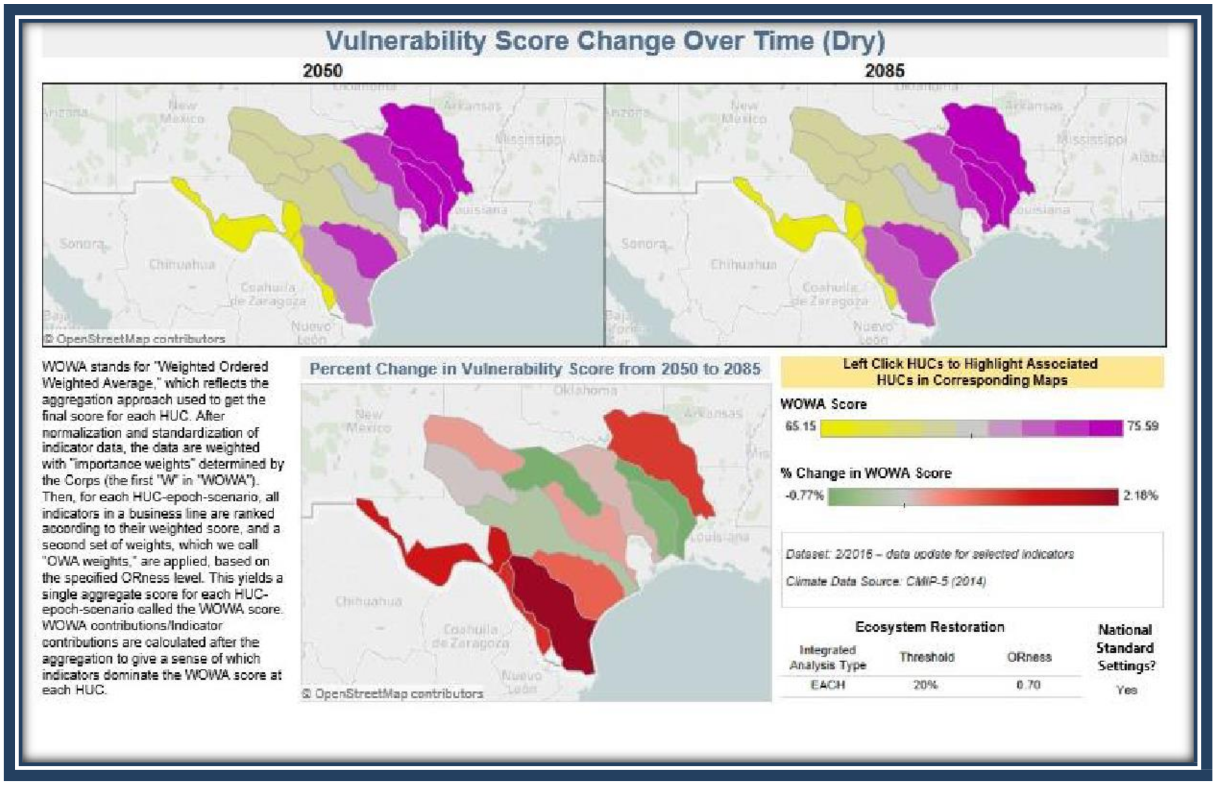

Figure 98 - Vulnerability Assessment Results5

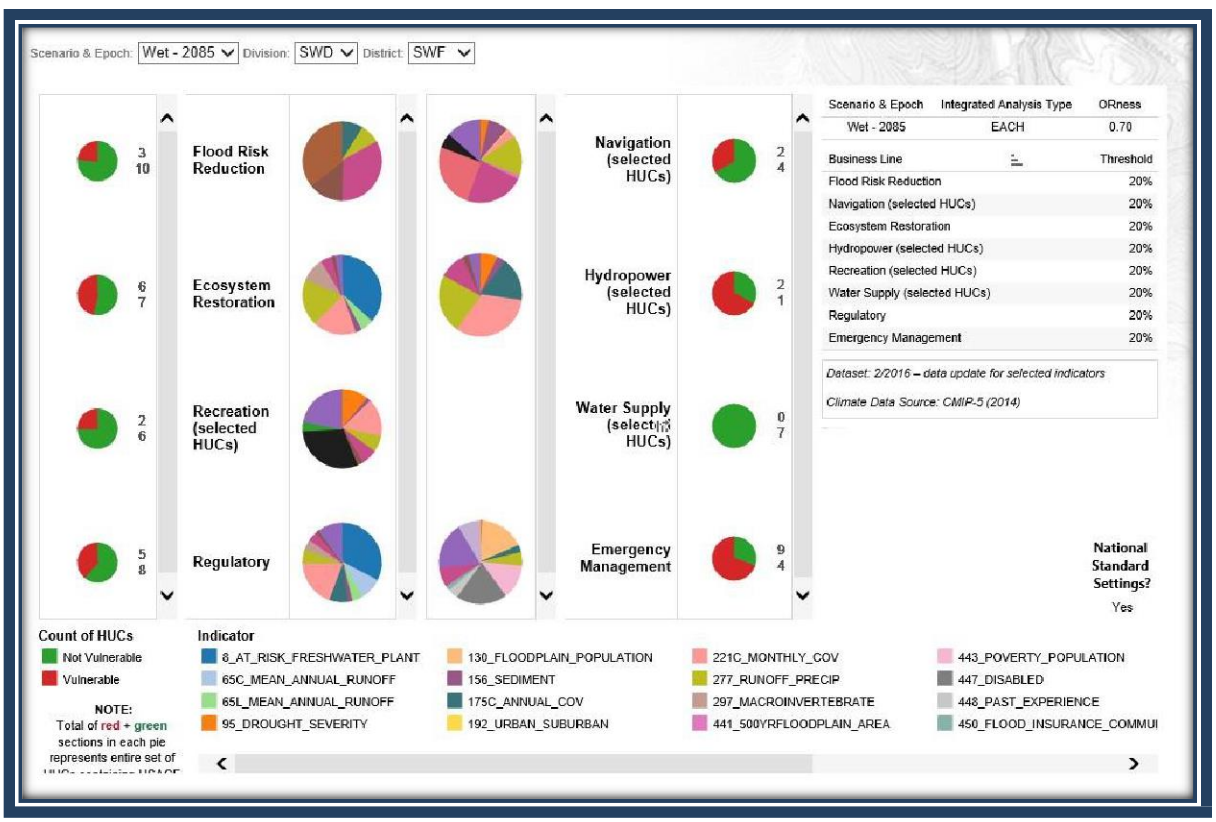

Figure 99 - Vulnerability Assessment Results6

Table 52 is a summary table of the contributing variables to the vulnerability of the study watershed for the Ecosystem Restoration business line. The values show that the dominant indicator is 8_At_Risk_Freshwater_Plants, an essential element of this project. The values tend to substantiate the trends in precipitation and temperature discussed in Appendix A, i.e. increases in temperature, more frequents periods of drought with more periods of intense precipitation.

The results of the USACE Watershed Climate Vulnerability Assessment Tool are presented in Table 53. The tool uses the Weighted Order Weighted Average (WOWA) method to represent a composite index of how vulnerable a given HUC-4 watershed (Vulnerability Score) is to climate change specific to a given business line. WOWA stands for “Weighted Ordered Weighted Average,” which reflects the aggregation approach used to get the final score for each HUC. Results show that the Central Texas Coastal Watershed is vulnerable to the impacts of climate change on Ecosystem Restoration. Results show that the Central Texas Coastal Watershed is vulnerable to the impacts of climate change on Ecosystem Restoration. (Appendix A – Hydrology, Hydraulics and Climate, Chapter 5).

Table 52 - Summary of Vulnerability Factors

Indicator	Scenario and Epoch			
	Dry 2050	Dry 2085	Wet 2050	Wet 2085
8_At_Risk_Freshwater_Plants	28.01	28.01	27.79	27.72
65L_Mean_Annual_Runoff	4.76	4.79	4.60	3.51
156_Sediment	1.34	1.30	2.14	2.20
221C_Monthly_Cov	15.71	16.62	16.01	16.71
277_Runoff_Precip	10.99	10.56	11.56	11.68
297_Macroinvertabrate	7.00	7.00	6.94	6.93
568C_Flood Magnification	1.82	1.79	3.07	4.78
568L_Flood_Magnification	0.72	0.71	0.93	1.12
700C_Low_Flow_Reduction	2.99	3.08	1.62	1.69

Table 53 - Projected Vulnerability with Respect to Ecosystem Restoration

HUC-4 Watershed	Projected Vulnerability with Respect to Ecosystem Restoration			
	Ecosystem Reduction Vulnerability Score			
Central Texas Coastal 121003	2050 Dry	2050 Wet	2085 Dry	2085 Wet
	73.34	74.66	73.87	76.34

5.1.2.2 Climate Change Impacts to the Study Area

The main purposes of the Mitchell Lake Aquatic Ecosystem Restoration Feasibility Study is to provide quality aquatic/wetland habitat within the study area. There are several key components to providing quality habitat for migratory neo-tropical birds and waterfowl: water access and appropriate native species plantings.

The climate change analysis for this project identified that average temperatures are trending upward along with the occurrence of high intensity rainfall events. Increased rainfall intensity may increase the frequency of releases out of Mitchell Lake. The releases would flow out of the lake through the uncontrolled spillway (Figure 8 and Figure 9). Outflows from Mitchell Lake during wet seasons may help remove undesirable (woody) vegetation from encroaching upon the project areas. The Leon Creek Wastewater Recycling Center (WRC) is necessary to ensure appropriate hydrologic conditions within all of the project areas during high temperature months, offsetting the likely increased evaporation rates dues to the increased temperatures. Mitchell Lake will be supplemented with water from the WRC to maintain the lake elevation at approximately 518.5’ (NAVD88) in the Future Without Project condition, thereby keeping Mitchell Lake wet and fully functional.

In FWOP conditions in the northern chain of wetlands (Bird Pond Wetlands, Central Wetlands and Skip’s Pond) would not be supplemented by water from Mitchell Lake and would have the possibility of drying more quickly as a result of the increasing temperatures. The existing northern wetlands provide some habitat for migrating neo-tropical birds and other wetlands species. Any project that includes these areas will provide some resiliency to the ecosystem that will allow it to thrive even with the impacts of the project climate changes.

The operations of Mitchell Lake will not be modified as a result of this ecosystem restoration. Releases from the WRC are not anticipated to decrease as household effluent water requirements will continue to be necessary to provide adequate services to homes within the San Antonio area. SAWS combined WRCs can provide up to 29 million gallons of highly treated effluent per day, approximately 35,000 acre-feet per year. This water is utilized for golf courses, parks, commercial and industrial customers and as a supplement in the upper San Antonio River and Salado Creek.

The polders are currently managed as open water habitat for waterfowl and water birds by the Mitchell Lake Audubon Center facility (Figure 10 and Figure 11) and SAWS. The polders are already supplemented with water from Mitchell Lake and would be unaffected by climate change.

Summary. The Vulnerability Assessment shows increases in temperature and more frequents periods of drought with more periods of intense precipitation. The climate risks and potential harm to the study area associated with the increased temperatures (water may no longer inundate restoration features during all or part of year, resulting in loss of habitat and reducing project benefits, increased surface water evaporation) will be mitigated by water supplemented from the Leon Creek WRC, Mitchell Lake and natural rainfall events. Intense precipitation events would not degrade the intent of the project – the operational features should be able to withstand these intense events (Appendix A – Hydrology, Hydraulics and Climate, Chapter 5).

5.2 Environmental Resources – Affected Environment and Environmental Consequences

This section describes the likely future conditions in the study area over the 50-year period of analysis. Because this is an ecosystem restoration project, the FWP is assumed to provide habitat benefits to all areas. Habitat benefits will be gained by native riparian, submergent, or wetland plantings, removal of low-quality vegetation, creation of wetland features, creation of mudflat features and invasive species management (Appendix C – Environmental Resources, Chapter 3).

Plan impacts were assessed primarily through the application of the USFWS HEP to:

- Quantitatively characterize existing fish and wildlife resources in the study area in terms of acreage and habitat values; and
- Estimate the area and condition of those resources over time in the future in order to compare quantitatively the net gains and losses of habitat that would occur under the different plans.

The HEP evaluates changes in habitat acreages and values (as measured by HSIs) over a 50-year period that begins at the conclusion of construction (Year “0”). Details of the HEP analysis are provided in Appendix C – Environmental Resources, Chapter 3. In addition to the broad, quantitative aspects of the HEP, the analysis also considered potential impacts on special status species or potential impacts that may result from invasive species.

Under NEPA, the significance of project impacts is a function of context and intensity. For biological resources, context refers to the importance (ecological, commercial, scientific, recreational, etc.) or regulatory (i.e., legally protected) status of the resource and intensity refers to the magnitude – scale and duration – of the impact. Both beneficial and adverse impacts are recognized; either can be significant. In the project area, the habitats of greatest importance are emergent wetlands and riparian habitat. Substantial long-term net changes in the acreage and / or value of these habitats would likely result in significant impacts.

Losses or gains of population and habitat for special status species may also be significant, depending on the magnitude of the impact relative to the population size and distribution of the species in the region.

Finally, an impact that led to new introductions or the expansion of invasive species in the study area would also be considered significant in terms of potential far-reaching effects on the ecosystem as a whole.

DIRECT VERSUS INDIRECT IMPACTS

The terms “effect” and “impact” are synonymous as used in this analysis. Both short- and long-term effects are relevant in considering the significance of an impact. Effects are also expressed in terms of duration. The duration of short-term impacts is one year or less. Long-term impacts are described as lasting beyond 1 year. They can potentially continue in perpetuity; in which case they would also be described as permanent. Effects may be beneficial or adverse and may apply to the full range of natural, aesthetic, historic, cultural and economic resources of the project area and the surrounding area. Definitions and examples of direct and indirect impacts as used in this document are as follows:

- **Direct Impact**. A direct impact is one that would be caused directly by implementing one of the two plans and that would occur at the same time and place.
- **Indirect Impact**. An indirect impact is one that would be caused by implementing a plan that would occur later in time or farther removed in distance but would still be a reasonably foreseeable outcome of the action. Indirect impacts may include induced changes in the pattern of land use, population density, growth rate, air, water and other natural resources and social systems.

Significance Criteria and Impact Characterization Scale

In accordance with CEQ regulations and implementation guidance, impacts are evaluated in terms of their significance. The term “significant,” as defined in 40 CFR 1508.27, part of the CEQ regulations for implementing NEPA, requires consideration of both context and intensity. Context means that the significance of an action must be analyzed in several settings, such as society as a whole (human, national); the affected region; the affected interests; and the locality. Significance varies with the setting of the Proposed Action. For instance, in the case of a site-specific action, significance would usually depend on the effects on the locale rather than on the world as a whole.

Intensity refers to the severity of impact regarding the above ratings (minor through significant). Factors contributing to the evaluation of the intensity of an impact include, but are not limited to, the following:

- balance of beneficial and adverse impacts, in a situation where an action has both
- degree to which the action affects public health or safety
- unique characteristics of the geographic area where the action is proposed, such as proximity to parklands, historic or cultural resources, wetlands, prime farmlands, wild and scenic rivers and ecologically critical areas
- degree to which the effects on the quality of the human environment are likely to be controversial
- degree to which the effects of the action on the quality of the human environment are likely to be highly uncertain or involve unique or unknown risks
- degree to which the action might establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration
- whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action “temporary” or by breaking it down into small component parts
- degree to which the action might adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the NRHP or might cause loss or destruction of significant scientific, cultural, or historic resources
- degree to which the action might adversely affect an endangered or threatened species or habitat that has been determined to be critical under the ESA
- whether the action threatens a violation of Federal, state, or local law or requirements imposed for the protection of the environment

Impacts are characterized by their relative magnitude. Significant adverse or beneficial impacts are the highest levels of impacts. Conversely, negligible adverse or negligible beneficial effects are the lowest level of impacts. In this document, nine descriptions are used to characterize the level of impacts. In order of degree of increasing impact, they are:

- significant adverse impact
- moderate adverse impact
- minor adverse impact
- negligible adverse impact
- no measurable impact
- negligible beneficial impact
- minor beneficial impact
- moderate beneficial impact
- significant beneficial impact

5.2.1 Climate and Climate Change

The proposed project area encompasses a relatively small area when compared to the global scale. Therefore, any changes to climate change resulting from any of the plans, including the No Action Plan, would be insignificant.

5.2.1.1 No Action Plan

As stated above, there would be no significant impacts to climatic conditions.

5.2.1.2 Proposed Action

Factors relating to climate change were analyzed and assessed during the plan formulation process. Climate change will not significantly impact the Proposed Action due to drought or extended wet periods. Because Mitchell Lake has a steady supply of water from rainfall, runoff and the Leon Creek WRC; the overall project area will not be impacted by drought periods. This water supply will be utilized to maintain the water elevation of Mitchell Lake at 518.5’ (NAVD88). Because the Bird Pond Wetlands, Central Wetlands and Skip’s Pond will be supplemented by water from Mitchell Lake, drought would be a non-issue for these project areas. Prolonged wet periods within the study area would benefit the Proposed Action by providing additional water to supplement the native vegetation plantings in the northern chain of wetlands, during this time frame pumping from Mitchell Lake would be unnecessary.

Features that could be impacted by climate change are the native species plantings. The wetland species planted will be dependent on a steady supply of water during the winter months. At this time, water should be in ready supply due to regular rainfall. However, in the case of drought water will be pumped from Mitchell Lake into the northernmost section of the wetlands, Bird Pond Wetlands. Because this lake has a steady supply of water, there should not be an issue with filling up the wetland cells with water from the lake. The water control structures, otherwise known as stoplog structures will be utilized to allow free flow of water or deter free flow of water. During periods of drought the logs can be dropped into place, deterring the amount of water exiting the wetland cells and holding an appropriate water level in place for the wetland vegetation. The northern chain of wetlands will act as a normal system and will be allowed to be somewhat dry in summer months.

The Polders will also be relatively unaffected by climate change because they have the same water supply. Additional water would provide more open water habitat for waterfowl and waterbirds. Because Mitchell Lake will be maintained at 518.5’ (NAVD88), Coves 1, 2 and 3 should not be impacted by climate change. An overabundance of water, due to prolonged wet periods, within Mitchell Lake will lead to a release through the spillway. This would eventually lower the water levels over time until they have returned to their normal condition. The polders will be resilient to climate change as well because a pump is already in place to allow transfer from Mitchell Lake into the polder cells. The berms added to the polders will allow for easier water management. Water will be allowed to sit in certain polders depending on the need to eradicate woody species, while other polders will be maintained at approximately 7” to allow for appropriate mudflat habitat for shorebirds. The berms will not be dependent on a water source, but should the need arise for additional water or a deduction of water from the polders, a temporary pump will be utilized to move the water between the cells or back into Mitchell Lake.

Although the small scale of the project area would limit any significant changes to the earth’s climate, the restoration of 148.85 acres of habitat would contribute to the collective sequestration of carbon. In particular, wetland habitats sequester significantly more carbon than the associated upland habitats. The Proposed Action will not have a significant impact on climate and climate change.

5.2.2 Geology, Topography and Soils (including Prime Farmlands)

No changes to the proposed project area geology would result from the No Action and Proposed Action.

5.2.2.1 No Action Plan

Under the No Action Plan, there would be no changes to proposed project area in its existing condition, there would be no measurable impacts to the Mitchell lake geology, topography, or soils (including Prime Farmlands).

5.2.2.2 Proposed Action

The Recommended Plan will require excavation to increase the extent and/or depth to create wetland habitats. Implementing the Bird Pond Wetlands, Central Wetlands and Skip’s Pond would result in the excavation of six inches to six feet of material to create the target wetlands. The Polders and Fringe Wetlands would not require changes to the topography in the proposed project area, except for the installation of berms to segment off three of the existing polder/basin cells. Any changes to topography resulting from the Proposed Action would result in the increased habitat quality within the proposed project area due to the improvement with vegetative diversity because of the topographical changes. No measurable impacts would occur due to the Proposed Action. Sedimentation and erosion Best Management Practices (BMPs) will be incorporated to avoid erosion and sedimentation to adjacent waterbodies and wetlands. Prime farmland soils occur at the site, but the proposed project area is within the city limits of

San Antonio. Therefore, Section 1541(b) of the FPPA of 1980 and 1995, 7 U.S.C. 4202(b) is not applicable.

5.2.3 Land Use

The Audubon Society manages the proposed project area for wildlife habitat and SAWS maintains and manages the water in Mitchell Lake and the Polders to ensure water quality impairments downstream of the lake are minimized. This management will continue into the Future Without and With Project conditions.

5.2.3.1 No Action Plan

There would be no measurable impacts to land use due to the No Action Plan.

5.2.3.2 Proposed Action

The Proposed Action would have no measurable impacts to land use as described above.

5.2.4 Air Quality

5.2.4.1 No Action Plan

Under the No Action Plan, there would be no measurable impacts to air quality within the study area.

5.2.4.2 Proposed Action

The operation of heavy equipment, support vehicles and other motorized machinery for construction would result in combustion of fossil fuels and the release of volatile organic compounds (VOCs), nitrogen oxides (NOx), carbon monoxide (CO), ozone (O_3), sulfur dioxide (SO_2) and particulates(PM_{10} and $PM_{2.5}$). Additionally, fugitive dust emitted to the atmosphere by heavy equipment and support vehicles moving across unpaved, non-vegetated roadways or staging areas, wind blowing dust from disturbed areas and storage piles into the atmosphere could create a haze over the project area and increase ambient concentrations of particulate matter. Fugitive dust emissions would be greatest during the initial site preparation activities and would vary from day to day depending on the construction phase, level of activity and prevailing weather conditions. The quantity of uncontrolled fugitive dust emissions from a construction site is proportional to the area of land being worked and the level of construction activity. Emissions would be temporary in nature. The use of BMPs during construction would minimize these emissions, including the use of cleaner burning fuels and energy efficient equipment.

Air quality impacts from implementation of any of the Proposed Plans would be similar in scope but varying in scale and duration. In general, each area plan would have minor and temporary direct impacts to ambient air quality from construction activities. Air emissions would be mobile in nature, temporary and localized to the restoration unit(s) being worked at that time. Implementation of the following BMPs would further reduce air quality impacts and should be incorporated when developing contract specifications:

Mobile Source Controls:

- the use of heavy machinery should be fitted with approved muffling devices that reduce emissions
- plan construction scheduling to minimize vehicle trips
- limit idling of heavy equipment
- maintain and tune engines per manufacture's specifications to perform at epa certification levels, prevent tampering and conduct inspections to ensure these measures are followed
- consider alternative fuel and energy sources (e.g. natural gas, electricity, etc.) when and where appropriate

Fugitive Dust Source Controls:

- stabilize open storage piles and disturbed areas by covering and / or applying water or chemical/organic dust palliative where appropriate at active and inactive sites
- install wind fencing and phase grading operations where appropriate and operate water trucks for stabilization of surfaces under windy conditions

The General Conformity Rule (GCR) was promulgated by the U.S. EPA. The GCR rule mandates that the Federal government does not engage in, support, or provide financial assistance for licensing or permitting, or approving any activity not conforming to an approved State Implementation Plan. In Texas, the applicable plan is the Texas State Implementation Plan (SIP), an EPA-approved plan for the regulation and enforcement of the NAAQS in each air quality region within the state. The General Conformity Rule is applicable only to non-attainment and maintenance areas as described in 40 CFR Part 93.153. The proposed project site is located within the Bexar County. Bexar County has been designated as a Marginal Nonattainment area by the EPA for the 2015 Eight-Hour Ozone NAAQS on July 25, 2018 with an attainment deadline of September 24, 2021. Bexar County is in attainment for all other NAAQS pollutants. For federal projects in this area General Conformity Determinations are required for projects where indirect and or direct emissions exceed the de minimis threshold of 100 tons per year (tpy) of the Ozone precursors, either NOx or VOC. The proposed project construction effort has been reviewed included the construction equipment types, size and hours running. Based on the size of the project and resulting construction effort emissions the project is expected to have direct emissions far below the de minimis threshold of 100 tpy (40 CFR Part 93.153(b)) and does not require a General Conformity Determination.

5.2.5 Noise

Pursuant to Chapter 21, Article III of the San Antonio Municipal Code, maximum permissible noise levels depend on the land use of the property that contains the noise source (e.g., industrial, commercial, or residential) and the land use of the property receiving that noise. Maximum permissible noise levels range from the 63 A-frequency weighted decibels (dBA) in residential zoning districts

5.2.5.1 No Action Plan

Under the No Action Plan, there would be periodic noise attributed to mowing equipment and vehicles during routine maintenance and site visits. Noise pollution attributed to aircraft and Toyota Texas manufacturing center nearby are infrequent and are not expected to increase in the No Action Plan based on current information. However, noise from growing residential areas may have a slight increase over a 50-year period.

5.2.5.2 Proposed Action

The Proposed Action would require heavy equipment to implement construction efforts, which would cause short-term localized increases in noise levels. These short-term increases are not expected to substantially affect adjacent noise sensitive receptors or wildlife areas. The nearest noise receptors to any of the restoration areas is the Mission del Lago neighborhood east of the polders. All of the final array of alternatives include construction activities at the polders, each plan would have a minimal temporary noise impact to the Mission del Lago community.

Noise levels created by construction equipment would vary greatly depending on factors such as the type of equipment, the specific model, the operation being performed and the condition of the equipment. The equivalent sound level of the construction activity also depends on the fraction of time that equipment is operated over the period of the construction. Construction would occur during daylight hours, thus reducing the day-night average sound levels and the chances of causing annoyances. Construction would also be in accordance with migratory bird nesting periods, due to their proximity to the project area. Because much of the construction activities would occur within the existing SAWS property, adjacent properties would be partially buffered from construction noises. The use of BMPs such as keeping equipment in good operating condition, proper training and providing appropriate health and safety equipment would minimize the potential noise impacts associated with the Proposed Action. Construction would be conducted in accordance with Chapter 21 of the San Antonio City Ordinances.

5.2.6 Transportation

Most traffic attributed to the study area is due to Texas A&M University. There are several alternate routes to the university including S Zarzamora Street, University Way and Verano Parkway that can be utilized if Pleasanton Road is unavailable. The nearby Toyota Texas Manufacturing center attributes to some light traffic near Mitchell Lake, but is otherwise not an impact.

Signage indicating the location of the Mitchell Lake Audubon Center facility (Figure 10 and Figure 11) and to the nearby trailheads are in place, along with designated parking to reduce congestion on the single lane roads near most of the visitor-friendly natural areas.

5.2.6.1 No Action Plan

Under the No Action Plan, there would be no measurable impacts to transportation.

5.2.6.2 Proposed Action

For the Proposed Action, short-term, insignificant impacts to traffic volumes would be expected during construction activities. Local roads are well designed and can handle a large volume of vehicles. However, during construction, traffic congestion could occur as construction vehicles enter and exit the project area. Road closures or restricted access would not be anticipated; however, temporary detours or traffic control may be needed during working hours. A traffic control plan would be prepared by the construction contractor and submitted for approval to Federal and local officials prior to the start of any construction activities.

Implementation of any of the action plans would have no measurable impact on transportation or transportation corridors. Insignificant indirect impacts to Pleasanton Road could include the additional wear and tear, caused by support vehicles entering the restoration units. The level of indirect impacts would be expected to be minimal and not cause a noticeable increase or hardship on local maintenance programs.

5.2.7 Light

The Mitchell Lake area is managed for natural resources and exposed to the fugitive light sources from adjacent neighborhoods, roads and the nearby urban development. Due to increasing urbanization, it is expected that fugitive light will occur more frequently in the study area.

5.2.7.1 No Action Plan

Light sources will become more frequent in the study area due increased urbanization, however; this is an unavoidable impact that will affect the study area over an extended amount of time.

5.2.7.2 Proposed Action

No permanent light sources would be added as the result of any of the plans and no construction would occur during nighttime hours. Therefore, there would be no measurable impacts associated with the construction of the proposed restoration features.

5.2.8 Water Resources

Each of the evaluated plans would result in the restoration or improvement of aquatic resources within the study area. Therefore, any temporary adverse impacts to water resources would be offset by the net gain in habitat quantity and quality. Each evaluated plan beneficially impacts the water resources of the study area to a different degree and is described below.

5.2.8.1 No Action Plan

Under the No Action Plan, there would be no measurable impacts to waters. The future water management plan for Mitchell Lake is to decrease the surface water elevation from 520.4’ to 518.5’ (NAVD88), thereby decreasing the open water surface area of the lake. Urbanization will be a contributing factor to the water quality of the northern wetlands, polders and Mitchell Lake itself. Although there are not permittable actions that would allow runoff from adjacent properties to enter Mitchell Lake, this may impact water quality of the study area regardless. Water quality would not be improved within the lake, although a complex of water quality treatment proposed for construction by SAWS would increase the water quality for the Mitchell Lake outflows. Large storm events may assist in improving water quality by increasing flow from Mitchell Lake, but any noticeable effects would be far outside the limits of the 50-year planning period of this feasibility study. However, the treatment wetlands would not affect the water quality within Mitchell Lake, the polders, or the northern wetlands.

It is expected that the levels of TSS (as high as 255 mg/l), DO (as low as 0.2 mg/l) and pH (as high as 9.8) will not show significant improvements over the next 50-year period under the No Action Plan.

5.2.8.2 Proposed Action

Each proposed plan would restore the form and function of specific aquatic features within the study area which would result in differing magnitudes of beneficial impacts. All proposed plans would have temporary localized water quality impacts during construction. However, these impacts would be minimized with the implementation of BMPs and a Stormwater Pollution Prevention Plan (SWPPP). The impacts to water resources for each of the proposed plans are provided below.

The Proposed Action alternatives are dependent on a steady water supply from Mitchell Lake. The Bird Pond Wetlands, Central Wetlands and Skip's Pond will be dependent on a single pipeline and pump beginning at the polders and running north to the uppermost reach of the Bird Pond Wetlands.

The polders are currently supplemented with water from Mitchell Lake. This will continue into the FWP, although the water levels are now expected to have more seasonal water elevations to accommodate shorebirds, waterfowl and waterbirds. However, polders should not go dry during this timeframe. Water would be pumped into the polders to supplement approximately seven inches of water during the migration season of shorebirds (March-May and August-October). Water would be moved between approximately two to three polders each spring and fall migration season. The polders would hold water for an extended period because the polders will be drained to a depth of approximately seven inches in the spring and fall storm events would extend the life of the mudflat habitat. The soil should be wet and have a mud-like appearance. Waterfowl and waterbird habitat will be readily available in the summer and winter with water levels between four feet and eight feet in the polders when shorebird habitat is not needed.

Mitchell Lake will be maintained at 518.5' (NAVD88) with recycled water from the Leon Creek WRC. Coves 1, 2 and 3 will not be affected by this FWOP condition because the drop in water elevation was addressed during plan formulation. Due to this FWOP condition, it is assumed that there will not be a shortage of water for any of the alternatives.

5.2.8.3 Surface Water and Wetlands

Implementation of Alternative 6 would result in the construction of berms to create two mudflat polders at the south end of the West Polder and one mudflat polder at the south end of the East Polder. The construction of the berms to create these mudflat polders would result in the loss of approximately 3.0 acres of open water habitat. An additional berm would be constructed in Basin 1 to create two similar sized mudflat polders; however, Basin 1 is managed to capture overflows of the adjacent polders during storm events and remains relatively dry most of the time. With the implementation of the Recommended Plan, the water management of the five mudflat polder units would result in temporal impacts to the open water habitat, but not a loss of overall open water acreage. At any one time, two mudflat polders would be managed as mudflats while the remaining three would remain as open water habitats. Once constructed, two of the five polders (the two Basin 1 mudflat polders) would have a lower water elevation, so any loss of open water habitat resulting from the draining of the East and West mudflat polders would be compensated by the creation of open water habitat in the Basin 1 mudflat cells. The loss of open water resulting from the construction of the berms is marginal considering the increased benefits that the mudflats provide for the avian community.

Alternative 7G would increase the surface water habitat by increasing species diversity and habitat structure to Coves 1, 2 and 3. This alternative includes the creation of 72.36 acres of emergent/submergent wetland habitat.

Alternative 3 adds the restoration of Skip's Pond, a 2.18-acre pond supporting emergent and submergent vegetation.

Alternative 2B adds the restoration of 10.46 acres of emergent wetlands (Central Wetlands) and the creation of an additional 7.91 acres of emergent wetland adjacent to the existing Central Wetlands. The restoration of the existing wetlands would have similar temporary impacts as those identified for Skip's Pond; however, the creation of the additional wetland areas would result from the conversion of upland habitats to wetlands and would not result in measurable impacts to surface water or wetland resources.

The Bird Pond Wetlands, Alternative 1B, would restore 3.17 acres of existing emergent wetland habitat and create an additional 3.25 acres adjacent to the existing wetland. The excavation required for the restoration of the existing wetland area would have the same temporary impacts as those identified above.

Although the Recommended Plan entails the excavation and re-contouring of portions of wetlands, the restoration would increase the habitat structure and diversity of the wetland resulting in a net increase in habitat quality by approximately 74 AAHUs.

5.2.8.4 Groundwater

The Mitchell Lake study area is located outside of the Edwards and Carrizo Wilcox Aquifer Recharge Zones; therefore, no measurable impacts on groundwater are anticipated from the No Action or Proposed Plan.

5.2.8.5 Water Quality

Implementation of the Proposed Action would directly impact surface waters in the study area through construction activities associated with excavation and contouring of wetland cells. During the construction period, these impacts are expected to temporarily degrade water quality as a result of ground disturbing activities. Erosion and sedimentation controls, such as silt fencing and sediment traps, the application of water sprays and the prompt revegetation of disturbed areas would be required during construction to reduce and control siltation or erosion impacts. In addition, every construction project poses a potential contamination risk from petroleum or chemical spills. The contractor would be required to prepare and follow a site-specific Spill Prevention Plan during construction, which would include use of BMPs such as proper storage, handling and emergency preparedness, reducing the risk of such contamination.

Impacts to surface waters following implementation of the proposed plans could have major beneficial impacts on water quality. The restoration and expansion of 148.85 acres of wetlands associated with the Recommended Plan increase the natural nutrient and pollutant filtering functions of the wetlands. This natural function is one of the ancillary benefits provided by the circulation of Mitchell Lake water through the Bird Pond Wetlands, the Central Wetlands, Skip's Pond, the drainage adjacent to the polder berms and Cove 1. Although the scale of these benefits may be relatively small, the proposed plan would be compatible with other FWOP water quality treatment methods in an integrated water quality program. Both the FWOP and FWP conditions will include SAWS' treatment wetlands, which will be downstream of Mitchell Lake and will be gravity fed with water from the lake. In turn, water that has been cycled through the northern chain of wetlands back into Mitchell Lake would eventually be released into SAWS treatment wetlands. It is anticipated that the Proposed Action will improve upon the current levels of TSS, DO and pH. Due to the amount of water quality degradation, it is assumed that the water released from Mitchell Lake through large storm events or prolonged wet periods could possibly impair water downstream of Mitchell Lake. This, however, is a FWOP condition that has the possibility of occurring with and without project implementation.

5.2.9 Visual Aesthetics

5.2.9.1 No Action Plan

Under the No Action Plan, there would be no changes to the visual landscape beyond those implemented by SAWS or the Audubon Society in the management of natural and water resources in the study area.

5.2.9.2 Proposed Action

Short-term impacts may occur where construction-related equipment, activities and dust could be visible to observers. Impacts would be anticipated in years in which construction is implemented. Plans that do not include construction of structures, would realize only temporary aesthetic degradation until the disturbed area blends in with the surrounding environment, at which time, it would be anticipated that the aesthetic value of the area would be improved over the existing condition.

Construction activities can introduce differing elements of form, line, color and texture into the landscape through construction or placement of constructed features such as roads, structures, equipment, or manipulation of vegetation. Effects can also result when actions change scenic integrity or result in conditions that produce unattractive landscapes.

Impacts associated with the proposed plans regarding aesthetics include visibility of construction disturbances, constructed structures and temporary roads. Vegetation clearing and/or placement of excavated material on upland sites before relocation would present an obvious contrast in color with the surrounding vegetation.

Temporary placement of staging areas, access roads and floating docks would be visually obvious until use of these is discontinued and the area naturally restores, or the structure is removed. Natural restoration would be expected to occur over a period of 1-5 years. Aesthetic degradation would decrease as the disturbed surface begins to blend in color, form and texture.

In general, restoration measures would have minor beneficial impacts to the aesthetic value of the area and pleasing to recreationists.

5.2.10 Recreation

5.2.10.1 No Action Plan

Under the No Action Plan, recreation within the study area will continue to improve. The Audubon Society management plan includes plans to improve upland wildlife habitats and improve trail access within the study area.

5.2.10.2 Proposed Action

Although the proposed plans may have a temporary adverse impact during construction by restricting pedestrian access to active construction sites, the overall recreation experience after construction would be improved as the improved habitat will support increased diversity and population sizes of birds and other wildlife. Any recreation features such as: boardwalks, trails, picnic areas and bird blinds will encourage the recreational use of the Mitchell Lake project areas. The improvement of 49.52 acres of mudflat habitat will attract shorebirds and other migratory birds. This will attract more birders as well as increasing overall recreation use of the project areas.

5.2.11 Biological Resources

Under NEPA, the significance of project impacts is a function of context and intensity. For biological resources, context refers to the importance (ecological, commercial, scientific, recreational, etc.) or regulatory (i.e., legally protected) status of the resource and intensity refers to the magnitude – scale and duration – of the impact. Both beneficial and adverse impacts are recognized; either can be significant. In the project area, the habitats of greatest importance are emergent wetlands and riparian habitat. Substantial long-term net changes in the acreage and/or value of these habitats would likely result in significant impacts.

Losses or gains of population and habitat for special status species may also be significant, depending on the magnitude of the impact relative to the population size and distribution of the species in the region.

Finally, an impact that led to new introductions or the expansion of invasive species in the study area would also be considered significant in terms of potential far-reaching effects on the ecosystem as a whole.

5.2.11.1 No Action Plan

Under the No Action Plan, there will be no added benefits to vegetative or wildlife habitat diversity. The spread of invasive species will most likely occur without proper management and will cause significant adverse impacts to the study area. The marginal existing native vegetation will continue to provide very poor wildlife habitat quality. SAWS and the Audubon Society will continue to manage the spread of invasive species and the Audubon Society is conducting grassland restoration on portions of the study area, but there are limited plans to improve aquatic habitats.

Although the polders and Mitchell Lake are polluted with residual sludge, they are not expected to have high impacts on existing wildlife species health. Fish are unable to survive within the waters of Mitchell Lake and the polders. This will continue with the No Action Plan. There have not been any reported wildlife kill-offs due to the water quality within the study area and they are not anticipated to occur within the next 50 years. The high nutrient loading within the lake and polders contributes to high invertebrate content as a waterfowl and waterbird food source. This variable has been an attractant for birds to continually rest in the area, regardless of poor habitat quality to sustain long-term energy levels.

5.2.11.2 Proposed Action

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

Plan 6 (Figure 100) 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

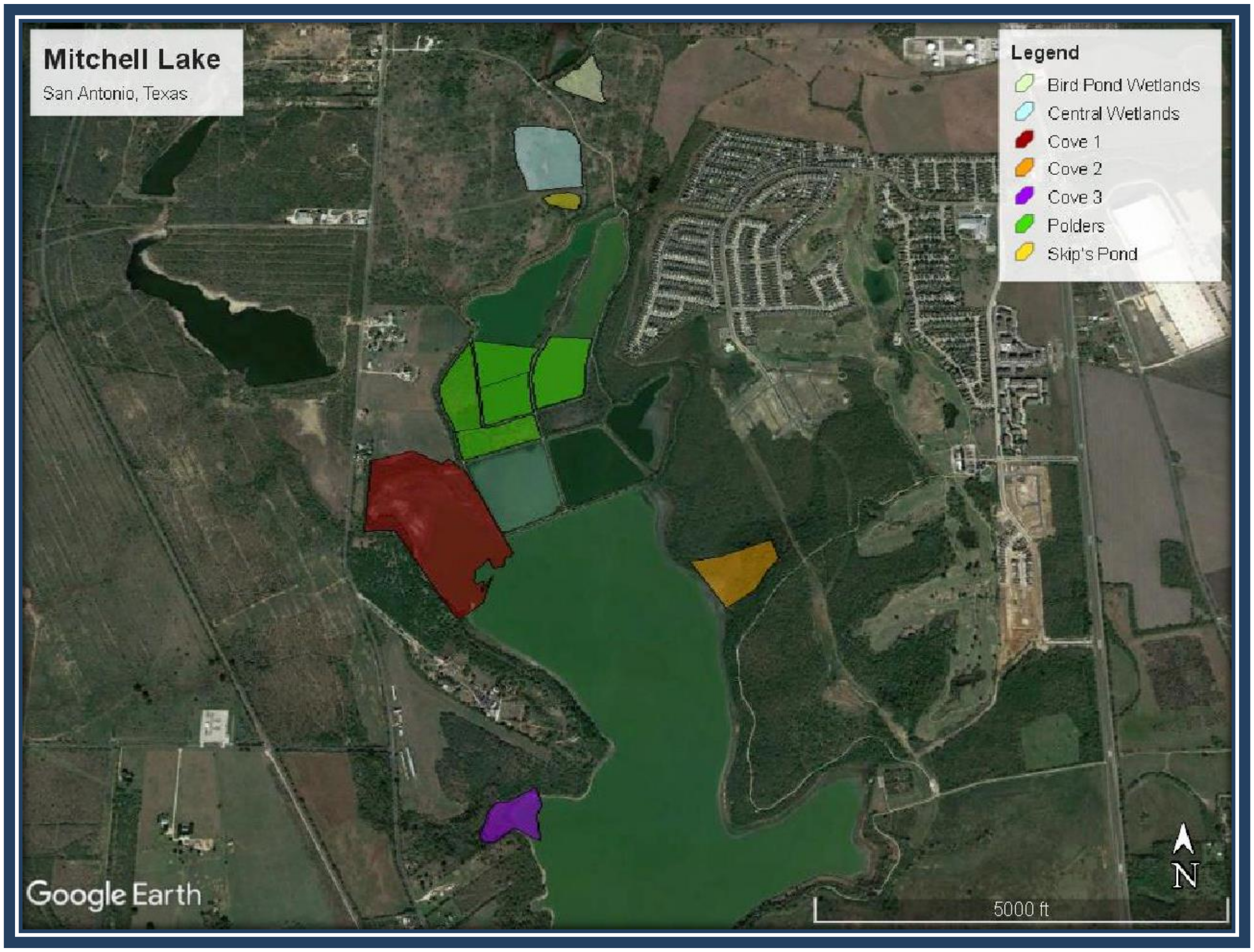

Figure 100 - Plan 6: Polders + Coves 1, 2 & 3 + 2B + 3 + 1B

5.2.11.3 Vegetation

The appropriate use of BMPs such as erosion control practices and tree protection devices at construction sites would protect existing high-quality trees and large blocks of high-quality vegetation/habitat adjacent to the construction areas. Temporary construction impacts to vegetation within staging areas are not anticipated since staging areas would be stationed in areas with very little vegetation and vegetative diversity. In which case, any vegetation permanently impacted by construction efforts will be for the purpose of wildlife habitat improvement. Installation of appropriate vegetation within the project area would provide connectivity for riparian forest and emergent/submergent, and emergent wetland habitats, more closely mimicking historical conditions. Approximately 99.33 acres of emergent and emergent/submergent wetlands will be planted within the project area, which should be hardier species to endure the poor water quality conditions of the lake (Table 54). Low quality and invasive species will be managed for removal as well. Efforts to restore native riparian and emergent wetland species through seeding, planting, prescribed burns and invasive species management within small areas of Coves 1, 2, and 3 will bring the environment closer to original conditions, in which case the vegetation structure and diversity is expected to increase in quality with the Proposed Action. The Proposed Action will have a long-term major beneficial impact on vegetation within the study area (Appendix C – Environmental Resources, Attachment K).

Table 54 - Recommended Emergent and Submergent Native Vegetation for Proposed Action

Name	*Scientific Name*	*Growth Form*
Squarestem spikerush	*E. quadrangulata*	Emergent
Tall burhead	*Echinodorus berteroi*	Emergent
Creeping burhead	*Echinodorus subcordatum*	Emergent
Slender spikerush	*Eleocharis acicularis*	Emergent
Flatstem spikerush	*Eleocharis macrostachya*	Emergent
Squarestem spikerush	*Eleocharis quadrangulata*	Emergent
Illinois pondweed	*Potamogeton illinoensis*	Submergent
American pondweed	*Potamogeton nodosus*	Submergent
Water stargrass	*Heteranthera dubia*	Submergent
Pecan	*Carya illinoinensis*	Riparian
American sycamore	*Platanus occidentalis*	Riparian
Live Oak	*Quercus virginiana*	Riparian

5.2.11.4 Wildlife

Where construction or disposal is proposed, there would be an increased level of human disturbance, such as noise, vehicular traffic and construction equipment, which could lead to temporary localized displacement of affected existing fish and wildlife populations. Mortality of fish or wildlife individuals is possible during the construction phase, but would be rare, as most species would avoid the areas of disturbance.

There would be major long-term major beneficial impacts on fish and wildlife populations from the implementation of the Proposed Action through geographic expansion and improved quality of their respective habitats. By restoring the Mitchell Lake project areas to more natural conditions, native fish populations could repopulate areas that have not been favorable for their existence or survival. Water quality improvements (resulting from planting 99.33 acres of wetland plantings) would improve habitat conditions for intolerant native species and would restore balance to the native tolerant/native intolerant species over time.

The overall increase of approximately 74 AAHUs due to the restoration of wetland vegetative structure and mudflat habitat would provide additional wildlife habitat (food, shelter and reproductive resources) for small mammals, amphibians, reptiles and birds (Appendix C – Environmental Resources, Attachment K).

5.2.12 Federally Listed Threatened and Endangered Species

The migratory birds: golden-cheeked warbler, least tern, piping plover, red knot and whooping crane, have the possibility of occurring in the Project Area before and after project implementation. However, these occurrences will most likely be limited to stopover use during migration. Quality stopover habitat is essential for migratory birds. The quality and quantity of natural stopover habitat within growing urban areas is decreasing due to the destruction of habitat for development and the spread of invasive species. Stopover habitat is essential for birds during migration, because these areas can provide food and shelter for the birds to refuel and rest. Close coordination among the USACE, USFWS and TPWD would continue as part of overall management of the project area and normal operations and maintenance activities for Mitchell Lake. The Proposed Action could cause short-term minor adverse impacts within the construction area. However, every effort will be made to avoid all contact with threatened and endangered species. After completion of construction and establishment of wetland and riparian plantings, the area will return to normal. The effects of effectively managing 148.85 acres of wetland and mudflat habitat will cause major long-term beneficial impacts for species by returning original habitat conditions, as best as possible and regulating habitat for shorebirds.

The Proposed Action would cause minor beneficial impacts to threatened or endangered species habitat within the study area. The Proposed Action would not cause any adverse impacts to federally listed threatened and endangered species. Although core habitat for the threatened and endangered birds listed above is not available within the study area, the Proposed Action has the potential to create the habitat conditions necessary for federally listed bird species. Should federally listed species change in the future, associated requirements will be reflected in construction efforts in coordination with the USFWS. The Recommended Plan is expected to have “no effect” on all of the federally listed threatened and endangered species with the chance to occur within the project area. A Letter of Concurrence stating “there are no federally listed species within the current project area; therefore no adverse effects to listed species are expected to occur with implementation of the proposed action” can be located in Appendix C – Environmental Resources, Attachment B.

5.2.13 Migratory Birds

Many important habitats in the focused study area provide migratory bird shelter, nesting, feeding and roosting habitat. All adverse impacts to migratory birds would occur during construction and cease post-construction. Significant beneficial impacts to migratory birds would be expected from ecosystem restoration measures. Restoration of wetlands, riparian and mudflat areas would result in an overall net increase in functional value and ultimately support larger populations of species and potentially increase species diversity.

During construction, there is a potential for harm and/or harassment of nesting migratory birds. Attempts would be made to conduct all restoration activities outside of the nesting season; however, this may not be possible, due to the extended length of the nesting season for some species. Prior to construction commencing, if during the nesting season, nest surveys should be completed. Coordination with USFWS should be completed prior to construction if nesting has been identified and USFWS guidelines should be followed to avoid adverse impacts to these species. By implementing these conservation measures, there should be no adverse effects to migratory birds. There will be major beneficial impacts to migratory birds as a result of the Proposed Action. The Proposed Action will provide crucial stopover habitat for migratory birds during migration. By improving the quality and quantity of habitat within the Central Flyway, the

Proposed Action incorporates measures that ensure the success of migration by providing food to sustain the birds during their migration and safe places to rest (Appendix C – Environmental Resources, Attachment E).

Implementation of the Proposed Action would comply with the Migratory Bird Treaty Act and EO 13186, Responsibility of Federal Agencies to Protect Migratory Birds.

5.2.14 Invasive Species

As with any ground-disturbing activity, the probability of introducing, spreading and/or establishing new populations of invasive, non-native species, particularly plant species, exists. Contractors would be required to clean all equipment prior to entering the construction area to avoid the spread of invasive species into the project area.

Areas that are expected to have high rates of erosion, are susceptible to invasive species establishment, or where recruitment of a monoculture is anticipated, would be vegetated with native species. Post-construction and plantings, if needed, each restoration unit would be monitored for invasive species and action taken to prevent establishment of any species.

EO 13112, Invasive Species, dated February 3, 1999, directs federal agencies to expand and coordinate their efforts to combat the introduction and spread of invasive species (i.e., noxious plants and animals not native to the U.S.). Implementation of BMPs such as cleaning equipment prior to entering restoration units and monitoring post construction for invasive species would prevent further spread of invasive species. Implementation of any of the action plans would comply with EO 13112 (Appendix C – Environmental Resources, Attachment K).

A healthy ecosystem with plentiful species diversity will help deter the spread and establishment of invasive species.

5.3 Cultural Resources

The USACE recommends intensive Section 106 cultural resource investigations to identify and evaluate any historic properties within proposed construction areas. The scope of these investigations will be determined in consultation with the Texas State Historic Preservation Officer and appropriate Native American Tribal Nations in accordance with the Programmatic Agreement developed for cultural resources for this study (Appendix D – Cultural Resources).

Section 106 (16 U.S.C. 470f) of the National Historic Preservation Act of 1966, as amended, (NHPA) requires that Federal agencies consider their undertakings, or projects and the potential of those undertakings to impact significant cultural resources through the procedures found in 36 Code of Federal Regulations (CFR) Part 800 (Protection of Historic Properties). To fully consider the effects of a proposed project on cultural resources, USACE must consult with the Texas State Historic Preservation Office (SHPO) and federally recognized Native American tribes who have traditionally or historically used the area affect by the proposed action. USACE initiated consultation with the SHPO and appropriate Native American tribes in 2018.

5.3.1 No Action Plan

Under the No Action Plan, cultural resources would not be impacted by the USACE undertaking. Any significant cultural resources will remain deeply buried and protected. Overall, no known measurable impacts to cultural resources would occur.

5.3.2 Proposed Action

Activities associated with the TSP include all new construction, improvements and maintenance activities. The preliminary APE includes the maximum horizontal footprint of all areas of direct and indirect impacts from the excavation and construction of wetlands, construction of water control structures, wetland plantings, berm construction and all terrestrial horizontal and vertical ground disturbance activities (Figure 101). No known terrestrial archaeological sites are within the Recommended Plan.

The Recommended Plan does not impact known historic properties listed in Table 15 based on background research; however, with the recommended plan not beingpreviously culturally surveyed to identify historic properties, pursuant to 36 CFR 800.4; thepotential to encounter newly identified historic properties is high.

The USACE will ensure, prior to construction, that intensive Section 106 cultural resource investigations to identify and evaluate any identified historic properties within proposed construction areas are performed, with the results being consulted on with the Texas SHPO and appropriate Tribal Nations. Further, any building, structure and/or object encountered during the proposed cultural resource investigations will be evaluated for potential inclusion in the NRHP, to include assessing its overall significance in the historic Mitchell Lake complex-specifically looking at those polders that are captured as part of the Recommended Plan.

Known terrestrial archaeological resources previously identified and recorded within the focused study area are primarily prehistoric in nature; however, some historic archaeological sites were previously identified and recorded (Figure 101). It is unknown what types of terrestrial archaeological resources will be encountered when the final developed APE is culturally surveyed to identify historic properties, but there is a potential to encounter both prehistoric and historic terrestrial archaeological resources based on background research.

A Programmatic Agreement (PA) is a Federal Agency program alternative, pursuant to 36 CFR § 800.14(b), used when a Federal Agency wants to create a Section 106 process that differs from the standard review process outlined in 36 CFR Part 800, of the regulations implementing Section 106 of the National Historic Preservation Act (NHPA) (54 U.S.C. § 306108). The USACE executed the PA in Appendix D to ensure that once the horizontal and vertical extent of the undertaking has been finalized, the PA process will be implemented. The PA outlines the process by which the USACE will define the Area of Potential Effects (APE), perform a cultural resource survey of the APE to identify prehistoric/historic archaeological sites and buildings, structures and objects (BSO) and evaluate any identified archaeological site and/or BSO for potential inclusion in the NRHP as historic properties (i.e., identified properties determined to be eligible for listing in the NRHP). Further, the PA outlines the process for assessing effects, making an effects determination and consultation with the TX SHPO and appropriate Tribal Nations. The USACE will be implementing the PA in Appendix D prior to the project's construction, engineering and design phase to ensure compliance with Section 106 of the NHPA.

Texas SHPO and Native American Tribal Nation consultation has been occurring throughout the planning process for this study, with all comments received addressed appropriately. The scope of these cultural resource investigations will be determined in consultation with the Texas SHPO and appropriate Native American Tribal Nations in accordance with the Programmatic Agreement developed for this study (Appendix D – Cultural Resources).

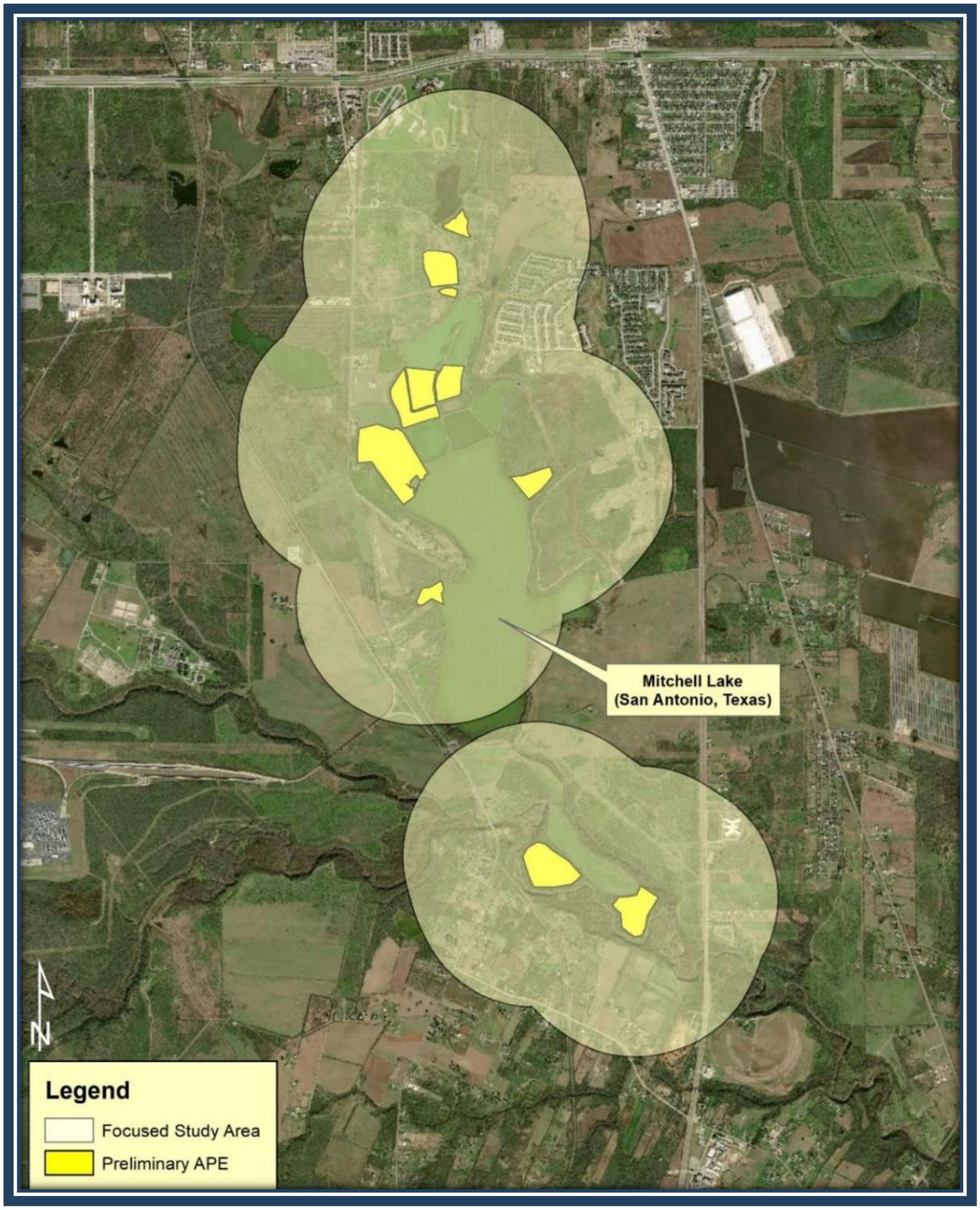

Figure 101 - Cultural Resources Study Area

Table 55 - Summary of Potential Effects Cultural Resources of the Recommended Plan

	In-depth evaluation conducted	Brief Evaluation due to minor effects	Resource unaffected by action
Historic properties-Desktop evaluation only	☒	☐	☐
Other cultural resources-Desktop evaluation only	☒	☐	☐

5.4 Environmental Engineering

5.4.1 Hazardous Materials

5.4.1.1 No Action Plan

Under the No Action Plan, no hazardous, toxic, or radioactive waste would be uncovered as there would be no future dredging of the lake or polders. Although these substances will continue to degrade current water and habitat quality.

5.4.1.2 Proposed Action

No anticipated measurable impacts are expected by implementation of the Proposed Action. The exposure of any unanticipated hazardous material unearthed during excavation activities would be dealt with in a manner consistent with ER 1165-2-132 Hazardous, Toxic and Radioactive Waste Guidance for Civil Works Projects. Because the polders will not be excavated or graded, it is assumed that exposure of hazardous materials will be avoidable.

To minimize potential impacts from hazardous and regulated materials during construction, all fuels, waste oils and solvents would be collected and stored in tanks or drums within a secondary containment system that consists of an impervious floor and bermed sidewalls capable of containing the volume of the largest container stored therein.

The refueling of machinery would be done following accepted guidelines and all vehicles would have drip pans, when not in use, to contain minor spills and drips. Although it would be unlikely for a major spill to occur, any spill of five gallons or more would be contained immediately within an earthen dike and the application of an absorbent (e.g., granular, pillow, sock, etc.) would be used to absorb and contain the spill. Any major spill of a hazardous or regulated substance would be reported immediately to SAWS and USACE environmental personnel who would notify appropriate Federal and State agencies.

Additionally, all construction personnel would be briefed as to the correct procedures for preventing and responding to a spill. All waste oil and solvents would be recycled if practicable. All non-recyclable hazardous and regulated wastes would be collected, characterized, labeled, stored, transported and disposed of in accordance with all Federal, State and local regulations, including proper waste manifesting procedures. A Spill Prevention Plan would be in place prior to the start of construction and all personnel shall be briefed on the implementation and responsibilities of this plan. Adoption and full implementation of the construction measures described above would reduce adverse hazardous/regulated substances impacts to insignificant levels.

NOTE: HTRW is not a known issue for this project. Further HTRW sampling of the polders may be warranted during the PED phase (Appendix E – HTRW, Chapter 4). However, should hazardous materials be discovered during construction, SAWS shall be responsible for ensuring that the development and execution of federal, state and / locally required HTRW response actions are accomplished at 100% non-federal expense. No cost sharing credit will be given for the cost of response actions.

5.5 Geotechnical Engineering

Geotechnical studies tailored to provide necessary and sufficient data for implementation of the Recommended Plan will be carried out during the Planning, Engineering and Design Phase. Studies will include subsurface investigations including soils characterization, to ensure that structural elements of the Recommended Plan are biddable, constructible, operable and environmentally feasible (Appendix I – Geotechnical Engineering, Chapter 4).

5.6 Socioeconomics and Environmental Justice

EO 12898 directs Federal agencies to determine whether their programs, policies and activities would have a disproportionately high or adverse effect on minority or low-income population groups within the Project Area.

5.6.1.1 No Action Plan

Under the No Action Plan, there would be no measurable impacts to the socioeconomic environment surrounding the Mitchell Lake study area.

5.6.1.2 Proposed Action

The Proposed Action would not result in the relocation of any residences or businesses. Therefore, there would be no measurable impacts to environmental justice populations and the proposed project would be consistent with EO 12898.

6 Cumulative Effects of the Recommended Plan

The CEQ regulations define a cumulative impact as an effect which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions (40 CFR Section 1508.7). Relatively minor individual impacts may collectively result in significant cumulative impacts. Project-related direct and indirect impacts must be analyzed in the context of non-project-related impacts that may affect the same resources. Cumulative impacts are the incremental impacts that the project's direct or indirect impacts have on a resource in the context of other past, present and future impacts on that resource from related or unrelated activities.

Unlike direct impacts, quantifying cumulative impacts may be difficult since a large part of the analysis requires forecasting future trends of resources in the study area and future projects that may affect these resources.

The initial step of the cumulative impacts analysis uses information from the evaluation of direct and indirect impacts in the selection of environmental resources that should be evaluated for cumulative impacts. The proposed action would not contribute to a cumulative impact if it would not have a direct or indirect effect on the resource. Similarly, the CEQ guidance recommends narrowing the focus of cumulative impacts analysis to important issues of national, regional, or local significance. Therefore, the Cumulative Impact Analysis for Mitchell Lake was focused on those resources that were substantially, directly, or indirectly, impacted by the study and resources that were at risk or in declining health even if the direct/indirect impacts were insignificant.

The resources considered for cumulative impacts assessment include Visual Aesthetics, Recreation, Water Resources and Biological Resources. These resources would be directly and/or indirectly, impacted by the Mitchell Lake Aquatic Ecosystem Restoration project.

6.1 Visual Aesthetics

Areas under construction or areas that are being considered for restoration activity are ecologically impoverished and perceived as aesthetically displeasing. Restoration activities that improve the heterogeneity and complexity of the natural environment would have beneficial impacts to the aesthetics of the Mitchell Lake study area. Any impacts caused by the grading and clearing necessary for wetland creation could have minor adverse impacts to aesthetics within the area but will be temporary.

The cumulative impacts to aesthetics of past, present, or reasonably foreseeable projects when considered with the impacts of the Proposed Action would be moderately beneficial.

6.2 Recreation

Recreation is a vital component to the sustainability of any urban restoration project. Almost all the areas have the potential for passive recreation features, meaning that while perhaps remotely accessible, persons could have the opportunity to view and interact with the natural resources of the area. Potential impact to the trails parallel to Mitchell Lake and birding opportunities around the Polders, uplands and grasslands during construction could have minor adverse impacts to recreational resources within the area. However, the plethora of recreation opportunities within San Antonio leads to negligible effects during this short timeframe.

The cumulative impacts to recreation after completion of construction to recreation of past, present, or reasonably foreseeable projects when considered with the impacts of the Proposed Action would be moderately beneficial.

6.3 Water Resources

Past impacts to Mitchell Lake habitats are documented in Chapter 3, Water Resources. Wetland habitats in Texas have been lost due to demand for natural resources, agriculture, urbanization and the introduction of non-native invasive species. The conservation of water resources in Bexar County continues to be a priority and initiatives by San Antonio, SARA, SAWS, Bexar County, TPWD and non-profit organizations such as the Mitchell Lake Audubon Society are making progress in increasing the extent of restored and protected aquatic habitats including wetland and riverine habitat. Although future restoration and conservation initiatives will undoubtedly continue, San Antonio and Bexar County are one of the top ten growth centers in the US. As a result, urban pressures would continue to encroach on the county's suburban and rural aquatic ecosystems. Because of projected future population growth and subsequent urbanization, the sustainability and ecological viability of aquatic habitats for fish and wildlife as well as human uses, highlights one of the greatest ecological needs of the county. The Proposed Action would effectively provide up to 99.33 acres of restored or created wetland habitat and approximately 49.52 acres of mudflat habitat with essential connectivity along a critical stopover corridor for the birds utilizing the Central Flyway (Table 56).

Table 56 – Approximate Increase of Mudflat and Wetland Habitat Acres by Restoration and Creation for Each Best Buy Plan

Plan	Mudflat Habitat Increase (Acres)	Emergent / Submergent Wetland Habitat (Acres)	Emergent Wetland Habitat (Acres)	Forested Wetland Habitat (Acres)
Plan 1: No Action	0.00	0.00	0.00	0.00
Plan 2: Polders	49.52	0.00	0.00	0.00
Plan 3: Polders + 7D	49.52	65.52	0.00	0.00
Plan 4: Polders + 7G	49.52	72.36	0.00	0.00
Plan 5: Polders + 7G + 3 + 2B	49.52	74.54	18.37	0.00
Plan 6: Polders + 7G + 3 + 2B + 1B	49.52	74.54	24.79	0.00

Plan	Mudflat Habitat Increase (Acres)	Emergent / Submergent Wetland Habitat (Acres)	Emergent Wetland Habitat (Acres)	Forested Wetland Habitat (Acres)
Plan 7: Polders + 10 + 7G + 3 + 2B + 1B	49.52	74.54	43.79	0.00
Plan 8: Polders + 10 + 7G + 3 + 2B + 1B + 9B	49.52	74.54	43.79	4.00

Planting native emergent and submergent wetland vegetation has the ancillary benefit of augmenting water quality at Mitchell Lake. Although these benefits will be focused in Mitchell Lake, the occasional large storm event allows water to flow out of the uncontrolled spillway east of the dam (Figure 8 and Figure 9). The water that flows from Mitchell Lake enters Cottonmouth Creek, which has a confluence with the Medina River. The Medina River then meets the San Antonio River and eventually feeds into the Guadalupe River ~10 miles from San Antonio Bay on the Gulf of Mexico.

The cumulative impacts to aesthetics of past, present, or reasonably foreseeable projects when considered with the impacts of the Proposed Action would be moderately beneficial.

6.4 Biological Resources

Fish and wildlife inhabiting Mitchell Lake and the surrounding areas prior to its utilization as a raw sewage disposal site would have consisted of a diverse community of native invertebrate, fish, amphibian, reptile, mammal and bird species. As the habitat within the study area degraded, wildlife species intolerant of such impacts such as the Texas tortoise (*Gopherus berlandieri*), indigo snakes (*Drymarchon couperi*), bobcat (*Lynx rufus*) and black bear (*Ursus Americana*) migrated out of the area over time and tolerant species such as raccoons (*Procyon lotor*), opossums (*Didelphis virginiana*) and great-tailed grackles (*Quiscalus mexicanus*) now thrive. The aquatic habitat that supported a diverse community of amphibians and aquatic invertebrates disappeared, further reducing wildlife diversity in this area of San Antonio. Finally, the introduction of non-native wildlife species such as feral hogs and nutria rats and vegetative species such as Johnsongrass (*Sorghum halepense*), Bermudagrass (*Cynodon dactylon*) and giant cane (*Arundo donax*) that have reduced habitat values, placed increased demands on scarce wildlife resources and resulted in the non-native species out-competing native species.

In the earlier discussion of direct impacts of the proposed actions, significant beneficial effects were recognized that improve habitat not only for migratory birds and other upper tier trophic species, but more importantly for lower trophic level organisms that support the more visible and mobile species.

As further discussed, these beneficial impacts are not limited to the Mitchell Lake study area but expand further into the San Antonio River Basin. For migratory birds, the benefits of the proposed Mitchell Lake habitats might be realized several thousand miles away after the successful breeding and fledging of young on the arctic tundra.

The Recommended Plan alone cannot ensure the continued survival and existence of migratory birds and other organisms depending on wetland and mudflat resources in the southwest.

However, the Recommended Plan can contribute to the cumulative conservation, preservation and restoration efforts underway both locally, regionally, nationally and internationally. Locally, previous and ongoing restoration efforts on the San Antonio River at Eagleland, Mission Reach and WSCs will improve migratory bird habitats in the San Antonio area. Additional conservation efforts in the region, including the implementation of the Southern Edwards Plateau Habitat Conservation Plan, conservation easements initiated by non-governmental conservation organizations and international initiatives such as the PIF and Joint Ventures, will continue to provide pieces of the migratory bird habitat puzzle that will ensure migratory birds have the resources to complete migration and successfully breed and fledge young.

The cumulative habitat incorporated into these migratory bird conservation efforts are predicated on the establishment of the lower trophic levels by ensuring that aquatic and riparian habitats properly function ecologically.

6.5 Irreversible and Irretrievable Commitment of Resources

NEPA 40 CFR 1502.16 requires that environmental analysis include identification of “any irreversible and irretrievable commitments of resources which would be involved in the Proposed Action should it be implemented.” Irreversible and irretrievable resource commitments are related to the use of nonrenewable resources and the effects that the use of these resources have on future generations. Irreversible effects primarily result from use or destruction of a specific resource (e.g. energy and minerals) that cannot be replaced within a reasonable period. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored because of the action (e.g. extinction of a threatened or endangered species or the disturbance of a cultural site).

The Proposed Action would result in the direct and indirect commitment of resources. These would be related mainly to construction components. Energy typically associated with construction activities would be expended and irretrievably lost under the Proposed Action. Fuels used during the construction and operation of dredging equipment, barges, placement equipment (e.g. bulldozers, backhoes, marsh buggies, etc.) and support vehicles would constitute an irretrievable commitment of fuel resources. Capital and labor resources, as well as, stone material would also be considered an irretrievable and irreversible commitment of resources. The use of such resources would not adversely affect the availability of such resources for other projects both now and in the future.

For the Proposed Action, most resource commitments are neither irreversible nor irretrievable. Benthic communities would be removed and lost along with sediment during excavation and placement operations. Benthic communities would also take several years to recover. Slow moving or non-motile fish, wildlife, invertebrates and plant (aquatic and terrestrial) species would be entrained in the materials during excavation or smothered during placement of excavated materials. These losses would be irretrievable as well. However, most impacts to the species’ population, would be insignificant. These impacts would only occur during construction.

No other impacts, such as water resources, existing land uses, or visual resources, have been identified which could result in irreversible or irretrievable commitments of resources which would preclude implementation of the Proposed Action.

6.6 Indirect Effects

Indirect effects, as defined by the CEQ's regulations, are "caused by the proposed action and occur later in time or farther removed in distance but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate and related effects on air and water and other natural systems, including ecosystems" (40 CFR 1508.8). Indirect effects differ from direct impacts associated with the construction and operation of the proposed project and are caused by an action or actions that have an established relationship or connection to the proposed project. However, indirect effects can be linked to direct effects in a causal chain, which can be extended as indirect effects that produce further consequences.

As previously discussed, implementation of the proposed action would directly result in a net beneficial impact to Mitchell Lake and the associated vegetation and wildlife. In addition, the proposed Mitchell Lake ecosystem restoration measures would result in benefits that extend further outside the study area for several notable environmental resources. These benefits would increase over time as the Mitchell Lake habitats develop and mature.

The indirect effects were examined for the study area as identified in Figure 5. As discussed below, even though portions of the indirect effects study area are located outside the proposed Mitchell Lake restoration limits, these areas would receive ecological benefits resulting from restoration activities.

The establishment of native plant species in the study area and the removal and control of nonnative, invasive species provides significant indirect benefits. The seed production of the vegetation in the study area can be transported downstream, during high water events and deposited in the Medina River banks. Under the No Action Alternative, these seeds would generally be comprised of non-native invasive species resulting in the further spread of these species. With implementation of the Recommended Plan, the seed source would generally be comprised of native species adapted to the conditions of the surrounding landscape. The improved aquatic habitats of Mitchell Lake would improve water quality downstream as the wetland vegetation would filter pollutants and sediments.

6.7 Cultural Resources

In assessing cumulative effects on known historic properties (or properties that are treated as eligible until formal evaluation by SHPO/appropriate Tribal Nations) within the focused study area there is the potential for cumulative effects from future habitat/wetland delineation, Audubon development and oil well drilling/gas pipeline construction. Future planning around Mitchell Lake by SAWS should make a reasonable and good faith effort to account for adverse effects that are reasonably foreseeable, may occur later in time, be farther removed in distance, or cumulative and appropriately avoid or mitigate them.

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7 Plan Implementation

The Recommended Plan at the Final Report is Plan 6. This Plan provides three distinct habitat types (emergent wetlands, submergent/emergent wetlands and mudflats). The Bird Pond Wetlands and Central Wetlands are attributed to emergent wetlands. Skip's Pond and Coves 1, 2 and 3 are attributed to submergent/emergent wetlands while the Polders are attributed to mudflat habitat.

Description of Selected Plan

Plan 6 provides 49.52 acres of mudflat habitat, 74.54 acres of emergent/submergent wetland habitat and 24.79 acres of emergent wetland habitat for a total of approximately 148.85 acres or restoration.

Habitat Features

1. Bird Pond Wetland, scale 1B (6.42 acres)
    a. Creates 6.42 acres of emergent wetlands
    b. 17,000 CY cut, 12,000 CY fill
    c. Drainage channel and water control structure (south) to connect to Central Wetlands
2. Central Wetland, scale 2B (18.37 acres)
    d. Creates 18.37 acres of emergent wetlands
    e. 29,600 CY cut, 26,000 CY fill
    f. Water control structure in the middle to connect to Bird Pond and Skip's Pond
3. Skip's Pond (2.18 acres)
    g. Creates 2.18 acres of emergent / submergent wetland
        a. Approximately 0.6 acres of submergent wetland vegetation
        b. Approximately 1.58 acres of emergent wetland vegetation
    h. 9,350 CY estimated excavation
4. Polders (49.52 acres)
    i. Creates 49.52 acres of mudflat habitat
    j. Construction of four berms (two in West Polder, one in East Polder and one with Basin 1). Total volume of fill for berms is 16,800 CY.
    k. Water control structures in East and West polders and Basin 1
5. Coves 1, 2 and 3, scale 7G (72.36 acres)
    l. Creates 72.36 acres of emergent / submergent wetlands and riparian habitat
        a. Approximately 22.4 acres of submergent wetland vegetation
        b. Approximately 49.7 acres of emergent wetland vegetation
    m. Construction features are native plantings.
    n. Small riparian planting areas intermixed with vegetation for buffering along shoreline

6. A 2-mile long, 10-inch pipeline is proposed to supply water from Mitchell Lake Polders to the upper chain of wetlands (Bird Pond, Central Wetlands and Skip's Pond).
7. Bird Blinds are added throughout the project area to add habitat value at low cost. Total count is six.

Recreation Features (Figure 93)

1. additional trails from Bird Pond to Skip's Pond – 2 miles
2. boardwalks at Polders
3. trailheads near new Bird Pond
4. trailhead near Skip's Pond
5. bird Blinds near Polders and Northern Chain of improved wetlands

7.1 Real Estate

Mitchell Lake is owned by the City of San Antonio and managed by the San Antonio Water System (SAWS). SAWS is a municipally owned utility and constituent unit of the City of San Antonio. Complete management and control of SAWS is vested in a Board of Trustees consisting of the Mayor and six members who are appointed by the San Antonio City Council. The mayor of San Antonio serves as an ex-officio voting member. The general operations of the utility are under the supervision of the President/Chief Executive Officer. Because SAWS is owned by the City of San Antonio, all property is owned in the name of the City of San Antonio for exclusive use by SAWS.

All the ecosystem restoration project lands will be acquired in fee for a total of 152.58 acres (Table 57). Approximately 2.0 acres of temporary easements will be required for the construction and staging. Approximately 1.2 acres of utility easement will be required for the waterline that will bring additional water from the polders to the Bird Pond Wetlands. This water utility line will cross an existing pipeline easement. USACE Real Estate and Office of Counsel have reviewed the easement document pertaining to said pipeline easement, the pipeline easement permits other utilities to be constructed across, but not parallel with the pipeline. Therefore, USACE has informed SAWS to coordinate with the pipeline holder in order to establish the best way for the new water line utility to be constructed. USACE believes that SAWS will not have to obtain permission, as the right to construct utilities across the existing pipeline was reserved to the Grantor in the easement (Appendix F – Real Estate).

Table 57 - LERRDs Required

AREA	ESTATE	ACRES	TRACTS
Area 1: Bird Pond Wetlands	Wetlands – Fee, Excluding Minerals with restriction of surface	6.42	1
	Drainage – Fee, Excluding Minerals with restriction of surface	0.53	1
Area 2: Central Wetlands	Fee, Excluding Minerals with restriction of surface	18.37	1

Area 3: Skip's Pond	Fee, Excluding Minerals with restriction of surface	2.18	1
Area 6: Polders	Fee, Excluding Minerals with restriction of surface	49.52	5
AREA	**ESTATE**	**ACRES**	**TRACTS**
Area 7: Coves	Fee, Excluding Minerals with restriction of surface	72.36	3
Temporary Construction Easements		2.00	1
Utility Easement (waterline)		1.20	1
	GRAND TOTAL	**152.58**	**14**

7.1.1 Sponsor's Authority to Participate

It is the opinion of USACE Office of Counsel that the San Antonio Water System does have the authority to serve as the NFS, despite their inability to hold title to the subject properties. All the project identified areas fall within lands already owned by the City of San Antonio, however, some surface right restrictions will be needed from mineral owners. The areas currently owned by the City of San Antonio include the Bird Pond Wetlands, Central Wetlands, Skip's Pond, the Polders and the Fringe Wetlands.

7.1.2 Non-Federal Sponsor's Financial Capability

SAWS can accomplish the required real estate tasks associated with this project. A capability assessment checklist has been drafted and is included at the end of the REP. The sponsor has been advised of the Uniform Act requirements and the requirements for documenting expenses for credit purposes. It is not anticipated that the Corps of Engineers will be requested to perform any LERRD acquisition unless eminent domain involving an entity such as a railroad company proves necessary.

SAWS can accomplish the required operations and maintenance tasks associated with this project.

7.1.3 Minerals and Timber

The City of San Antonio does not currently own the mineral rights for the Bird Pond Wetlands, Central Wetlands and Skip's Pond areas. We are recommending and have informed the NFS that they will be required to restrict the surface rights from the mineral rights holder for the project identified lands by restricting the mineral owner's use of the surface and subordinating the mineral estate for SAWs to have the right to flood the project lands to proceed forward with the project as the footprint exists at this time. The NFS has adequate water rights to support the recommended plan. No real property water rights will be acquired by the NFS.

An initial review of the Texas Railroad Commission's GIS Viewer of oil and gas wells in Bexar County did reveal activity of mineral production within the project area, more specifically within the Central Wetland and Bird Pond areas only (Figure 102). Within the Central Wetland area there is one plugged well, one permitted location and several active wells within the vicinity of the project area. Also, within the Bird Pond area there appeared to be multiple active wells within the project area. USACE contacted TRRC after viewing the area from Google Earth and noticing that the wells may have been plotted incorrectly on the TRRC GIS viewer. TRRC, investigated the location of the wells specifically in the proposed Bird Pond area. Upon investigation, the well locations were moved and are now located along what appears to be access roads visible in aerial imagery. The non-Federal sponsor will be required to restrict the surface rights of the mineral rights holder within the project identified areas. Figure 102 below shows the numerous active, plugged, abandoned, permitted and dry well locations plotted from the Railroad Commission of Texas GIS viewer.

Sponsor will be required to obtain a surface rights waiver for all the project lands. The estimated cost to obtain the surface rights waiver for the project lands has been quoted from $10,000 to $50,000 plus. According to information obtained from the Texas Railroad Commission the average cost to cap a well in the State of Texas is $4,500 (Appendix F – Real Estate).

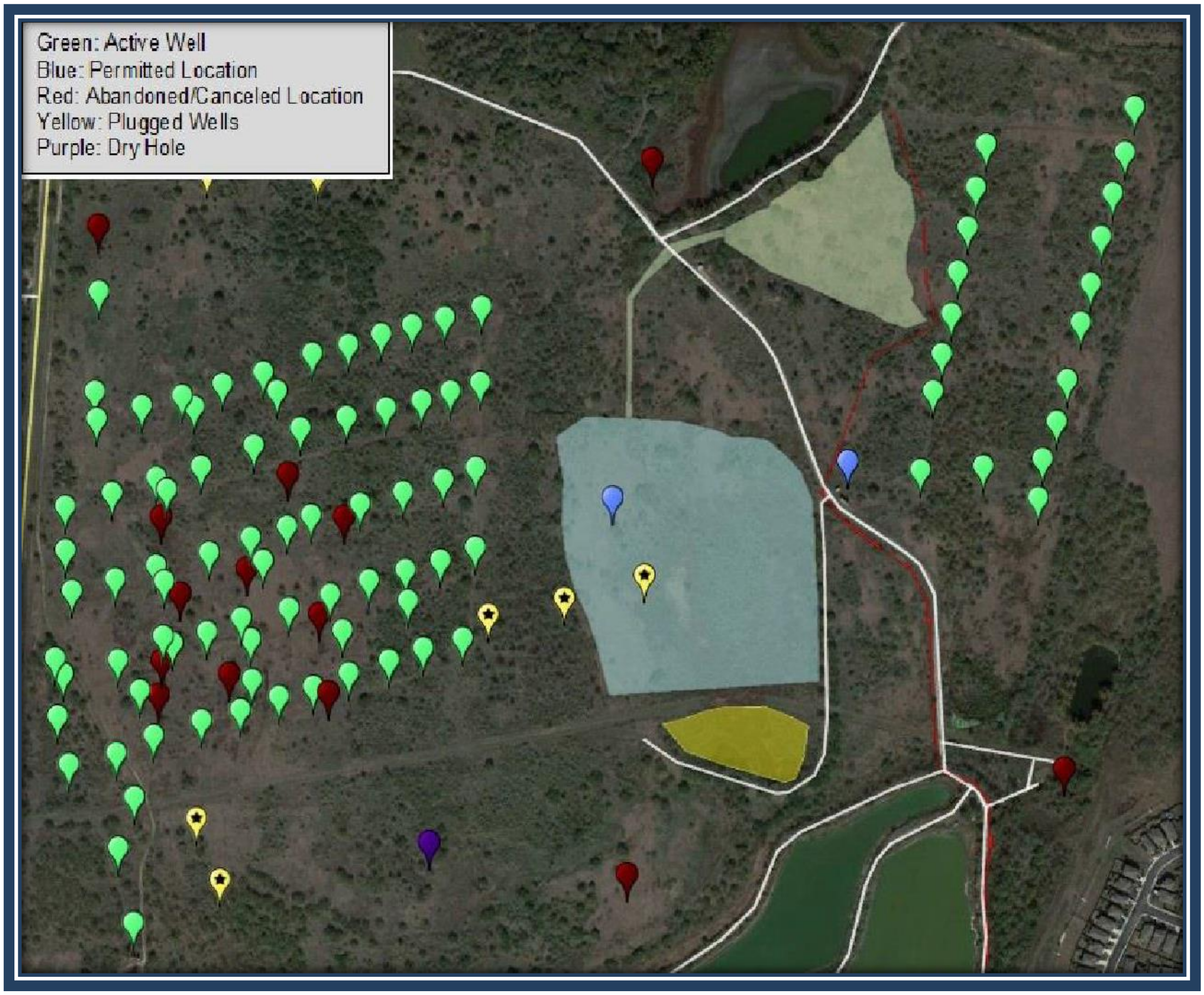

Figure 102 – All Oil and Gas Well Sites Within Project Area

A preliminary analysis by the Fort Worth District Forester indicates that some merchantable timber may be located on the subject properties, but not of enough quantity to be economically harvested.

7.1.4 Utility and Facility Relocations

The Civil Design Appendix should be referenced, regarding all roads or utility relocations. No facility or utility relocations are anticipated; however, the Government will make a final determination of the relocations necessary for the construction, operation, or maintenance of the project after further analysis, completion and approval of the Final Attorney's Opinions of Compensability for each of the impacted utilities and facilities. Cost estimates for the relocation of water lines, sanitary lines, gas lines, telephone lines and electric lines can be found in the Cost/Spec Analysis Appendix. There does not appear to be any relocation of utility and facilities currently. However, it should be noted that if an active well is later found to be within any of the proposed project lands there will be a need to cap the active well within any of the project lands. The approximate cost to cap a well was obtained from the Texas Railroad Commission website with an estimated cost of $4,500 per well.

7.1.5 Borrow and Disposal

Material excavated from within the wetland areas will be used onsite as fill in Area 6 of the project. Should there be any excess excavated material, it will be disposed of in an area owned by the NFS, following HTRW testing. If any of the excavated material is contaminated, it will be disposed of commercially. Should any borrow material need to be purchased for the project, it will be bought from a commercially available site. The contractor is not to acquire property for the use of borrowed material or disposal of excavated material. All the project LERRD is within the 100-year floodplain. As such, all the project areas are vacant, floodplain, open space properties.

7.2 Design and Construction Considerations

- construction occurs between 2023 and 2024
- The Non-Federal Sponsor shall be responsible, as between the Government and the Non-Federal Sponsor, for the costs of HTRW cleanup and response, including the costs of any studies and investigations necessary to determine an appropriate response to the contamination as stated in the Project Partnership Agreement. Such costs shall be paid solely by the Non-Federal Sponsor without reimbursement, or credit, by the Government.

7.2.1 Design and Schedule Risks

An Abbreviated Risk Analysis was performed in January of 2020 (Table 58). No non-typical risk elements were identified by the team. Only one concern had a Risk Level of 3 and two concerns with a Risk Level of 2. The rest of the concerns were considered standard with either negligible or marginal impacts and unlikely or only possible tooccur (Appendix H – Cost Engineering).

Table 58 - Abbreviated Risk Analysis

Concern	Impact	Likelihood	Risk Level
If funding is staggered significantly costs may increase due to inflation.	Marginal	Likely	2
The soft sediments may cause an issue to getting equipment out to be able to form the berms.	Moderate	Likely	3
Possible need for specialty floatable tires for polder work	Moderate	Possible	2

7.3 Operations and Maintenance Considerations

Per Implementation Guidance for Section 1161 of the WRDA 2016, Completion of Ecosystem Restoration Projects, “Ten years after ecological success has been determined pursuant to paragraph 7.c, the responsibility of a non-federal sponsor to conduct O&M activities on nonstructural and non-mechanical elements of an ecosystem restoration project (or component of a project) will cease. Operation, maintenance, repair, replacement and rehabilitation of structural and mechanical elements of an ecosystem restoration project (or component of a project) will continue as outlined in the operations manual for the project.”

AAEQ O&M Costs, annualized in IWR Planning Suite over 5-years at a 2.5% discount rate is $37,155 (Table 59).

Table 59 - Annual OMRR&R Cost

Year	Annual OMRR&R Cost		
	Non-Structural	Structural	Total
2023	$52,000	$25,200	$77,200
2024	$52,000	$25,200	$77,200
2025	$52,000	$25,200	$77,200
2026	$31,200	$25,200	$56,400
2027	$31,200	$25,200	$56,400
2028	$31,200	$25,200	$56,400
2029	$19,500	$25,200	$44,700

Year	Annual OMRR&R Cost		
	Non-Structural	Structural	Total
2030	$19,500	$25,200	$44,700
2031	$19,500	$25,200	$44,700
2032	$19,500	$25,200	$44,700
2033-2072	$0	$25,200	$25,200

The existing invasive species within the restoration areas include: spreading hedge parsley, chinaberrytree, cheatgrass, Sesbania, alligator weed, Bermudagrass, bastard cabbage, rescuegrass and Johnsongrass. Most of these species are not too difficult to eliminate or would not likely be a major issue after restoration is implemented. In the case of alligator weed, this invasive was focused within the coves of Mitchell Lake. Alligator weed can be treated with a biological control that would be a one-time upfront cost. Essentially, the acreages for the coves are removed from the total for invasive species management because alligator weed will be treated during construction and shouldn't be as widespread upon completion. Bermudagrass is prevalent on the site. We can assume that changes in hydrology – the inundation of the northern chain of wetlands, will contribute to the eradication of the Bermudagrass within this restoration area. In addition, the Mitchell Lake Audubon Society conducts prescribed burns around the Central Wetlands and Skip's Pond so it can be assumed this treatment would contribute to the removal of Bermudagrass and Johnsongrass as well. There will still be a need for supplemental treatments after construction, but costs will be reduced if these assumptions prove correct.

- Acreage for O&M Invasive Species Management: 26.97 acres
    - years 1-3: $2,000 per acre
    - years 3-6: $1,200 per acre
    - years 6-10: $750 per acre

7.3.1 Adaptive Management and Monitoring

To ensure the success of the proposed action, the restoration measures implemented will be periodically surveyed to provide feedback on the response of the ecosystem and its resources to the management measures taken. By connecting the ecosystem response to the restoration as well as the management measures, potential beneficial adaptations and adjustments to the project or management plan can be identified to ensure continued success of the project. This is especially true of the plantings that will have to be frequently monitored from their initial planting until reasonable stabilization is achieved. To accomplish this goal, periodic monitoring of the restoration measures will be conducted over a three-year period beginning after the completion of the construction of project features and the initial plantings (Appendix C – Environmental Resources, Attachment K).

7.3.2 Operation and Maintenance

SAWS will be responsible for the operation of the project features and systems including pumps and water control structures. At their discretion, they will manage the water levels and flows and adapt their operations to observed field conditions to provide the desired habitat conditions. All pumps and water control structures will be manually operated.

7.3.2.1 Inspections

A representative of SAWS shall perform routine inspections to ensure timely identification of potential problems. Inspections will be performed as indicated and preferably, before and/or after the typical rainy seasons for the area. Inspection schedules should be monitored and adjusted based on the conditions observed and the age of the project. Three types of inspections are required to ensure that the proposed project functions as designed.

1. annual inspections of access roads and gate structures will be accomplished by SAWS personnel to determine if the roads are safe, passable and operable
2. annual inspections of all proposed and existing culverts, gate and drainage structures shall be inspected for functionality, operability, sediment, debris and corrosion
3. annual inspections of all pumps will be completed by trained SAWS personnel. Pumps will be evaluated for performance, operation, corrosion, power connections, piping connections and safety. All hoses for the portable pump will be inspected for wear, holes, corrosion and operable connectors.
4. annual inspection of the earthen berms between the polders to include visual inspections for slope failure, erosion and invasive plant growth
5. annual inspection of all bat and bird nest boxes to determine if structures remain in good condition and are habitable.

7.3.2.2 Preventative Maintenance

Preventive maintenance will be performed on the access roads, pumps, drainage structures, earthen berms and habitat structures. The list below is a preliminary list of maintenance items known at this point of the study.

1. **Access Roads –** Fill any ruts or minor depressions with similar soil and compact it to surrounding grade. Inspect the access gates for operation and make repairs as needed to keep them operational and safe to operate. Paint any observed areas where the metal is exposed, or corrosion is occurring. Properly prep the metal surface prior to painting. Inspect gate posts and verify condition, replace if they show signs of possible failure. Verify that all vegetation is clear for proper operation of the gates.
2. **Culverts, Gates and Drainage Structures –** Remove all debris and vegetation at the inlet and outlet side of all culverts, gates and drainage structures. Restore corroded metal to original condition by replacing or welding on new metal and painting to prevent corrosion. Inspect entire culvert interior either manually or by camera depending on accessibility and repair as needed. Replace boards with similar as needed for stop log structures.

3. **Pumps, Piping and Hoses –** Inspect pump controls for proper operation and connectivity. Replace or repair any loose or worn electrical connections. Inspect all pumps by switching them on, verifying that they are operational. Note any unusual noises or vibrations during operation. Inspect pump for corrosion or exposed metal and repair/repaint surface to prevent further corrosion or rust. Inspect the pump connections to the piping or hoses, verify the connections are operational and in good working order. Verify that all connection points are tight and relatively leak proof. Repair connections as required. Remove pump, inspect and maintain in accordance with the manufacturer's operation and maintenance manual. For engine driven pumps, inspect and maintain the motor for the pump in accordance with the manufacturer's operations and maintenance manual. Inspect hoses for pump for holes and wear points. Repair or replace the hoses as necessary. Inspect all pump inlet piping and screens, removing all debris and foreign matter. Replace all damaged screens as required. Inspect concrete structures for spalling and cracking. Repair and seal any leaking cracks.
4. **Earthen Berms –** Inspect the berms for signs of ruts, minor depressions, or erosion. Fill any ruts, minor depressions, or eroded areas with similar soil and compact it to surrounding grade.
5. **Bat and Bird Nest Boxes –**Verify structure is not rotted or corroded, if so, replace sections of structure with new parts (wood panels, screws, nails, metal siding, etc.). Repair or reinstall base of structure if damaged.

NON-STRUCTURAL / NON-MECHANICAL ELEMENTS

Per Implementation Guidance for Section 1161 of the WRDA 2016, Completion of Ecosystem Restoration Projects, "Ten years after ecological success has been determined pursuant to paragraph 7.c, the responsibility of a non-federal sponsor to conduct O&M activities on nonstructural and non-mechanical elements of an ecosystem restoration project (or component of a project) will cease. Operation, maintenance, repair, replacement and rehabilitation of structural and mechanical elements of an ecosystem restoration project (or component of a project) will continue as outlined in the operations manual for the project."

Non-Structural / Non-Mechanical Elements of Plan 6 include:

- clearing and excavation
- habitat structure augmentation
- invasive species management
- low quality vegetation removal
- native submergent wetland plantings
- native riparian plantings
- native emergent wetland plantings

WHAT IF ANALYSIS

It is assumed that if the non-federal sponsor does not pursue operations and maintenance of non-structural / non-mechanical measures beyond the 10-year period after the date on which the Secretary makes a determination of success, some ecological benefits of the non-structural measures: invasive vegetation management, native submergent wetland plantings, native riparian plantings and native emergent wetland plantings could be negatively impacted.

Invasive vegetative species are prevalent within the study area, however; focused management on the establishment of native vegetative species should diminish the likelihood of the reestablishment of invasive species within the specified project areas. Native species, once established, should be able to maintain influence and deter the spread of invasive species around Mitchell Lake.

Unforeseen circumstances, such as significant storm events, can cause disturbances to the ecosystem. Disturbed areas, lacking enough native vegetative cover, are more likely to become inhabited by fast-growing invasive species. The non-federal sponsor should remain vigilant and enact management where possible and if it is still within their means to do so within the 50-year life of the project. Coordination with the Mitchell Lake Audubon Society regarding success of native species would help support the success of the Mitchell Lake Aquatic Ecosystem Restoration.

Depending on the level of disturbance, reestablishment of invasive species could occur within a single growing season. However, full-scale establishment, negatively affecting wildlife habitat, may take up to several years depending on the species. If invasive species come back into the project area and are left unrestricted over a 50-year period, then the full FWP ecosystem benefits may not be realized.

7.3.3 Water Permits

The need to acquire water rights beyond what the sponsor already has for Mitchell Lake is not expected for the project. If this changes, the NFS would be required to work with the appropriate entities to secure any water rights or permits needed for plan success. This requirement will be laid out in the Project Partnership Agreement with the federal government.

7.3.4 Non-Federal Sponsor's Responsibilities Post-Feasibility

The NFS is responsible for all actions and costs as laid out in the USACE Project Partnership Agreement for Aquatic Ecosystem Restoration[6].

[6] USACE Project Partnership Agreements (army.mil)

7.4 Institutional Requirements

7.4.1 The USACE Campaign Plan[7]

The USACE is marching forward with a new FY21 Campaign Plan to transform the way we do business. These are historic times in our Nation and in the world and USACE will play a pivotal role in helping shape America's future. The USACE will grow stronger and become a great organization by delivering superior performance, setting the standard for our profession, making a positive impact on the Nation and other nations and building to last, as evidenced by the strength of our team — educated, trained, experienced and certified professionals. We will deliver superior performance every time through disciplined people, thought and action. We will use the Campaign Plan to establish our priorities, focus our transformation initiatives, measure and guide our progress and adapt to the needs of the future.

Our intent is for USACE to be one disciplined team — in thought, word and action — and to meet our commitments by saying what we will do and doing what we say.

The Recommended Plan addresses Goals 3 and 4 of the Campaign Plan.

- Campaign Plan Goal 3: Improve Partnering and Strength Relationships
    - Objective 11: Improve Partnering Consistency
- Campaign Plan Goal 4: Revolutionize Program and Project Deliver
    - Objective 12: Institute Risk Informed Decision Making

7.4.2 Environmental Operating Principles[8]

In 2002 and again in 2012, the USACE formalized a set of Environmental Operating Principles (EOP) applicable to decision-making in all programs. The principles are consistent with the NEPA, the Army Strategy for the Environment, other environmental statutes and the WRDA of 2007. The EOPs inform the plan formulation process. They are integrated into all project management processes.

The Recommended Plan is consistent with the EOPs, which are as follows:

- foster sustainability as a way of life throughout the organization
- proactively consider environmental consequences of all the USACE activities and act accordingly
- create mutually supporting economic and environmentally sustainable solutions
- continue to meet our corporate responsibility and accountability under the law for activities undertaken by the USACE, which may affect human and natural environments
- consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs

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[7] https://www.usace.army.mil/About/Campaign-Plan/

[8] http://www.usace.army.mil/Missions/Environmental/Environmental-Operating-Principles/

- leverage scientific, economic and social knowledge to understand the environmental context and effects of the USACE actions in a collaborative manner
- employ an open, transparent process that respects the views of individuals and groups who are interested in the USACE activities

8 Environmental Compliance

This section demonstrates how the Recommended Plan would comply with applicable environmental laws and regulations.

8.1 Migratory Bird Treaty Act

The MBTA of 1918 extends Federal protection to migratory bird species. To comply with the MBTA, the timing of resource management activities would be coordinated to avoid impacts on migratory and nesting birds (Appendix C – Environmental Resources, Attachment E).

8.2 Section 402 of the Clean Water Act

The construction activities that disturb upland areas (land above Section 404 jurisdictional waters) are subject to National Pollutant Discharge Elimination System (NPDES) requirements of Section 402(p) of the Clean Water Act (CWA). Within Texas, TCEQ is the permitting authority and administers the Federal NPDES program through its Texas Pollutant Discharge Elimination System (TPDES) program. Construction activities that disturb one or more acres are subject to complying with TPDES requirements. Operators of construction activities that disturb 5 or greater acres must prepare a SWPPP, submit a Notice of Intent to TCEQ, conduct onsite posting and periodic self-inspection and follow and maintain the requirements of the SWPPP. During construction, the operator shall assure that measures are taken to control erosion, reduce litter and sediment carried offsite (silt fences, hay bales, sediment retention ponds, litter pick-up, etc.), promptly clean-up accidental spills, utilize BMPs onsite and stabilize site against erosion before completion.

8.3 Section 404 of the Clean Water Act

The USACE under direction of Congress regulates the discharge of dredged and fill material into all waters of the US, including wetlands. Although the USACE does not issue itself permits for construction activities that would affect waters of the US, the USACE must meet the legal requirement of the Act. A CWA Section 404(b) (1) analysis has been completed for the Mitchell Lake project. A Final CWA Section 404(b) (1) analysis is in Appendix C – Environmental Resources, Attachment F, describing potential impacts to water quality within the study area.

In a letter dated 01 March 2021, the TCEQ stated that they had reviewed the Mitchell Lake feasibility study. TCEQ certified that there have reasonable assurance that the project will be conducted to not violate water quality standards.

8.4 Section 176(c) Clean Air Act

The Clean Air Act is the comprehensive federal law that regulates air emission from Federal agencies that are required by this Act to review all air emissions resulting from Federal funded projects or permits to insure conformity with the State Implementation Plans in non-attainment areas. Bexar County is currently in Marginal Nonattainment status for O_3 pollutants. The USACE will ensure the use of BMPs during construction to minimize emissions, including the use of cleaner burning fuels and energy efficient equipment where applicable.

8.5 Executive Order 11312, Invasive Species

The Recommended Plan would comply with EO 13112 by restoring native aquatic and riparian vegetation species to the degraded habitat. Mitchell Lake is dominated by non-native invasive plant species. The measures included in the Mitchell Lake Aquatic Ecosystem Restoration Feasibility Study would reduce the invasive plant species and replace them with native plant species adapted to the study area. Required operation and maintenance of the study area by the non-Federal sponsor during the required 10-year management of the area would keep the negative influence of non-native invasive plants at a minimum. The Proposed Action would comply with EO 13112 by restoring native emergent/submergent wetland and riparian species to the degraded habitat.

8.6 Executive Order 11990, Protection of Wetlands

EO 11990 requires Federal agencies to minimize the destruction, loss, or degradation of wetlands and to preserve and restore the natural and beneficial values of wetlands in executing Federal projects. The Recommended Plan complies with EO 11990 by increasing the areal extent of wetlands within the study area.

8.7 Executive Order 11988, Floodplain Management

EO 11988 was enacted May 24, 1977, in furtherance of the National Environment Policy Act of 1969, as amended (42 USC. 4321 et seq.), the National Flood Insurance Act of 1968, as amended (42 USC. 4001 et seq.) and the Flood Disaster Protection Act of 1973 (PL 93-234, 87 Star. 975). The purpose of the EO was to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative.

The order states that each agency shall provide and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities for:

1. acquiring, managing and disposing of federal lands and facilities
2. providing federally undertaken, financed, or assisted construction and improvements
3. conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating and licensing activities

All alternatives were designed to ensure that the combination of all ecosystem restoration measures proposed would not result in a decrease in the floodplain capacity and an increase in flood risk to the study area. The Recommended Plan would remain in compliance with EO 11988 by protecting the values of the Mitchell Lake floodplains.

8.8 Executive Order 13186, Migratory Birds

The proposed ecosystem restoration would contribute directly to the USFWS Migratory Bird Program goals to protect, conserve and restore migratory bird habitats to ensure long-term sustainability of all migratory bird populations.

8.9 Executive Order 12898, Environmental Justice

EO 12898 “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations” dated February 11, 1994, requires all Federal agencies to identify and address disproportionately high and adverse effect of its programs, policies and activities on minority and low-income populations. Data were compiled to assess the potential impacts to minority and low-income populations within the study area. Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies. Even though minorities account for a large portion of the local population and the low-income population is above the national and local averages, construction of the proposed alternatives would not have a disproportionately high or adverse effect on these populations. No environmental justice concerns are anticipated and the Recommended Plan would be consistent with EO 12898.

8.10 Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks

EO 13045 “Protection of Children from Environmental Health Risks” dated April 21, 1997 requires Federal agencies to identify and address the potential to generate disproportionately high environmental health and safety risks to children. This EO was prompted by the recognition that children, still undergoing physiological growth and development, are more sensitive to adverse environmental health and safety risks than adults.

Short-term impacts on the protection of children would be expected. Numerous types of construction equipment such as backhoes, bulldozers, graders and dump trucks and other large construction equipment would be used throughout the duration of construction of the Proposed Action. Because construction sites and equipment can be enticing to children, construction activity could create an increased safety risk. During construction, safety measures would be followed to protect the health and safety of residents as well as construction workers. Barriers and “No Trespassing” signs would be placed around construction sites to deter children from playing in these areas and construction vehicles and equipment would be secured when not in use. Since the construction area would be flagged or otherwise fenced, issues regarding Protection of Children are not anticipated.

8.11 Endangered Species Act of 1973

Current lists of threatened or endangered species were compiled for the Mitchell Lake Feasibility Study. There would be no adverse impacts on threatened or endangered species resulting from the Recommended Plan. However, continued long-term beneficial impacts, such as habitat improvement, could occur because of the Recommended Plan. The purpose of the assessment is to coordinate with the USFWS about the likelihood if impacting threatened and endangered species. A rating of “no effect” was determined through a threatened and endangered species assessment for the Recommended Plan and has been verified by the USFWS (Appendix C – Environmental Resources, Attachment D).

8.12 Fish and Wildlife Coordination Act

In accordance with the Fish and Wildlife Coordination Act of 1934, as amended, from the initial stages of this study the USFWS and TPWD have been involved in the planning process.

All agencies provided comments throughout the planning process. The USFWS and the TPWD biologists provided input on the models, participated in fieldwork and participated in the model projections meetings. The USACE initiated public involvement and agency scoping meetings to solicit input on the Mitchell Lake Feasibility Study process, as well as identify prospective areas and identify significant issues related to the Recommended Plan. Information provided by the USFWS and the TPWD on fish and wildlife resources has been utilized in the development of the Recommended Plan.

A Final Fish and Wildlife Coordination Act Report describing existing and FWOP conditions and FWP conditions has been prepared for this project and is in Appendix C – Environmental Resources Attachment D.

8.13 Advisory Circular 150/5200-33A – Hazardous Wildlife Attractants on Near Airports

The advisory circular provides guidance on locating certain land uses having the potential to attract hazardous wildlife to or near public-use airports. The circular provides guidance on wetlands in and around airports and establishes notification procedures if reasonably foreseeable projects either attract or may attract wildlife.

In response to the Advisory Circular, the US Army as well as other Federal agencies, signed a Memorandum of Agreement with the Federal Aviation Administration (FAA) to address aircraft-wildlife strikes. The MOA establishes procedures necessary to coordinate their missions to address existing and future environmental conditions contributing more effectively to aircraft-wildlife strikes throughout the US.

In accordance with the Advisory Circular, the USACE has coordinated with the FAA to address potential hazardous wildlife attractants near airports within San Antonio with respect to the Recommended Plan. Appendix C – Environmental Resources, Attachment J includes the FAA’s decision of no impact.

8.14 National Historic Preservation Act 1966, as amended

Compliance with the NHPA of 1966, as amended, requires identification of all properties in the project area listed in, or eligible for listing in, the NRHP. All previous surveys and site salvages were coordinated with the Texas State Historic Preservation Officer. Known sites are mapped and avoided by maintenance activities. Areas that have not undergone cultural resources surveys or evaluations would need to do so prior to any earthmoving or other potentially impacting activities.

A Programmatic Agreement has been signed by the Texas State Historic Preservation Office and the SWG District Commander (Appendix D – Cultural Resources). SAWS was an invited signatory but has not signed the Programmatic Agreement.

8.15 National Environmental Protection Act

NEPA was signed into law on January 1, 1970. NEPA requires federal agencies to assess the environmental effects of their proposed actions prior to making decisions. Section 102 in Title I of the Act requires federal agencies to incorporate environmental considerations in their planning and decision-making through a systematic interdisciplinary approach. Specifically, all federal agencies are to prepare detailed statements assessing the environmental impact of and alternatives to major federal actions significantly affecting the environment.

Environmental information on the proposed action has been compiled and the DPR-EA has been prepared and coordinated for public, state and Federal agency review. The Proposed Action is in compliance with NEPA through the analysis of environmental impacts proposed by USACE.

8.16 Acts Not Applicable to the Study

- Farmland Protection Policy Act: This project is exempt from the Farmland Protection Policy Act because it is on land already in urban development or used for water storage.
- Archaeological and Historic Preservation Act 1974, as amended
- Archaeological Resources Protection Act 1979, as amended
- Coastal Zone Management Act 1972, as amended
- Magnuson Fisheries Conservation and Management Act
- River and Harbors Act, 1899
- Wild and Scenic Rivers Act, as amended
- Native American Graves Protection and Repatriation Act, 1990

8.17 Views of the Non-Federal Sponsor

SAWS is supportive of the Recommended Plan. Mitchell Lake and its surrounding habitat is a critical stopover spot for migrating birds. The lake is also an important open space recreation area for San Antonio.

8.18 Participating and Cooperating Agencies

Copies of agency coordination letters are presented in Appendix C – Environmental Resources, Attachment L. Formal and informal coordination has been and will continue to be conducted with the following resource agencies:

- US Army Corps of Engineers,
- US Environmental Protection Agency,
- US Federal Aviation Administration,
- US Fish and Wildlife Service,
- US National Resource Conservation Service,
- Texas Parks and Wildlife Department,
- Texas Commission on Environmental Quality,
- Texas State Historic Preservation Office and
- National Audubon Society at the Mitchell Lake Audubon Center

The TPWD, the USFWS, the NRCS and the TCEQ have been involved throughout the study process. These organizations participated in initial brainstorming and problem identification and provided comments throughout the Mitchell Lake Feasibility Study process. The TPWD, USFWS and the TCEQ also participated in the data collection, field surveys and contributed in the assessment of FWOP and FWP benefits

8.19 Comments

8.19.1 Public Scoping

The USACE began its public involvement process with a public scoping meeting to provide an avenue for public and agency stakeholders to ask questions and provide comments. This public scoping meeting was held on 13 March 2019 at the Mitchell Lake Audubon Center, 10750 Pleasanton Road, San Antonio, TX 75221 facility (Figure 10 and Figure 11). The USACE, SWF placed advertisements on the USACE webpage and mailed official Public Notices, while SAWS posted advertisements on social media prior to the public scoping meeting.

Table 60 displays the single public comment that was received after the public scoping meeting on 13 March 2019. One written comment was received, but seven individuals attended and provided verbal comments.

Table 60 - Public Scoping Meeting Comment and Response

Public Comment	USACE Response
"I am a member of a club a relatively short distance from Mitchell Lake. Our club, which adjoins the San Antonio River, is experiencing the same excessive aquatic growth and elevated nitrogen levels in our three lakes, though none of our water flows into any river. When I read that a project was to be undertaken at Mitchell Lake to control the problems at the lake with "natural means", I became very interested. It is my hope that the Mitchell Lake project will provide answers that can assist us in controlling the problems at our lakes."	The USACE will keep the public informed of final plans and decisions for the Mitchell Lake Aquatic Ecosystem Restoration Feasibility Study through the DPR-EA.

8.19.2 Public Review of DRAFT Integrated Detailed Project Report and EA

In accordance with NEPA, a 30-day review period of the DFR-EA and a Draft FONSI was provided via a Notice of Availability. During the review period, agencies had the ability to respond in favor of or against the project. A copy of the Notice of Availability, Public Notices and Resource Agency Letters of Support can also be found in Appendix C – Environmental Resources, Attachment L.

9 List of Preparers

Name	Technical Specialty
Andrew Johnston	Project Management
Zia Burns	Project Management
Kathy Skalbeck	Plan Formulation
Michael Danella	Hydrology and Hydraulic Engineering
Jennifer Purcell	Economics
Justyss Watson	Environmental Resources
Daniel Allen	Environmental Resources
Seth Sampson	Cultural Resources
Ramanujachari Kannan	Geotechnical Engineering
Eugenia Barnes	HTRW
Anthony Mendolia	Real Estate
James Stitzel	Civil Engineering
Ninfa Taggart	Cost Engineering

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10 District Engineer's Recommendation

I recommend that the restoration plan as generally describe in the FINAL Feasibility Report and Integrated Environmental Assessment, now a Detailed Project Report and Integrated Environmental Assessment, be implemented under the authority of Section 206 of the WRDA of 1996, Public Law 104-303, with such modifications as in the discretion of the appropriate authority may be deemed advisable. The total project first cost is currently estimated to be $8,100,000 (rounded).

Prior to the commencement of construction, local interests must agree to meet the requirements of Local Sponsor responsibilities as outline in this report and future legal documents. The San Antonio Water System has demonstrated that they have the authority and financial capability to provide all Local Sponsor requirements for the implementation, operation and maintenance of the project. The recommendations contained herein reflect the information available at the time and current Department of the Army policies governing formulation, evaluation and development of individual projects under the U.S. Army Corps of Engineers Continuing Authorities Program

16/Aug/21
DATE

for [signature]
Jonathan S. Stover, P.E., PMP
Colonel, U.S. Army
Commanding

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12 Quality Control

District Quality Control (DQC) Reviewers	
Name	**Title**
Natalie Garrett – RPEC	DQC Lead
Thomas Jester – RPEC	Plan Formulation
Sarah Harris – SWT	Hydrology and Hydraulic Engineering
Bret Higginbotham – SWF	Hydrology and Hydraulic Engineering
Bob Needham – RPEC	Economics
Jennifer Morgan – RPEC	Environmental Resources
John Campbell – RPEC	Cultural Resources
Ephraim Redden – SWT	Geotechnical Engineering
Eric Lam – RPEC	HTRW
Landis Grimmett – SWF	Civil Engineering
Johnathan Bennett – SWF	Structural Engineering
Tracy Ng – SWF	Cost Engineering
John Derinzy – SWF	Compliance

Agency Technical Review (ATR) Team	
Name	**Title**
Michael Scuderi – NWS	ATR Lead
Scott Miner – SPK	Plan Formulation
Zachary Corum – NWS	Hydrology and Hydraulic Engineering
Charyl Barrow – NWS	Economics
Beth McCasland – NWS	Environmental Resources
Jonathan Van Hoose – SPA	Cultural Resources
Jennifer Coor – SAJ	Geotechnical Engineering
Jon Korneliussen – MVM	Civil Engineering
Bill Bolte – NWW	Cost Engineering
Charles Rairdan – SPD	Real Estate
Ann Banitt – MVP	Climate

13 Acronyms and Abbreviations

~	Approximate or Approximately
°	Degree or Degrees
$	US Dollars
‘	Foot or Feet
>	Greater Than
≥	Greater Than or Equal To
“	Inch or Inches
<	Less Than
#	Number
AAHU	Average Annual Habitat Unit
AO	Administrative Order
AOI	Area of Interest
APE	Area of Potential Effect
ATR	Agency Technical Review
BCC	Birds of Conservation Concern
BMP	Best Management Practice
BOD_5	Biochemical Oxygen Demand
CE/ICA	Cost Effective–Incremental Cost Analysis
CEM	Conceptual Ecological Model
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CfB	Miguel Fine Sandy Loam
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
City	City of San Antonio, Texas
cm	Centimeter
CN	Curve Number
CNM	Curve Number Method
CO	Carbon Monoxide
CO_2	Carbon Dioxide
cy	Cubic Yards

dbh	Diameter at Breast Height
DQC	District Quality Control Review
DO	Dissolved Oxygen
DoD	Department of Defense
DPR-EA	Detailed Project Report and Environmental Assessment
EA	Environmental Assessment
EC	Engineering Circular
ECO-PCX	Ecosystem Restoration Planning Center of Expertise
e.g.	For example
EO	Executive Order
EOP	Environmental Operating Principle
EP	Engineering Pamphlet
EPA	Environmental Protection Agency
ER	Engineering Regulation
ERDC	Engineer Research and Development Center
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FPPA	Farmland Protection Policy Act
FWOP	Future Without-Project
FWP	Future With-Project
Gpm	Gallons per Minute
GRR	General Re-evaluation Report
HEC	Hydrologic Engineering Center
HEP	Habitat Evaluation Procedure
HMS	Hydrologic Modeling System
HsB	Houston Black Clay
HSI	Habitat Suitability Index
HTRW	Hazardous, Toxic and Radioactive Waste
HU	Habitat Unit
HuB	Houston Black Gravelly Clay
IBI	Index of Biological Integrity
i.e.	Id Est or That Is
L	Liter

LRSI	Life Requisite Suitability Index
m	Meter
MBTA	Migratory Bird Treaty Act
Measures	Management Measures
MVM	Vicksburg District
MVP	St. Paul District
PL	Public Law
n	Number of Observations or Measurements
NAAQS	National Ambient Air Quality Standards
NABCI	North American Bird Conservation Initiative
NAWCP	North American Waterbird Conservation Plan
NAWMP	North American Waterfowl Management Plan
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NO_2	Nitrogen Dioxide
NOAA	National Oceanic and Atmospheric Administration
NWS	Seattle District
NWW	Walla Walla District
O_3	Ozone
OMRR&R	Operation and Maintenance, Repair, Replacement and Rehabilitation
OSE	Other Social Effects
Pb	Lead
PIF	Partners in Flight
PL	Public Law
PM10	Particulate Matter Less Than 10 Microns
PM2.5	Particulate Matter Less Than 2.5 Microns
PMF	Probable Maximum Flood
QHEI	Qualitative Habitat Evaluation Index
RPEC	Regional Planning and Environmental Center
RRC	Railroad Commission
s	Second
SACIP	San Antonio Channel Improvement Project

SAJ	Jacksonville District
SARA	San Antonio River Authority
SAWS	San Antonio Water System
SO_2	Sulfur Dioxide
SPA	Albuquerque District
SPD	South Pacific Division
SPK	Sacramento District
SWF	Fort Worth District
SWT	Tulsa District
TCEQ	Texas Commission on Environmental Quality
TDS	Total Dissolved Solids
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
TSP	Tentatively Selected Plan
TSS	Total Suspended Solids
TWDB	Texas Water Development Board
TWQB	Texas Water Quality Board
TY	Target Year
USC	US Code
UDC	Unified Developed Code
US	United States
USACE	US Army Corps of Engineers
USFWS	US Fish and Wildlife Service
WeC2	Floresville Fine Sandy Loam
WRDA	Water Resources Development Act
WSC	Westside Creeks
WWTP	Wastewater Treatment Plant