Mitchell Lake, San Antonio, Texas

Integrated Feasibility Report and Environmental Assessment, Bexar County

December 2019

DRAFT

US Army Corps of Engineers®
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 Feasibility Report and Environmental Assessment, Bexar County

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EXECUTIVE SUMMARY

STUDY DESCRIPTION

Mitchell Lake, TX is a single-purpose, ecosystem restoration, general investigation feasibility 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.

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 located 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.

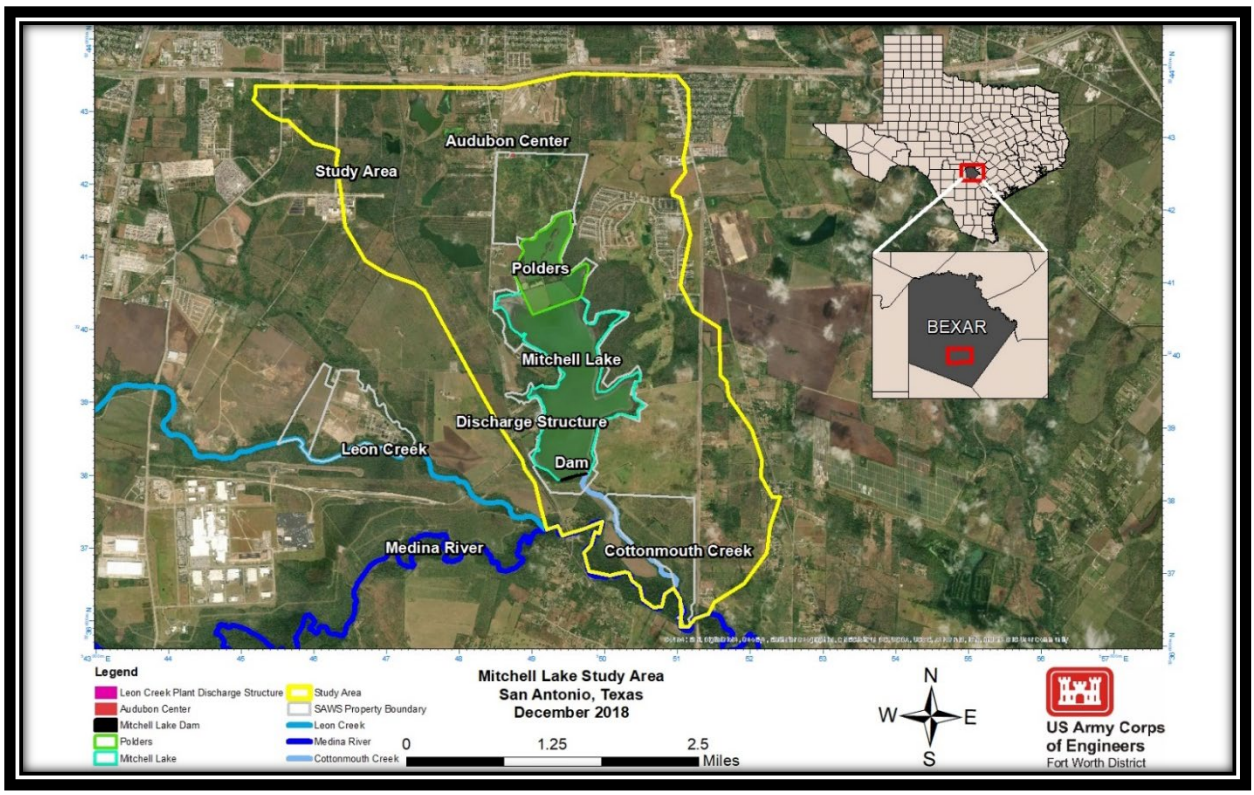

Figure 1 - Location of Mitchell Lake, Bexar County, Texas

1. 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. Salinity and nutrient loading 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 is high nutrient loading and extreme daily variation 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 life of the project.
2. Increase the floral and faunal species diversity and richness in the study area for the life of the project.
3. Manage and control invasive species in the study area for the life of the project.

EXECUTIVE SUMMARY

CONSTRAINTS

Specific Planning Constraints:

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

Institutional Constraints:

1. Avoid increasing flood risks
2. Plans must be consistent will existing Federal, State, and Local laws.

PLANS

Ecosystem Restoration management measures were brainstormed by the full PDT – NFS, 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).

Area 1 – Bird Pond Wetland Alternatives

- Alternative 1A - Enhancing the footprint of the existing 3.17-acre wetland
- Alternative 1B - Expanding the existing wetland to form a 6.42-acre wetland

Area 2 – Central Wetland Alternatives

- Alternative 2A - Enhancing the footprint of the existing 10.46-acre wetland
- Alternative 2B - Expanding the existing wetland to form a 18.37-acre wetland

Area 3 – Skip's Pond Alternative

- Alternative 3 (No Scaling) - Enhancing the footprint of the existing 2.18-acre wetland

Area 6 – Polders Alternative

- Alternative 6 (No Scaling) - Management/Modification of Existing 49.52 Polders/Basins

Area 7 – Fringe Wetlands / Coves 1 – 3 Alternatives

- Alternative 7A – Enhancing 53.68 acre Cove 1 alone
- Alternative 7B – Enhancing 11.84 acre Cove 2 alone
- Alternative 7C – Enhancing 6.84 acre Cove 3 alone
- Alternative 7D – Enhancing 65.52 acres of Coves 1 & 2

- Alternative 7E – Enhancing 60.52 acres of Coves 1 & 3
- Alternative 7F – Enhancing 18.68 acres of Coves 2 & 3
- Alternative 7G – Enhancing 72.36 acres of Coves 1 - 3

Area 9 – Dam Forested Wetland Alternatives

- Alternative 9A - Enhancement of the existing 2.55-acre wetland footprint, no dam modification
- Alternative 9B - Expanding the existing wetland to form a 4.48-acre wetland, no dam modification

Area 10 – Downstream Wetlands Alternative

- Alternative 10 (No Scaling) – Creation of 51.32 acres of wetlands

Table 1 - Average Annual Habitat Benefits by Alternative

Area	Alternatives	FWOP AAHU	FWP AAHU	Annual Benefits AAHU	FWP Acres
Area 1: Bird Pond Wetlands	1A: Enhancement of Existing Wetlands	0.86	2.39	1.53	3.17
	1B: Expansion/Enhancement of Existing Wetlands and Enhancement of Additional Wetlands	0.86	4.71	3.85	6.42
Area 2: Central Wetland	2A: Enhancement of Existing Wetlands	2.85	7.88	5.03	10.46
	2B: Expansion/Enhancement of Existing Wetlands and Enhancement of Additional Wetlands	2.85	13.54	10.69	18.37
Area 3: Skip's Pond	3: Enhancement 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: Enhancement of Cove 1 (Wetland/Riparian Plantings)	13.43	43.33	29.9	53.68
	7B: Enhancement of Cove 2 (Wetland/Riparian Plantings)	2.96	9.56	6.6	11.84
	7C: Enhancement 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: Enhancement of Existing Wet Riparian Habitat	0.71	1.19	0.47	2.55
	9B: Expansion/Enhancement of Existing Wet Riparian Habitat and Enhancement of Additional Riparian Habitat	1.25	2.08	0.83	4.48
Area 10: Downstream Wetlands	10: Creation of Wetlands Downstream of Mitchell Lake	0	36.73	36.73	51.32

Table 2 - Average Annual Benefits and Costs by Alternative

Area	Alternatives	Annual Benefits AAHU	Annual Cost ($1,000) October 2018 Prices
Area 1: Bird Pond Wetlands	1A: Enhancement of Existing Wetlands	1.53	$29.98
	1B: Expansion/Enhancement of Existing Wetlands and Enhancement of Additional Wetlands	3.85	$40.57
Area 2: Central Wetland	2A: Enhancement of Existing Wetlands	5.03	$47.28
	2B: Expansion/Enhancement of Existing Wetlands and Enhancement of Additional Wetlands	10.69	$72.48
Area 3: Skip's Pond	3: Enhancement 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: Enhancement of Cove 1 (Wetland/Riparian Plantings)	29.9	$164.94
	7B: Enhancement of Cove 2 (Wetland/Riparian Plantings)	6.6	$36.38
	7C: Enhancement 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: Dam Forested Wetlands	9A: Enhancement of Existing Wet Riparian Habitat	0.47	$28.73
	9B: Expansion/Enhancement of Existing Wet Riparian Habitat and Enhancement of Additional Riparian Habitat	0.83	$34.59
Area 10: Downstream Wetlands	10: Creation of Wetlands Downstream of Mitchell Lake	36.73	$173.07

COST EFFECTIVENESS–INCREMENTAL COST ANALYSIS

Environmental restoration benefits (increase in with-project AAHUs) and annual costs (expressed in thousands of dollars) were entered into IWR Planning Suite, resulting in 1,728 plans.

COST EFFECTIVE AND BEST BUY PLANS

Of the 1,728 Plans (including various scales), 29 were identified as cost effective plans, including the No Action Plan. Of the Cost Effective plans, nine were also Best Buy plans, including the No Action Plan.

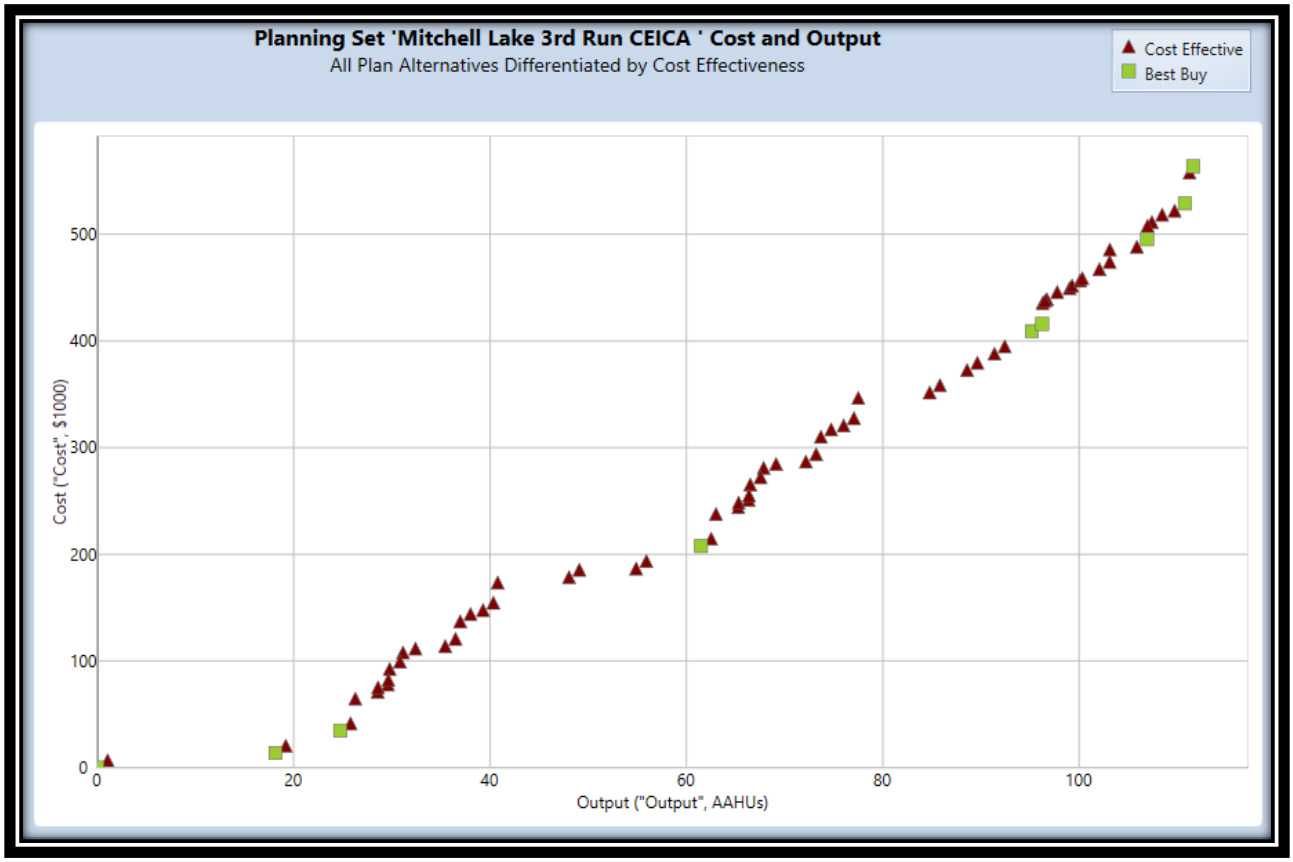

Figure 2 - Cost Effective [red triangles] and Best Buy Plans [green squares]

TENTATIVELY SELECTED PLAN at the DRAFT REPORT

Plan 8 is the recommended National Ecosystem Restoration plan. This Plan provides:

1. Three distinct habitat types (emergent wetlands, submergent / emergent wetlands, and mudflats) out of the four targeted habitat types;
2. Resilient habitat for migratory birds;
3. The creation of a complex of wetlands that can be managed to improve water quality as an ancillary benefit;

4. The restoration of 95.7% of the proposed restoration areas;
5. An incremental cost per incremental output of $8,787 over Plan 7;
6. An approximate first cost of $5.2 million.

BENEFITS AND COSTS OF THE TENTATIVELY SELECTION PLAN

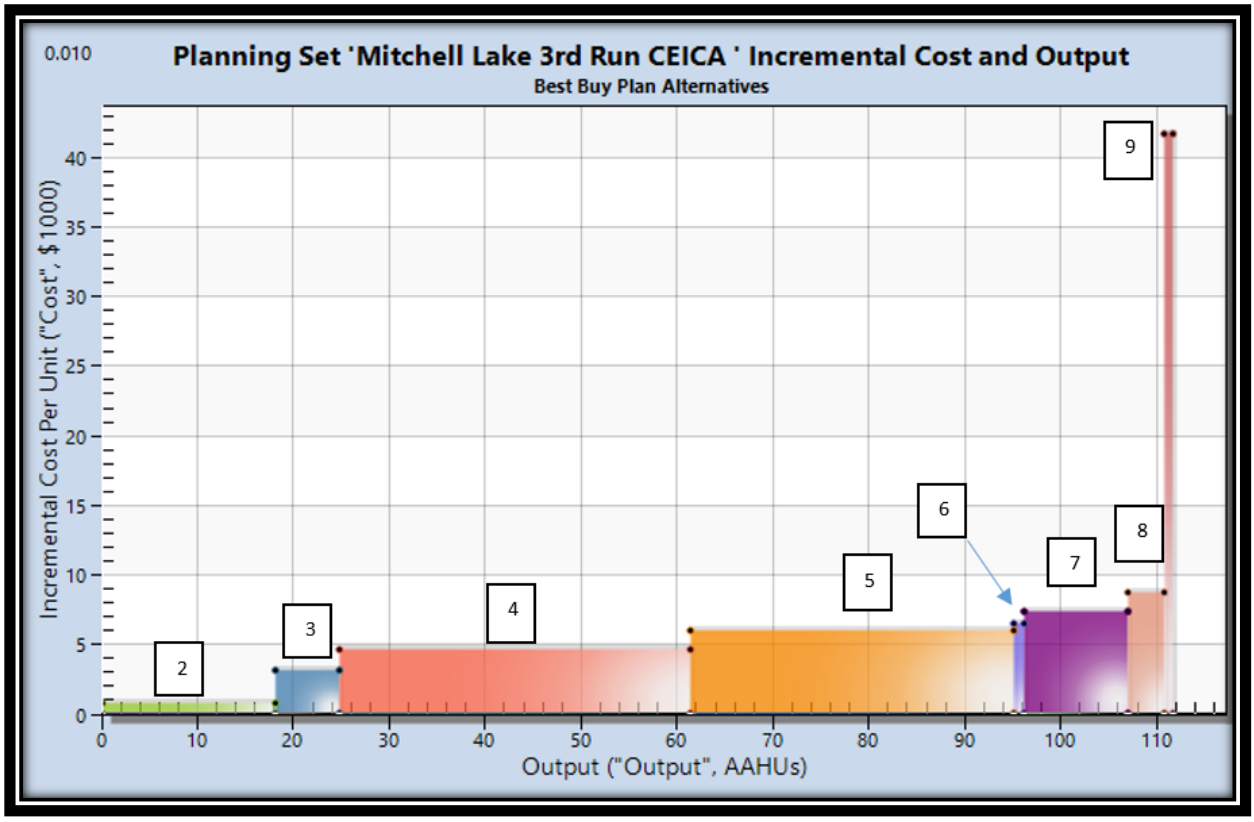

Figure 3 - Bar Chart comparing Best Buy Plans Benefits vs. Costs for Implementation

Plan 8: Central Wetland, Skip's Pond, Polders, Fringe Wetlands, and the downstream wetlands (Alternatives 1B + 2B + 3+ 6 + 7G + 10).

110.8 AAHUs are provided by Plan 8. The allocation of the AAHUs is 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

The incremental cost per incremental output for Plan 8 is $8,787, with a first cost of $5,115,007; a first cost increase of approximately $472,000 over Plan 7. Plan 8 would restore 95.7% of the total area identified for restoration under this study.

Best Buy Plan 8 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. Plan 8 is worth the Federal and local investment because of:

1. The increased diversity of bird species benefiting from the restoration,
2. The increased water quality function resulting from adding the Bird Pond Wetland to the Plan,
3. The relatively small increase in incremental cost to incremental output ratio, and
4. The increase in first cost resulting from moving from Plan 7 to Plan 8.

NON-FEDERAL SPONSOR SUPPORT

The SAWS presented their support for the Tentatively Selected Plan during the TSP Milestone on 25 September 2019. They said:

- 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.

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FINDING OF NO SIGNIFICANT IMPACT

Mitchell Lake – Integrated Feasibility Report and Environmental Assessment

San Antonio, Bexar County, Texas

The U.S. Army Corps of Engineers, Fort Worth District (Corps) has conducted an environmental analysis in accordance with the National Environmental Policy Act of 1969, as amended. The final Integrated Feasibility Report and Environmental Assessment (IFR/EA) dated DATE OF IFR/EA, for the Mitchell Lake Aquatic Ecosystem Restoration Feasibility Study addresses aquatic ecosystem restoration opportunities and feasibility in the San Antonio, Bexar County, Texas area. The final recommendation is contained in the report of the Chief of Engineers, dated DATE OF CHIEF'S REPORT.

The Final IFR/EA, incorporated herein by reference, evaluated various alternatives that would reduce the impacts of habitat degradation and promote increased structure and function in the study area. The recommended plan is the National Ecosystem Restoration (NER) Plan and includes:

- A first cost of $5,115,007 and restoration of 97.8% of the project area identified for restoration under this study.

In addition to a "no action" plan, seventeen alternatives were evaluated. The alternatives included Bird Pond Wetlands enhancement (1A) and expansion (1B), Central Wetlands enhancement (2A) and expansion (2B), Skip's Pond enhancement (3), Polder enhancement (6), Cove enhancement (7A-7G), Dam Forested Wetland enhancement (9A) and expansion (9B), and Downstream Wetlands creation (10). All alternatives feature measures that would benefit the aquatic ecosystem within the Mitchell Lake study area and address restoration of migratory bird stopover habitat. Alternatives 1A, 1B, 2A, 2B, and 3 will enhance and/or expand upon existing wetlands north of Mitchell Lake with native species plantings, invasive species management, and seasonal water pulses. The goal of Alternative 6 is to create shorebird, waterbird, and waterfowl habitat within the Mitchell Lake polders through the use of berms and temporary pumps. These features will provide controls over the operational management of water levels within the Mitchell Lake polders. Mitchell Lake has three coves that can be enhanced with native species plantings and invasive species management. Enhancement of these coves can be implemented as stand-alone or in combination with one another. These combinations are shown through the development of Alternatives 7A-7G. Alternatives 9A and 9B include the enhancement and/or expansion of forested wetlands below the Mitchell Lake dam with nuisance species thinning, invasive species management, and native species plantings. Implementation of Alternative 10 would create new wetland habitat from the shrubland habitat downstream of Mitchell Lake. Although seventeen alternatives were evaluated and compared, only six were integrated into the Recommended Plan. The Recommended Plan incorporates enhancement and expansion of the Bird Pond Wetlands, enhancement, and expansion of the Central Wetlands, enhancement of Skip's Pond, enhancement of the Polder operational management, enhancement of all three coves within Mitchell Lake, and creation of the Downstream Wetlands. All of the alternatives are discussed in more detail in Chapter 4 of the IFREA.

For all alternatives, the potential effects to the following resources were evaluated:

Table: Summary of Potential Effects of the Tentatively Selected Plan

	In-depth evaluation conducted	Brief Evaluation due to minor effects	Resource unaffected by action
Aesthetics	☒	☐	☐
Air quality	☒	☐	☐
Aquatic resources/wetlands	☒	☐	☐
Invasive species	☒	☐	☐
Vegetation	☒	☐	☐
Threatened/Endangered species	☐	☐	☒
Historic properties	☒	☐	☐
Other cultural resources	☒	☐	☐
Floodplains	☒	☐	☐
Hazardous, toxic & radioactive waste	☒	☐	☐
Hydrology	☒	☐	☐
Land use	☒	☐	☐
Navigation	☐	☐	☒
Noise levels	☒	☐	☐
Public infrastructure	☐	☐	☒
Socio-economics	☒	☐	☐
Environmental justice	☒	☐	☐
Soils	☒	☐	☐
Tribal trust resources	☐	☐	☒
Water quality	☒	☐	☐
Climate change	☒	☐	☐
Migratory Birds	☒	☐	☐
Recreation	☒	☐	☐
Light	☒	☐	☐
Transportation	☒	☐	☐

All practicable and appropriate means to avoid or minimize adverse environmental effects were analyzed and incorporated into the recommended plan. Best management practices (BMPs) as detailed in the IFR/EA will be implemented, if appropriate, to minimize impacts. Some BMPs that will be implemented during construction of the project include: avoidance and/or minimization of impacts to migratory bird nests and the migratory bird nesting season, heavy machinery fitted with devices to reduce emissions, and placement of silt fences to avoid further degradation of water quality within Mitchell Lake.

No compensatory mitigation is required as part of the recommended plan.

Public review of the draft IFREA and FONSI was completed on 9 January 2020. All comments submitted during the public review period were responded to in the Final IFR/EA and FONSI. A 30-day state and agency review of the Final IFR/EA was completed on DATE SAR PERIOD ENDED. PICK OPTION BASED ON RESULTS OF STATE AND AGENCY REVIEW.

Pursuant to section 7 of the Endangered Species Act of 1973, as amended, the U.S. Army Corps of Engineers determined that the recommended plan will have no effect on federally listed species or their designated critical habitat.

Pursuant to section 106 of the National Historic Preservation Act of 1966, as amended, the U.S. Army Corps of Engineers determined that historic properties may be adversely affected by the recommended plan. The Corps and the Texas Historical Commission entered into a Programmatic Agreement (PA), dated DATE OF AGREEMENT. All terms and conditions resulting from the agreement shall be implemented in order to minimize adverse impacts to historic properties.

Pursuant to the Clean Water Act of 1972, as amended, the discharge of dredged or fill material associated with the recommended plan has been found to be compliant with section 404(b)(1) Guidelines (40 CFR 230). The Clean Water Act Section 404(b)(1) Guidelines evaluation is found in Appendix C of the IFR/EA.

A water quality certification pursuant to section 401 of the Clean Water Act will obtained from the Texas Commission on Environmental Quality prior to construction. In a letter dated DATE OF LETTER, the Texas Commission on Environmental Quality stated that the recommended plan appears to meet the requirements of the water quality certification, pending confirmation based on information to be developed during the pre-construction engineering and design phase. All conditions of the water quality certification will be implemented in order to minimize adverse impacts to water quality.

All applicable environmental laws have been considered and coordination with appropriate agencies and officials has been completed.

Technical, environmental, and cost effectiveness criteria used in the formulation of alternative plans were those specified in the Water Resources Council's 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable laws, executive orders, regulations, and local government plans were considered in evaluation of alternatives. Based on this report, the reviews by other Federal, State and local agencies, Tribes, input of the public, and the review by my staff, it is my determination that the recommended plan would not cause significant adverse effects on the quality of the human environment; therefore, preparation of an Environmental Impact Statement is not required.

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Date

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Kenneth N. Reed, PMP
Colonel, Corps of Engineers
District Commander

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Table of Contents

APPENDICES

List of Figures

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List of Tables

1 General Information

The San Antonio Water System (SAWS), of San Antonio, Texas, sent a letter of intent to the 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 was signed between the US Army Corps of Engineers (USACE), the SWF, and the SAWS on September 27, 2018.

The Mitchell Lake, San Antonio, Texas, Integrated Feasibility Report and Environmental Assessment (IFR-EA), Bexar County, hereafter called "Study," is a single purpose, General Investigation study. This is an interim, or partial, response to the study authority.

1.1 Study Authority

The Mitchell Lake IFR-EA is 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, 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 authority for feasibility studies 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 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. Similar to other project purposes, the value of ecosystem restoration outputs are 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) wetland that teemed with many and varied species of flora and fauna.

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 currently remains able to provide limited services 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.

1.3 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 bio-diversity 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.

T&E species known to utilize Mitchell Lake are Red Knot, Interior Least Tern, and Piping Plover. For more information, see Section 2.2.1 Resource Significance and Appendix C – Environmental Resources – Chapter 2 Resource Significance.

1.4 Study Area

Partial History of the Great 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. The majority of oil production takes place in southeast Texas, but reserves have been found across Texas, and up into Oklahoma.

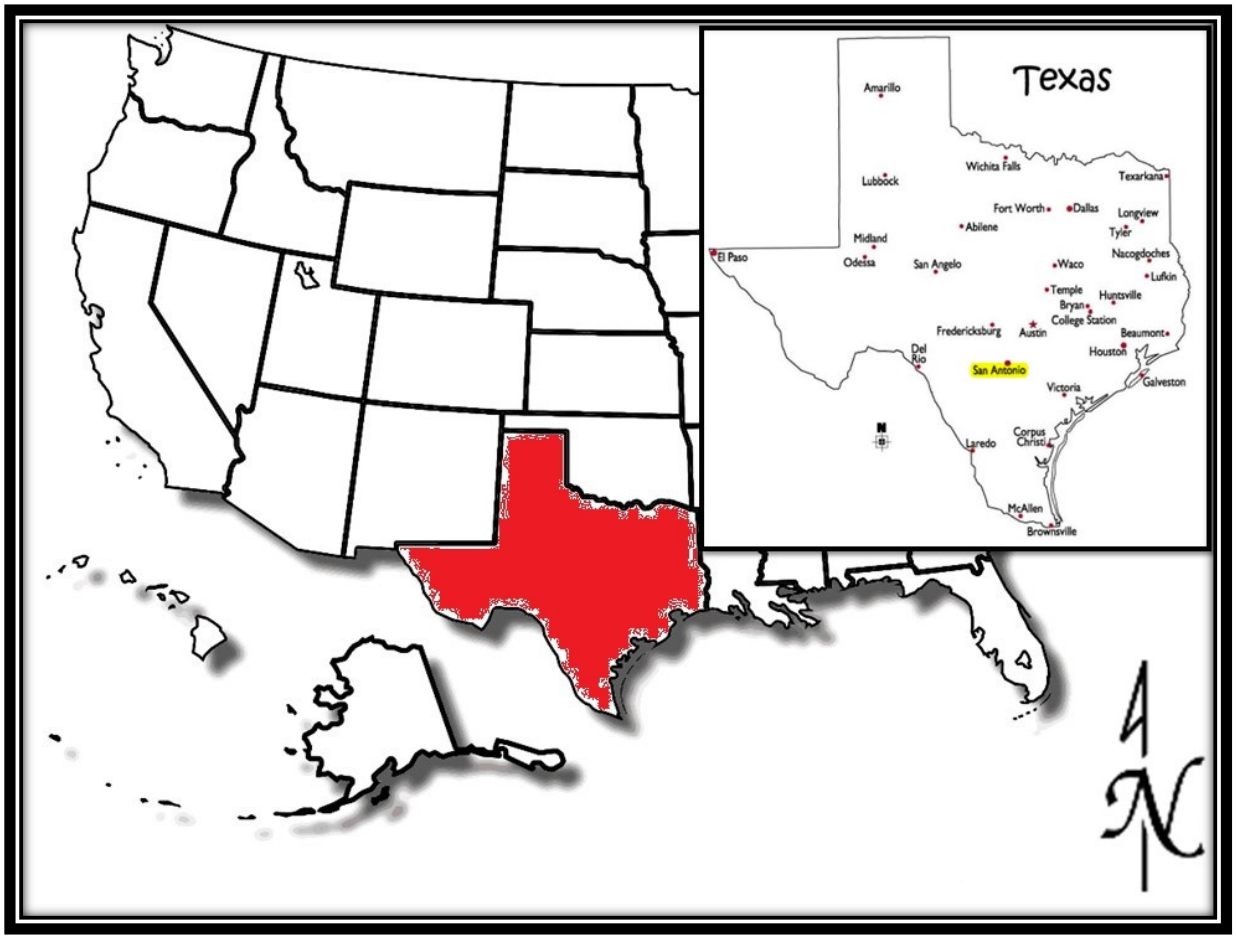

Figure 4 - Location of the State of Texas, United States of America, and of the City of San Antonio

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 and Figure 6).

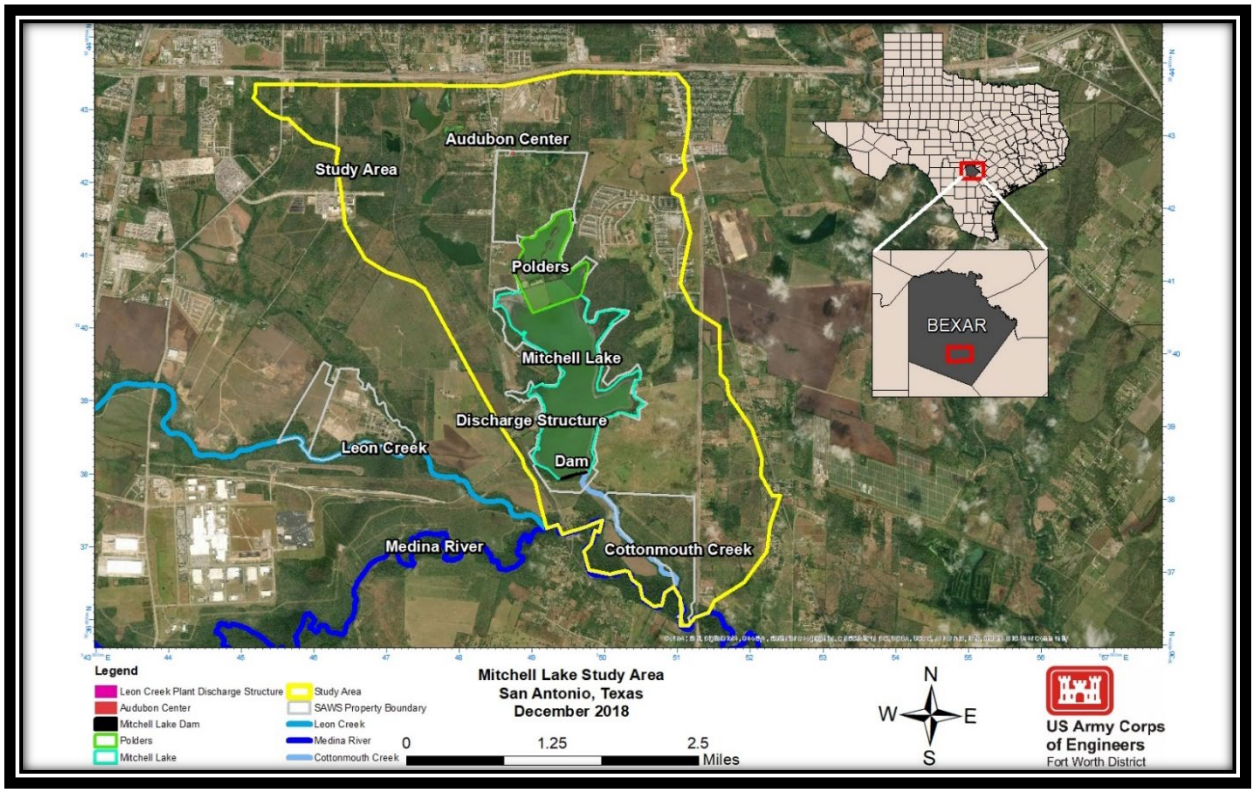

Figure 5 - Map showing location of Bexar County and the City of San Antonio, Texas (Yellow – study area)

City of San Antonio, Texas

The City of San Antonio (City), Texas is located in Bexar, County (Figure 4, Figure 5 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. Part of that purchase included a little marshy area not so far from the Alamo.

Dr. Rudolph Menger, a City native born in 1851, described the area that was to become Mitchell Lake. He described the area as "Tule [swamp weed] jungles" man-high and covered the three

miles long lake from one end to the other". He said 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 The City 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, the City grew rapidly from ~12,000 in 1870, to ~53,000 in 1900. By the end of the 19th century, the City had sewer lines that extended over 25 miles to 500 acres called the Stinson Field, and still needed more. Therefore, an open-air ditch was dug from the Stinson Field to Mitchell Lake, and the dam 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' (approximately) high x 500' long, with a top crest width of 14'.

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

The water from both ditches was used to irrigation cattle feed land, and truck farms. By 1910, the City prohibited the sale, or giving away, of any fruits or vegetables irrigated with water from either the San Antonio Canal, or Cottonmouth Creek.

Raw sewage flowed into Mitchell Lake until 1930. During the wet winter months, there were times of high surface water runoff such that Mitchell Lake water was released into Cottonmouth Creek to flow into the Medina River, and on to the San Antonio River.

In 1925, the City 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 the City 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, the City took over the surface property rights to the lake's outfall, with an easement to use Mitchell Lake. During period of high precipitation, untreated sewage from the treatment plant still went into the lake.

The population of The City remained steady during the 1930s and through World War II. However, after the war, the population increased and the City expanded its political limits. In 1956, a study recommended the construction of a sewage treatment plant on Leon Creek. Instead, the City added to the Rilling Road Treatment Plan in 1956, 1958, and again in 1962.

In 1963, the City 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 emergency 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, the City, 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 The City recommending that Mitchell Lake be designated as a wildlife refuge for waterfowl. The 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 the City.

Because the City 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, after complaints of smell. The City also constructed Bird Pond, Skip's Pond, and Edward's Tank north of Mitchell Lake. Bird Pond held excess sludge, Skips Pond caught runoff from Bird Pond, and Edward's Pond appeared to stay wet from groundwater seepage. It used to have alligators.

Mitchell Lake Today

Mitchell Lake is a 600-acre impoundment managed and owned by THE 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 (Appendix C – Environmental Resources, Section 3.9.3).

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’.

The 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 - Aerial view of primary spillway on east side of Mitchell Lake

Figure 9 - Lakeside view of primary spillway

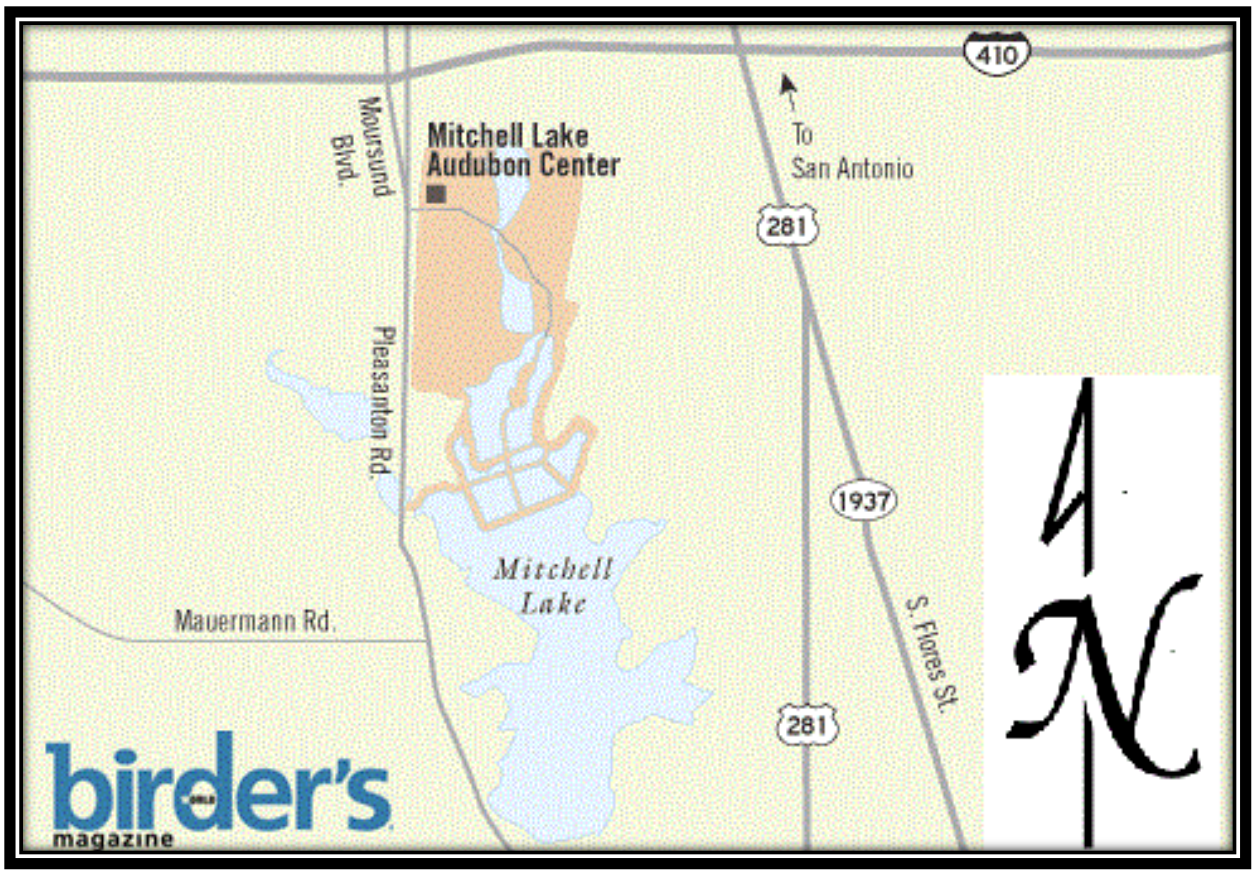

Figure 10 - Map showing Audubon Center in relation to Mitchell Lake

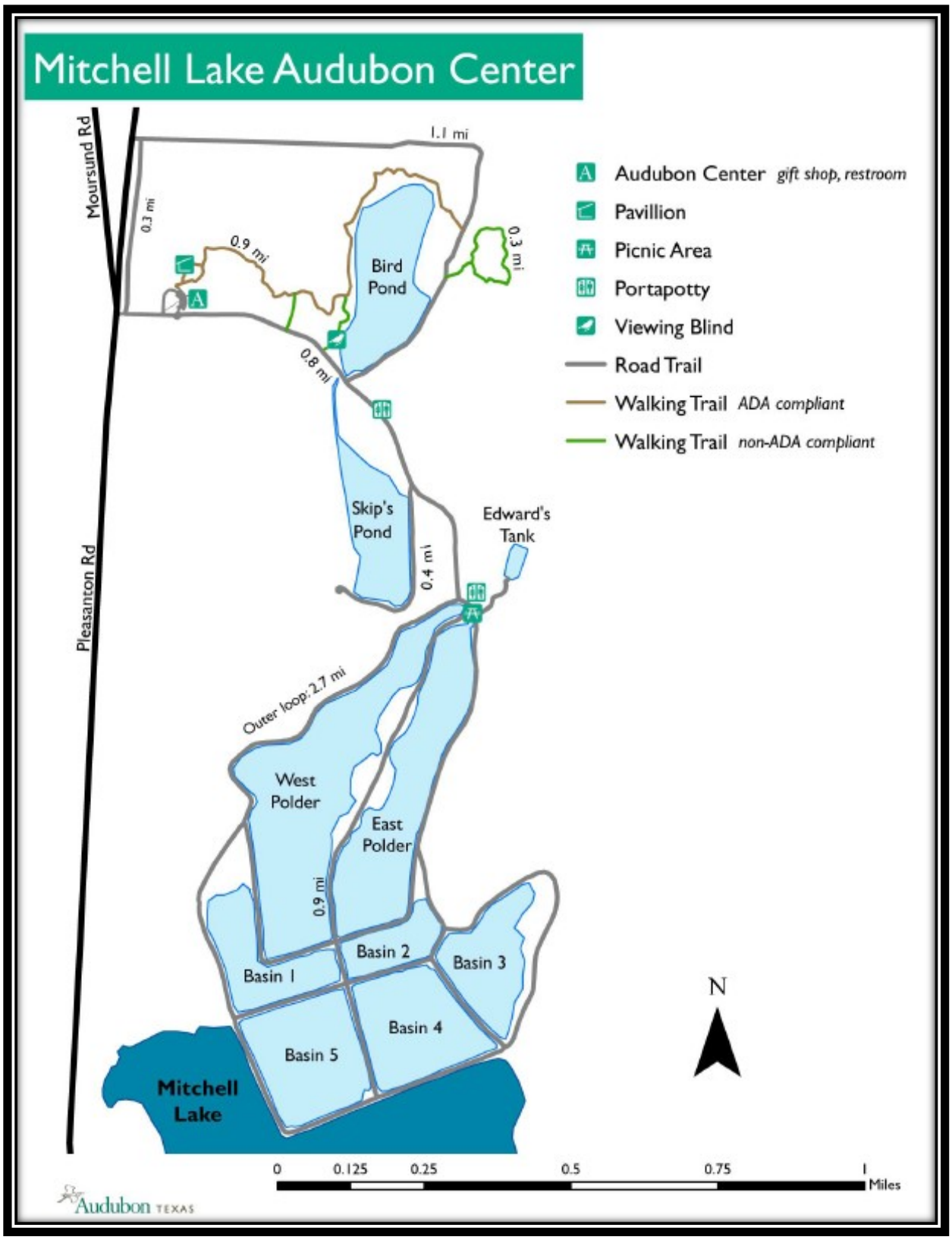

Figure 11 - Another map showing Audubon Center in relation to Mitchell Lake

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

There is significant development activity near Mitchell Lake, including the City'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.

1.4.1 Non-Federal Sponsor

San Antonio Water System, San Antonio, Texas

In 1992, THE SAWS was established as "a single utility responsible for water, wastewater, stormwater, and reuse…THE SAWS was created through the consolidation of three predecessor agencies: the City Water Board (the previous city-owned water supply utility); the City Wastewater Department (a department of the city 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 the city's treated wastewater).

"In the consolidation, SAWS was also assigned the responsibility for complying with federal permit requirements for treatment of the city's stormwater runoff. In addition, the water resources planning staff of the City 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]

1.4.2 Congressional Representatives

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

1. Senator – John Cornyn
2. Senator – Ted Cruz
3. Representative 23rd District – Will Hurd

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

1.5 Prior Reports and Existing Water Projects

1.5.1 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 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 the 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. The 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.”

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

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

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 the City. 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."

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." For more information, see Appendix C – Environmental Resources, Section 1.2.1.

1.5.2 Existing Water Projects

Eagleland Section 1135, San Antonio, Texas - The Eagleland project is located in the City 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 the vast majority 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. For more information, see Appendix C – Environmental Resources, Section 1.2.2.

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 the City'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. For more information, see Appendix C – Environmental Resources, Section 1.2.2.

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”es 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. For more information, see Appendix C – Environmental Resources, Section 1.2.2.

SACIP – WSCs – The purpose of the SACIP GRR and Environmental Assessment (EA), WSC, Ecosystem Restoration, San Antonio, Texas, was to identify ecosystem restoration measures to restore the riverine ecosystem within the WSC that was severely degraded due to the construction and continuing maintenance of the authorized and constructed SACIP and identify recreation opportunities that were compatible with the ecosystem restoration objectives.

The WSC study area encompassed those portions of Martinez Creek, Alazán Creek, Apache Creek, and San Pedro Creek within the originally constructed SACIP footprint. These creeks, collectively known as the WSC, are located west of the San Antonio River on the west side of The City. Changes in the hydraulic regime of the WSC over the last half-century are largely due to shifts in urbanization, the construction of the SACIP, and required operation and maintenance practices. Channelization has led to an increased bed slope and loss of sinuosity.

The recommended plan was the combined NER / National Economic Development (NED) plan. The NER plan restored 67% of the lower trophic organism carrying capacity possible for the WSC riverine system and provided 114% improvement in habitat quality over the no action alternative for 11 miles along the WSC. At maturity (75 years), the NER plan will provide 222 acres of mixed riparian meadow and riparian woody vegetation. The 6.5-mile pilot channel network incorporated 146 pool-riffle-run sections and 143 off-channel slack water areas. The implementation of the NER plan provided a total migratory bird diversity benefit of 101 average annual avian community units, which represented 82% of the diversity benefits available in the system.

The NED plan for recreation provided 44,600' of concrete walk, jog, and bike trails. In addition to trails, other components included shade structures, interpretive / directional signage, benches, water fountains, picnic tables with pads, and trash receptacles.

1.6 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.
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.

1.6.1 Problems and Opportunities – Step 1

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 Section 8.14.1 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 (Section 1.4 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. 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. Salinity and nutrient loading 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 is high nutrient loading and extreme daily variation 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.

1.6.2 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 a number of 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 Goals

The 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 National Environmental Restoration (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 life of the project.
2. Increase the floral and faunal species diversity and richness in the study area for the life of the project.
3. Manage and control invasive species in the study area for the life of the project.

Specific Planning and Institutional Constraints

Specific Planning Constraints:

3. Avoid mobilization of contaminants that would exceed EPA water quality criteria limits
4. Avoid currently developed areas

Institutional Constraints:

1. Avoid increasing flood risks
2. Plans must be consistent will existing Federal, State, and Local laws.

1.6.3 Key Uncertainties

1. The Rio Mia Corporation owns the mineral rights underneath Mitchell Lake, not the City. There are 80 oil wells on 308 acres. Underground pipes run to collection stations, and the oil removed by tanker truck.
2. A natural gas pipeline easement runs across the Mitchell Lake property north of the polders.

1.6.4 Key Assumptions

1. No measures, or Plans, will require real estate actions involving existing mineral rights.
2. No measures, or Plans, will require real estate actions involving the existing natural gas pipeline.

2 Existing Conditions – Step 2, Part 1

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 5), 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 located 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 percent but with more relief on the north side of the watershed with slopes between one percent and four percent. The majority of the watershed is open space with a mix of grass and small trees. The primary developments in the area are the City'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 – H&H, Section 1.1).

2.1.2 Climate

The City is located in the south-central portion of Texas on the Balcones escarpment (Appendix A – H&H, Section 1.2). 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 black land 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, The City experiences a modified subtropical climate. During the summer, the climate becomes tropic-like with prevailing south and southeast winds. The moderating effects of the Gulf of Mexico prevent extremely high temperatures;

however, summers are usually long and hot with daily maximum temperatures above 90 over 80 percent of the time. In many years, summer conditions continue into September and sometimes to October. The average monthly temperatures range from the 50s in winter to 80s in summer. The historic recorded high and low temperatures occurred 6 September 2000 (111º F) and 21 January 1949 (0º F).

2.1.3 Precipitation

The City 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 (Appendix A – H&H, Section 1.3). The average long-term annual precipitation for The City is around 29”es, although it may range from as low as 10 to near 50”es from one year to another. The extremes vary from 10.11”es in 1917 to 52.28”es in 1973. Most precipitation occurs in May, June, September, and October. During some of these events, rain has exceeded 5”es in several hours and caused flash flooding. The net lake evaporation rates range from 0.08”es per day in January to 0.29”es per day in August. Figure 12 shows the annual precipitation for The City from 1934 through 2018. Monthly and yearly precipitation totals from 2000 to 2019 are shown in Table 3 - Monthly and Yearly Precipitation 2000 – 2019.

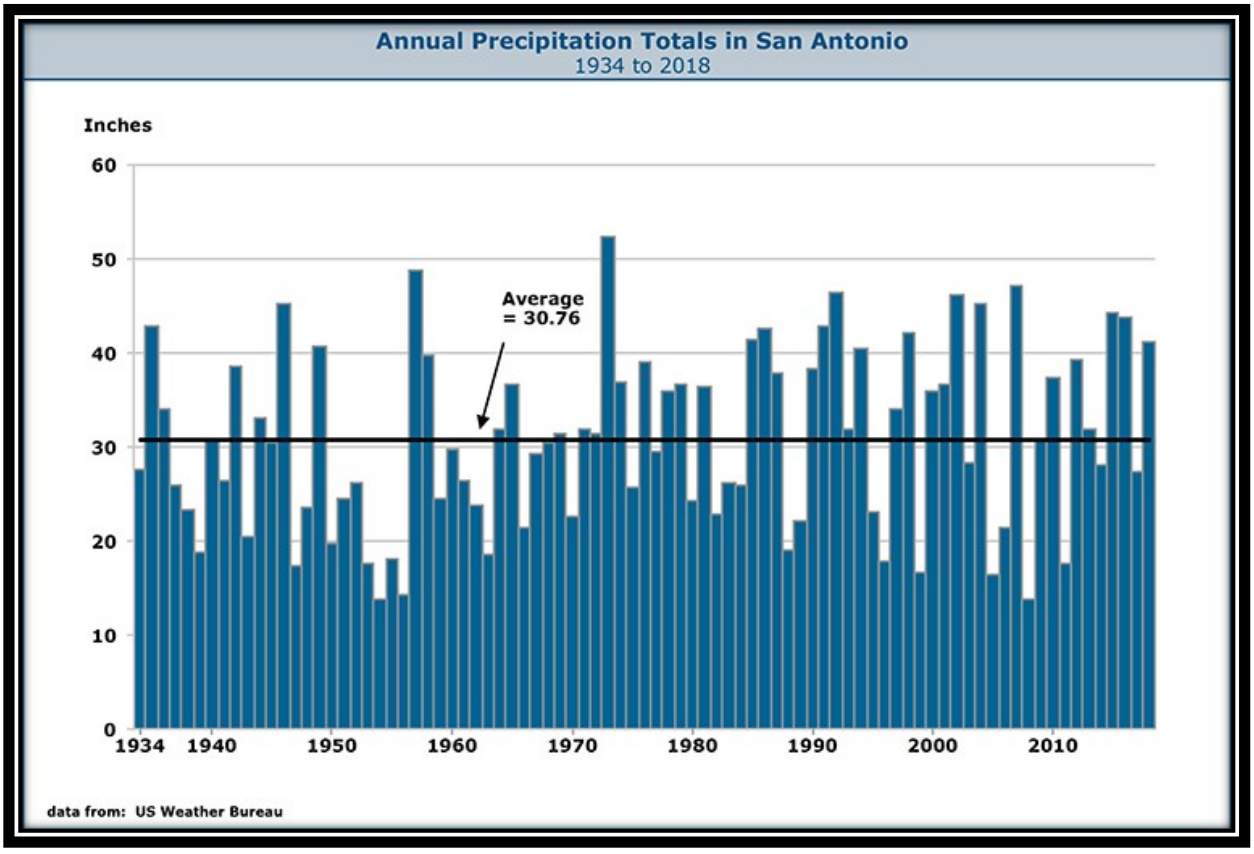

Figure 12 - 1934 through 2018 Precipitation Totals for San Antonio, Texas

Table 3 - 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	.14	.31	1.45	4.02	.21+	M	20.97+
AVE	1.65	1.73	1.89	2.6	4.72	4.29	2.05	2.56	2.99	3.86	2.60	1.97	32.91

2.1.1 Hydrology

ARCADIS developed an existing conditions hydrologic model of the Mitchell Lake watershed (Appendix A – H&H, Section 2.1). 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 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 the City's Unified Development Code."

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.

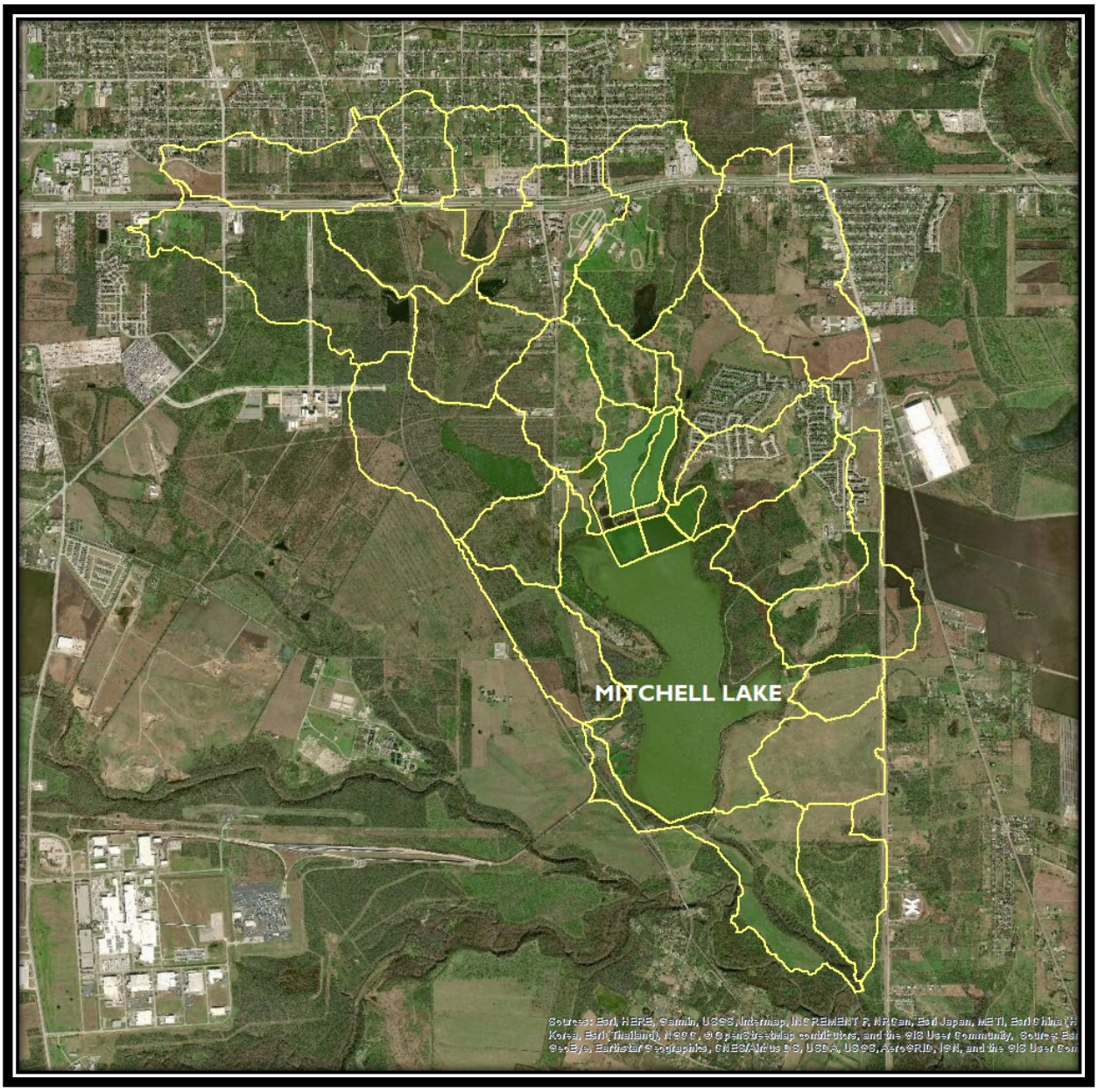

Figure 13 - Mitchell Lake Study Area Sub-Basins Used in the HEC-HMS Model

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 4) (Appendix C – Environmental Resources, Section 3.9.3).

Table 4 - 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 (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 percent 12-hour PMP	6,673	526.0
40 percent 12-hour PMP	11,620	527.5

2.1.2 Hydraulic Conditions

2.1.2.1 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 located in southern Bexar County (Figure 5), and was purchased by the City in 1901. It is currently operated and managed by the 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 Wastewater Treatment Plant (WWTP) (Figure 10 and Figure 34). 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 – H&H, Section 1.4).

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).

2.1.2.2 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 (Table 5). Treated effluent (recycled water) is piped to the lake from the Leon Creek Water Recycling Center. Recycled water enters the lake within the polder complex, and is used to maintain lake levels during dry periods (Appendix A – H&H, Section 1.4).

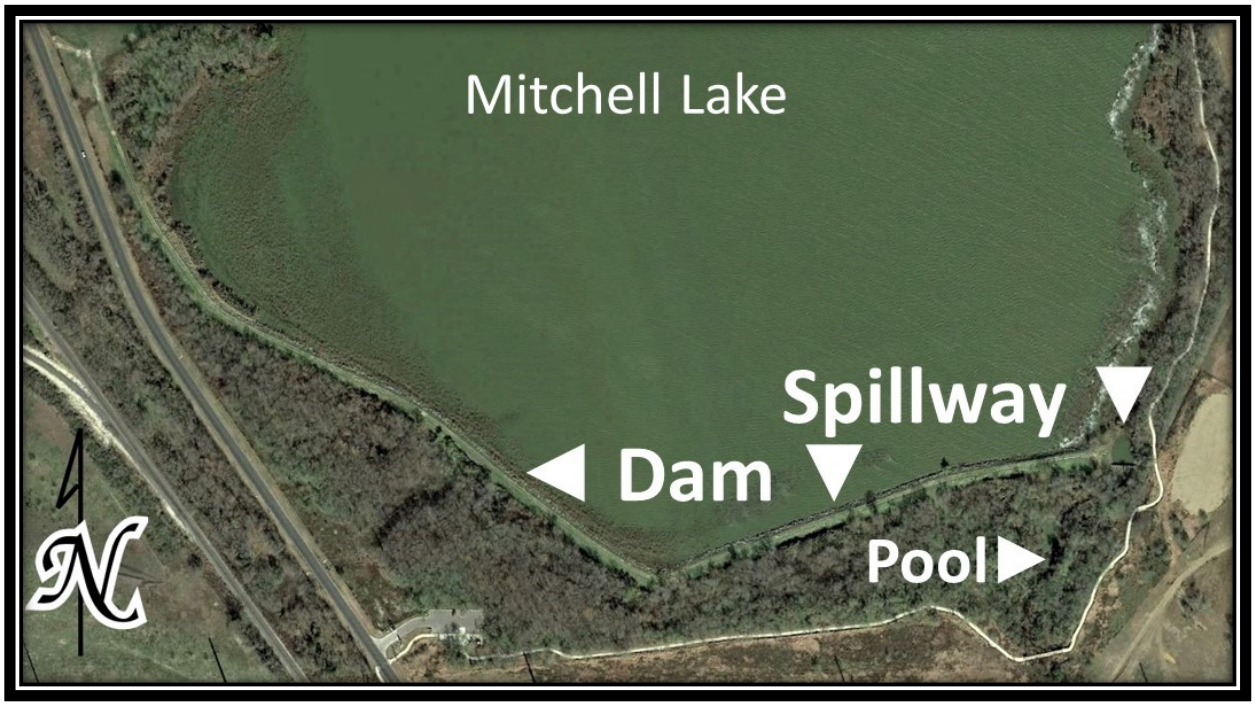

Figure 14 - Mitchell Lake Dam, Spillway, and Plunge Pool

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 percent of the Probable Maximum Flood (PMF) without overtopping the respective dam. The TCEQ, in a letter to the SAWS, recommended a 28 percent 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 (Appendix C – Environmental Resources, Section 3.9.3).

Table 5 - 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’
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’
Primary Service Spillway Crest	520.73’
Emergency Spillway Crest	527’
Top Width	15’

The primary concrete spillway, located at the southeastern end of Mitchell Lake is ~55’ wide and has eight 36” diameter gate valves (ARCADIS US, Inc. 2014). The valves are positioned at an elevation of 520.73’ 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 6. 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, the SAWS intends to retire the primary concrete spillway, and build a new spillway structure; designs are unknown at this time. The 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).

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

Table 6 - Spillway Rating Curve (ARCADIS US Inc., 2014)

Elevation (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), and 32 CFR 775 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, and
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. (Appendix C – Environmental Resources, Section 3).

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)), guidance for USACE ecosystem restoration projects 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 (Appendix C – Environmental Resources, Section 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, Section 2.1:

- Endangered Species Act (ESA) – Federally listed species that have the possibility of occurring in the study area are the golden-cheeked warbler, red knot, piping plover, interior least tern, and whooping crane. However, their occurrences may be limited due to the lack of suitable habitat within the project area. The red knot, piping plover, and least tern 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.

- 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 11990: Protection of Wetlands – EO 11990 directs Federal agencies to take action 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 enhance 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 enhancing 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.
- Texas Senate Bill 2, 77th Legislature – The State of Texas recognizes the San Antonio River basin as a critical fish and wildlife resource. This bill requires the TPWD, the TWDB, the TCEQ, and other state and local agencies to establish an interagency in stream flow program to determine conditions necessary to support a sound ecological environment. Several Texan agencies are participating in the Mitchell Lake feasibility study.

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 particular resource. Recognition of public significance for the Mitchell Lake study area can best be demonstrated by the actions of the 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. 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, the 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.
- The 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.

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, critical 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, Section 2.3:

- 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. In an effort 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 enhance 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.

2.2.2 Climate

The City has a modified subtropical climate with a relatively continental influence during the winter and maritime influence from the Gulf of Mexico during the summer. The mean annual temperature is 68.7ºF (US Climate Data 2019). Mild weather prevails most of the winter, with freezing temperatures occurring ~20 days per year. Summers are usually long and hot with daily maximum temperatures over 90ºF occurring ~80% of the time. The mean annual precipitation is 32.91”es per year (Appendix C – Environmental Resources, Section 3.1).

2.2.3 Geology and Topology

The geology of an area includes bedrock materials and mineral deposits. The principal geologic factors influencing the stability of structures are soil stability, depth to bedrock, 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’ above mean sea level (amsl) to 604’ amsl 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 (Appendix C – Environment Resources, Section 2.3.2).

2.2.4 Soils, Including Prime Farmlands

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.

Twenty-seven soil types occur within the study area (NRCS, 2019) (Figure 15). The names to correspond to the symbols can be located in Appendix C – Environment Resources, Section 3.3.

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 The City, the proposed project is exempt from the Farmland Protection Policy Act (FPPA) requirements.

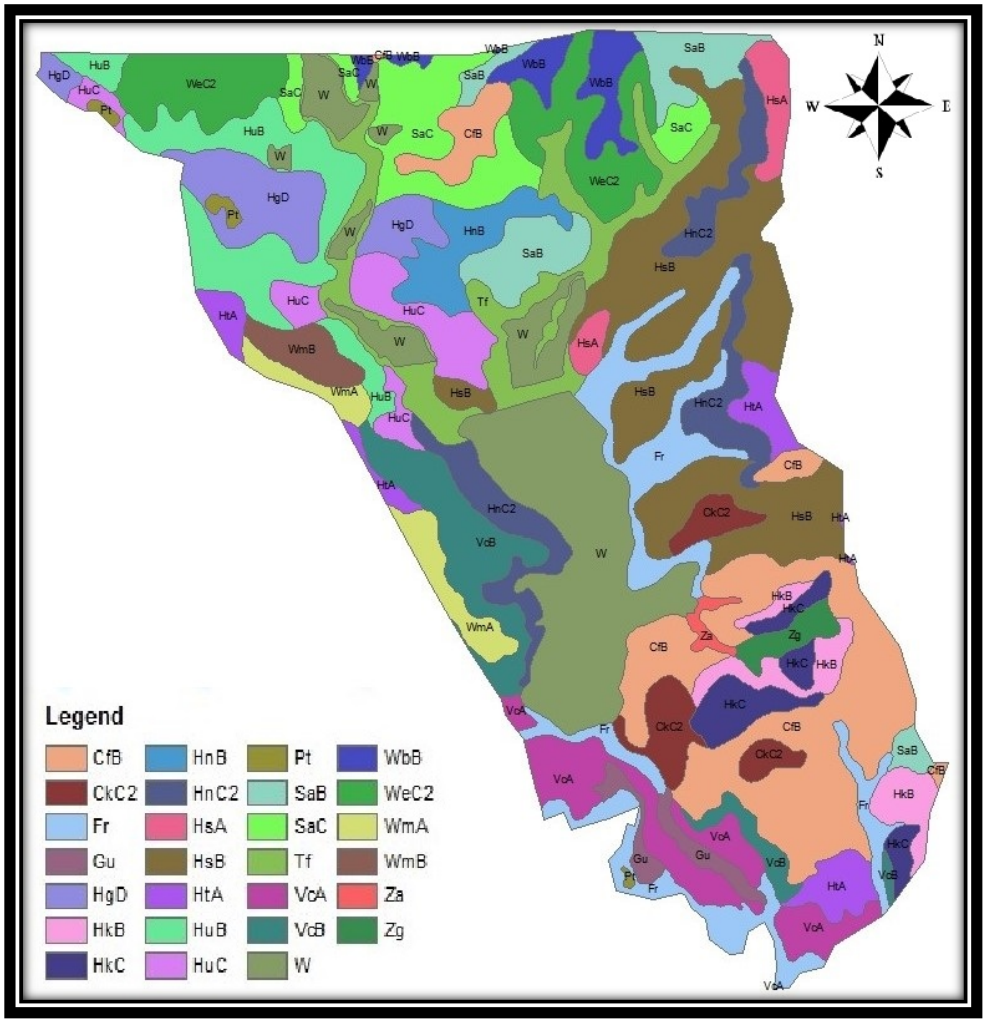

Figure 15 - NRCS Web Soil Survey Map of the Mitchell Lake Study Area (2019)

2.2.5 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.

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 2019). Due to the fertile soils and proximity to the water from Mitchell Lake, much of the study area has been utilized for agricultural purposes (Appendix C – Environment Resources, Section 3.4).

2.2.6 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 16), particulate matter less than 10 microns (PM10), particulate matter less than 2.5 microns (PM2.5), 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 located in Bexar County, which is currently in marginal nonattainment and has an attainment deadline of September 24, 2021. The City is currently in non-attainment status as well (Appendix C – Environmental Resources, Section 3.5).

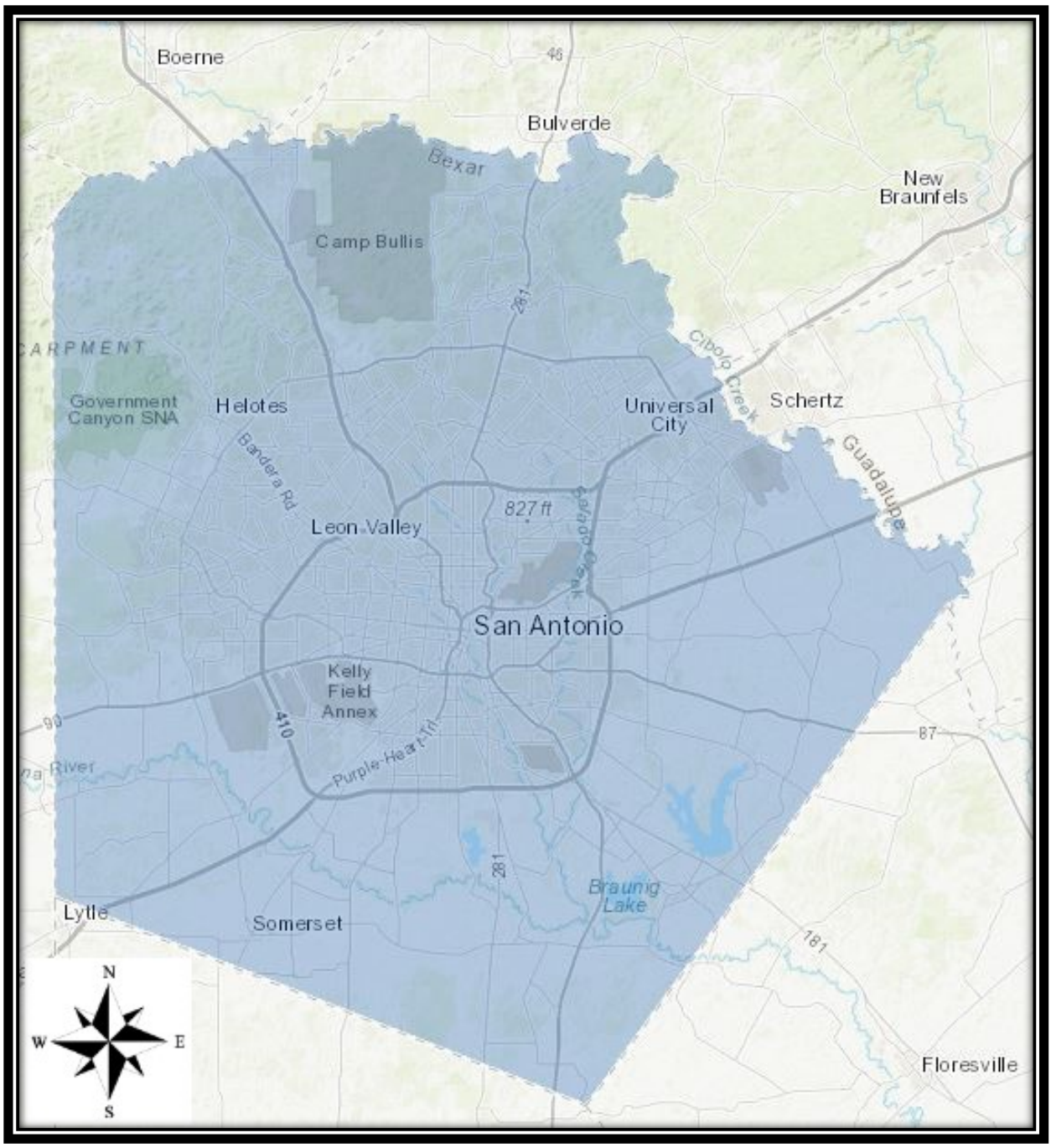

Figure 16 – NAAQS Non-Attainment Area State Level Maintenance Nonattainment Area: Ozone 8-hour 2015 for Bexar County, TX (EPA AirData Air Quality Monitors)

The study area is located in Bexar County, which is currently in marginal nonattainment and has an attainment deadline of September 24, 2021. The City is currently in non-attainment status as well (Appendix C – Environmental Resources, Section 3.5).

2.2.7 Noise

The study area is located in a relatively rural area of The City 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 is located west of Mitchell Lake; however, the airport facilities are in disrepair and it appears that the facility is no longer in use (Appendix C – Environmental Resources, Section 3.6).

2.2.8 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 the majority of 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 The City, TX and lies within the study area. As stated above, the airport appears to be non-operational (Appendix C – Environmental Resources, Section 3.7).

2.2.9 Light

The study area is located in a relatively rural area on the edge of the urbanized areas of The City. 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 and trailhead south of Mitchell Lake, and from neighborhoods, businesses, and industries adjacent to the lake (Appendix C – Environmental Resources, Section 3.8)

2.2.10 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 (Figure 17). 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 17) (Appendix C – Environmental Resources, Section 3.9).

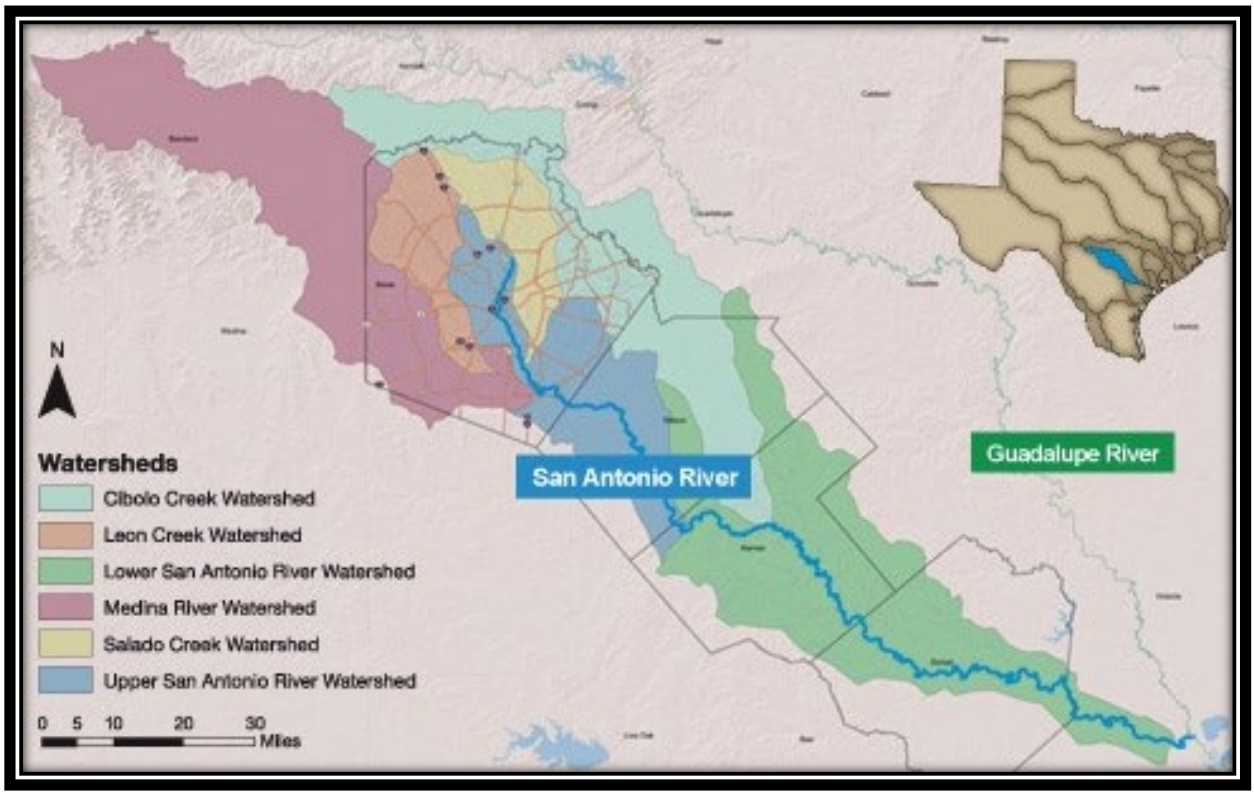

Figure 17 - San Antonio River Basin and Its Tributaries (SARA 2019)

Mitchell Lake is located within the Medina River Watershed. ~1,112 square miles drain into this watershed (SARA 2019). A majority 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.

2.2.10.1 Surface Water

Mitchell Lake has ~670 acres of surface water at an elevation of 520.4 ‘ amsl. The water surface elevation is maintained through surface water runoff in the upper basin and inputs from the Leon Creek WWTP west of the lake. Inputs from the WWTP are used to offset the evaporation in Mitchell Lake in an effort to maintain a consistent surface water elevation. Due to the impaired water quality of the lake, no releases are allowed out of Mitchell Lake. However, flooding from large storm events results in uncontrolled releases over the water control structure associated with the Mitchell Lake Dam. For the FWOP condition, the SAWS intends to lower the normal elevation to 517’ or 518’ amsl in the near future.

Water is pumped from Mitchell Lake into the polders to minimize odors and mobilization of its sediments. The polders are maintained at a relatively consistent water surface elevation. They cumulatively provide ~50 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 3-3). 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.

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 (Appendix C – Environmental Resources, Section 3.9.1).

2.2.10.2 Groundwater

Groundwater in the study area is provided from the Carrizo-Wilcox Aquifer (Figure 18). The Carrizo-Wilcox Aquifer extends from the Louisiana border to the border of Mexico in a wide band adjacent to the Gulf Coast Aquifer. The aquifer is located in the Wilcox Group and the overlying Carrizo Formation of the Clairborne Group. The aquifer is primarily composed of sand locally interbedded with gravel, silt, clay, and lignite. Although the aquifer is ~3,000' thick, the freshwater saturated thickness of the sands averages 670'. Irrigation comprises ~50-percent of the water pumped from the aquifer while municipal water supply accounts for 40-percent (Appendix C – Environmental Resources, Section 3.9.2).

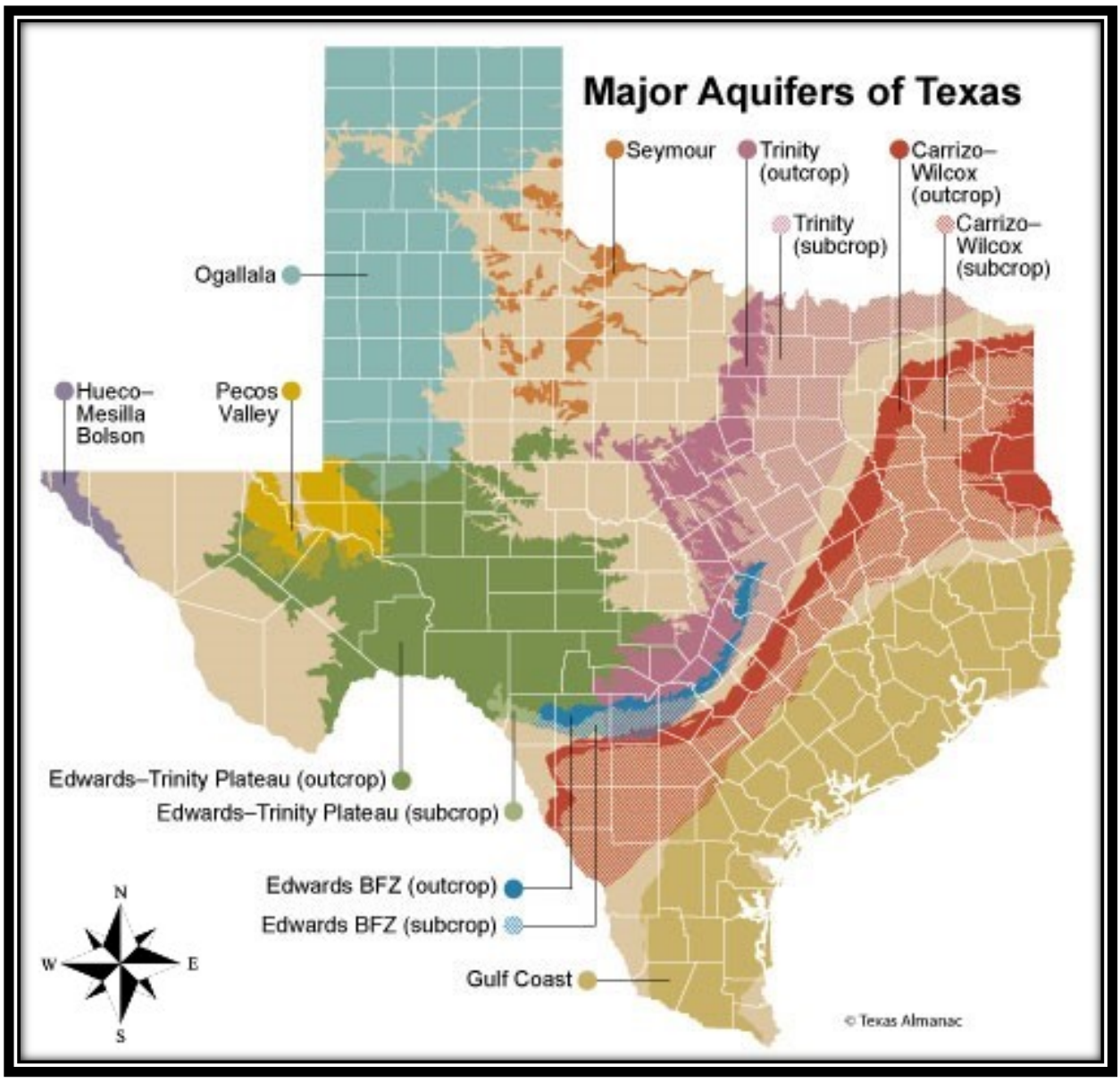

Figure 18 - Major Aquifers of Texas (Texas Almanac 2019)

2.2.10.3 Wetlands

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.

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 19). 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.

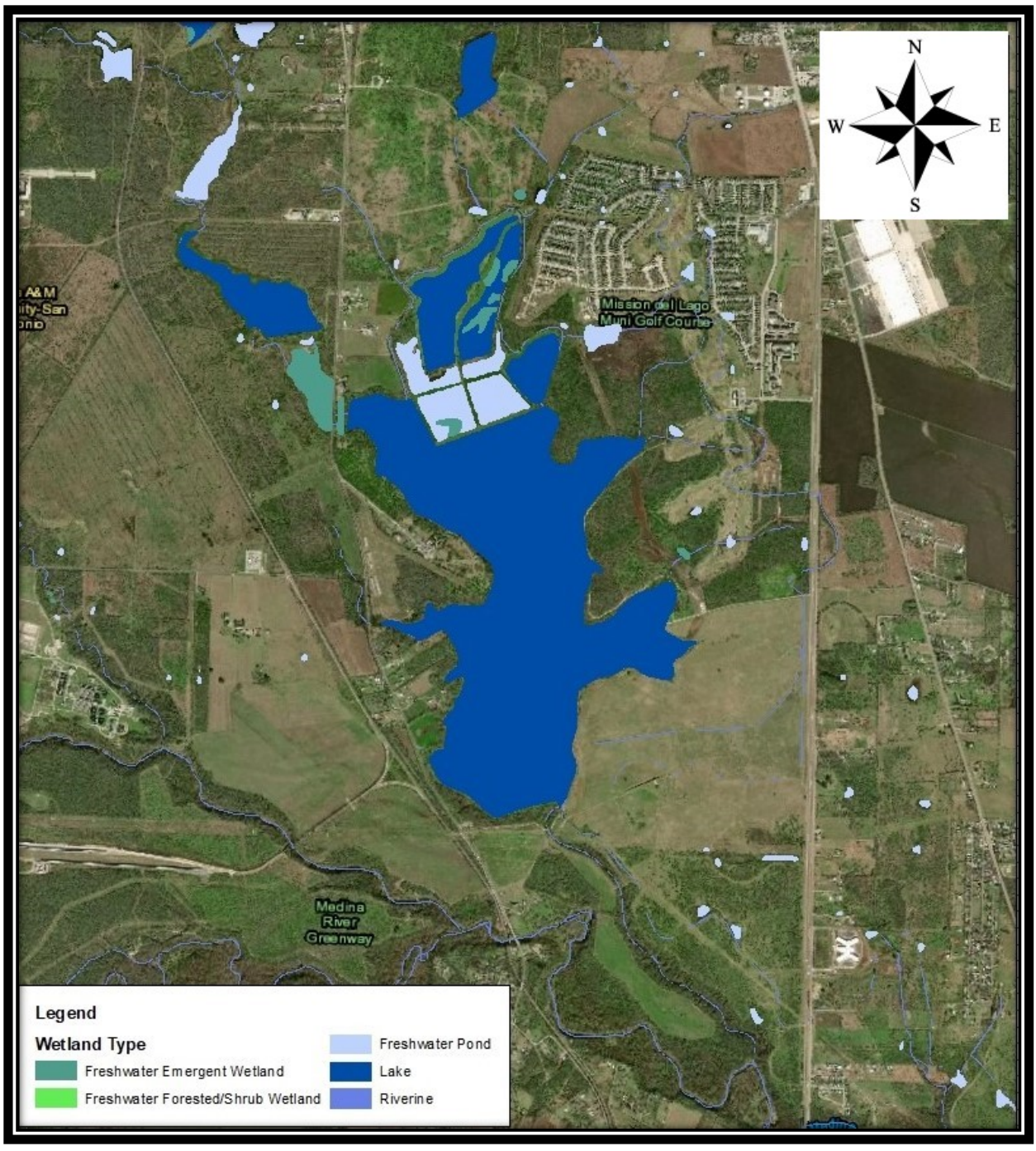

Figure 19 - National Wetlands Inventory of the Study Area (USFWS 2019)

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 20 (Appendix C – Environmental Resources, Section 3.9.4).

Figure 20 - Field Wetland Survey (June 2019)

2.2.10.4 Water Quality

The SAWS operates Mitchell Lake as a permitted wastewater treatment unit under the TCEQ Texas Pollutant Discharge Elimination System (TPDES) Permit No. WQ0010137004 (Alan Plummer and Associates, Inc. 2016).Under this permit, the SAWS is required to monitor and report outflows of the lake, pH, five day Biochemical Oxygen Demand (BOD_5), DO, and Total Suspended Solids (TSS) when discharges occur. The maximum allowable water quality parameters allowed under the TCEQ TPDES permit are provided in Table 7. Discharges only occur during substantial rainfall events out of the uncontrolled primary spillway (Appendix C – Environmental Resources, Section 3.9.4).

Table 7 - Mitchell Lake TCEQ TPDES Maximum Allowable Water Quality Parameters (Alan Plummer and Associates, Inc. 2016)

Parameter	Existing Permit
BOD_5, mg/L	30
TSS, mg/L	90
Ammonia, mg/L	N/A
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 in regards to 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 8). The Simpson Group data represents a single point in time and not a seasonal average. Currently the 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 is allowed from Mitchell Lake, nutrients and salts concentrate in the lake. Therefore, under the FWOP conditions, the water quality at Mitchell Lake is expected to degrade. 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 8 - 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)

2.2.11 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 (Appendix C – Environmental Resources, Section 3.13).

2.2.12 Recreation

The study area has several popular recreation sites: the Mitchell Lake Audubon Center, 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 view of vegetation, wetlands, and various species of wildlife. Parking at the Pleasanton Road Trailhead is available and easily accessible at all points of entry (Figure 21). See Section 2.2.1 Resource Significance.

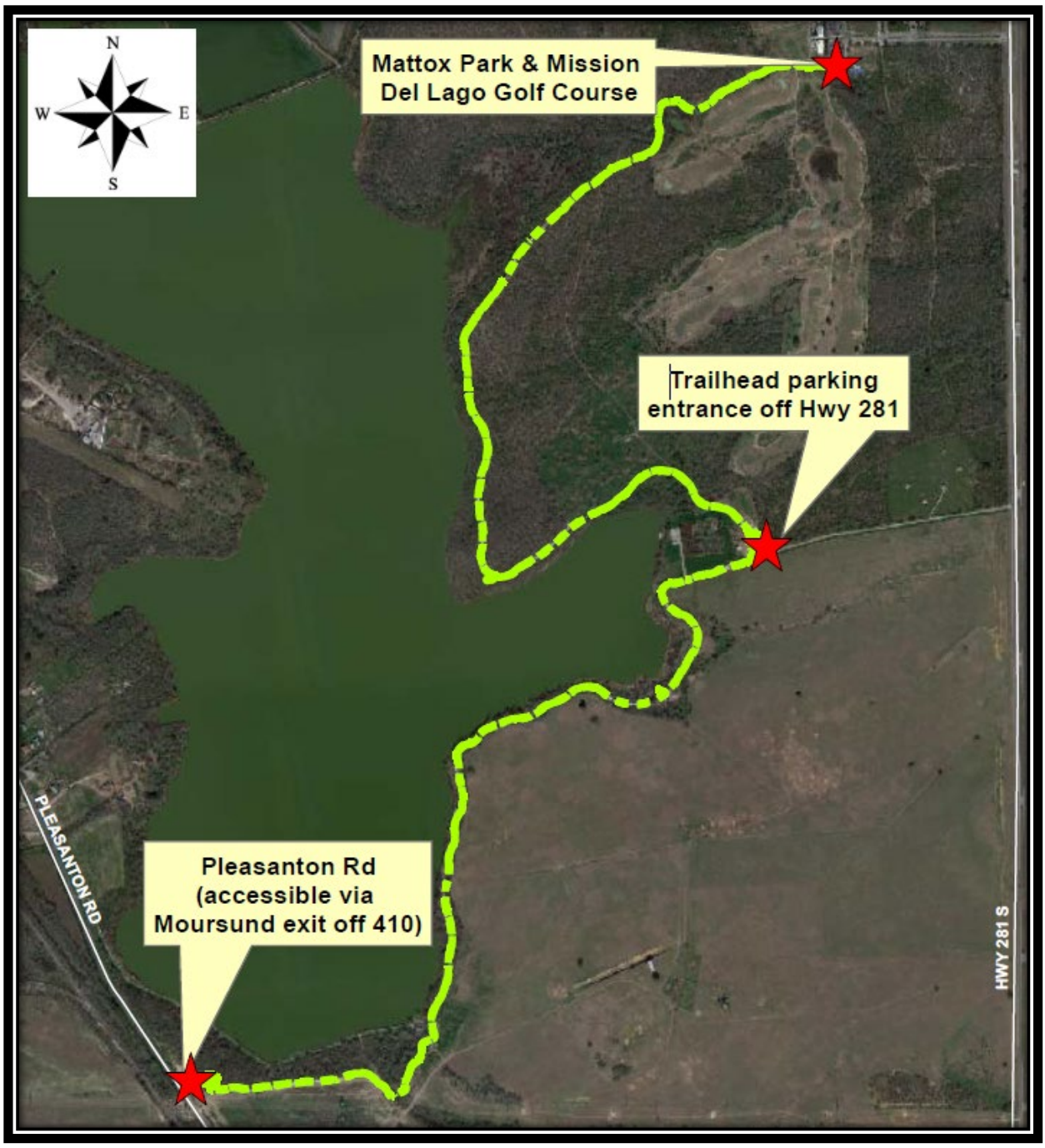

Figure 21 - Pleasanton Road and Mattox Park Trailheads (City of San Antonio, TX 2019)

The Mitchell Lake Audubon Center, north of the lake, is owned by the 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 the SAWS property boundary. Access to the lake is restricted and controlled by a 10' fence (Appendix C – Environmental Resources, Section 3.15).

2.2.13 Vegetation

The Mitchell Lake study area is dominated by non-native invasive species and native nuisance species resulting in habitats with low plant diversity. Lists of woody, herbaceous, wetland, aquatic and invasive plant species can be found in Appendix C – Environmental Resources, Section 3.16.1.

2.2.14 Wildlife

Wildlife inhabiting the study area includes species typical of pastoral, savannah, and woodland habitats. Lists of mammal, avian, and reptile species can be found in Appendix C – Environmental Resources, Section 3.16.2.

2.2.15 Federally Listed Threatened & 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 Appendix C – Environmental Resources, Section 3.16.3, and Attachment C.

No critical habitat is designated within the study area. Threatened and Endangered species have been known to use the Mitchell Lake. Examples: Interior Least Tern, Piping Plover, Red Knot

2.2.16 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.

Figure 22 - Habitat Assessment Survey Points (July 2019)

The past several decades have 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 (Appendix C – Environmental Resources, Section 3.16.5).

2.2.17 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. A list of invasive species can be found in Appendix C – Environmental Resources, Section 3.16.6.

2.3 Cultural Resources

In the focused study area, and up to a kilometer surrounding, was examined for the presence of any known cultural resources using the Texas Historical Commission's Atlas database. Five archaeological sites have been recorded, as well as six identified architectural resources (Table 9). The recorded sites were reported to the Texas Historical Commission. Although the review identified previous surveys, it is important to note that the majority of the focused study area has not been culturally surveyed.

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 9 - Cultural Resources within the Focused Study Area

Resource	Type	Component	Description	NR Status
41BX1376	Archaeological	Prehistoric	Lithic Scatter	Ineligible
41BX1835	Archaeological	Prehistoric	Prehistoric Open Campsite	Ineligible within ROW
41BX1871	Archaeological	Prehistoric	Lithic Scatter	Ineligible within ROW
41BX1872	Archaeological	Historic	Acequia	Ineligible
41BX2216	Archaeological	Prehistoric	Lithic Scatter	Recommended Ineligible
N/A	Structure	Historic	Embankment Dam	Eligible
N/A	Structure	Historic	Flood gate	Eligible
N/A	Structure	Historic	Spillway	Eligible
N/A	Structure	Historic	Purge pond	Eligible
N/A	Structure	Historic	Irrigation canal system	Ineligible
N/A	Structure	Historic	Electric transmission line	Ineligible

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 HTRW appendix for more information about risks from these sites (Appendix E – Environmental Engineering, Section 2.1).

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 contaminated 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 contamination. It is important to consider this if Basin 3 were to be included in any excavation or construction plans. At this time, however, there are no plans to disturb this Basin and the recommended treatment is to leave the contaminant “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. This is a relatively low concentration of sites given the large area of land and the number of oil and gas wells in the surrounding area. San Antonio is a highly developed city within close proximity and most potential HTRW sites are located in or around this settlement (Figure 23).

Figure 23 - 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 24). 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 HTRW Appendix for maps of

known pipelines and oil and gas wells surrounding the Lake. However, all of these instances have an extremely low potential to affect the proposed project (Appendix E – HTRW, Section 2).

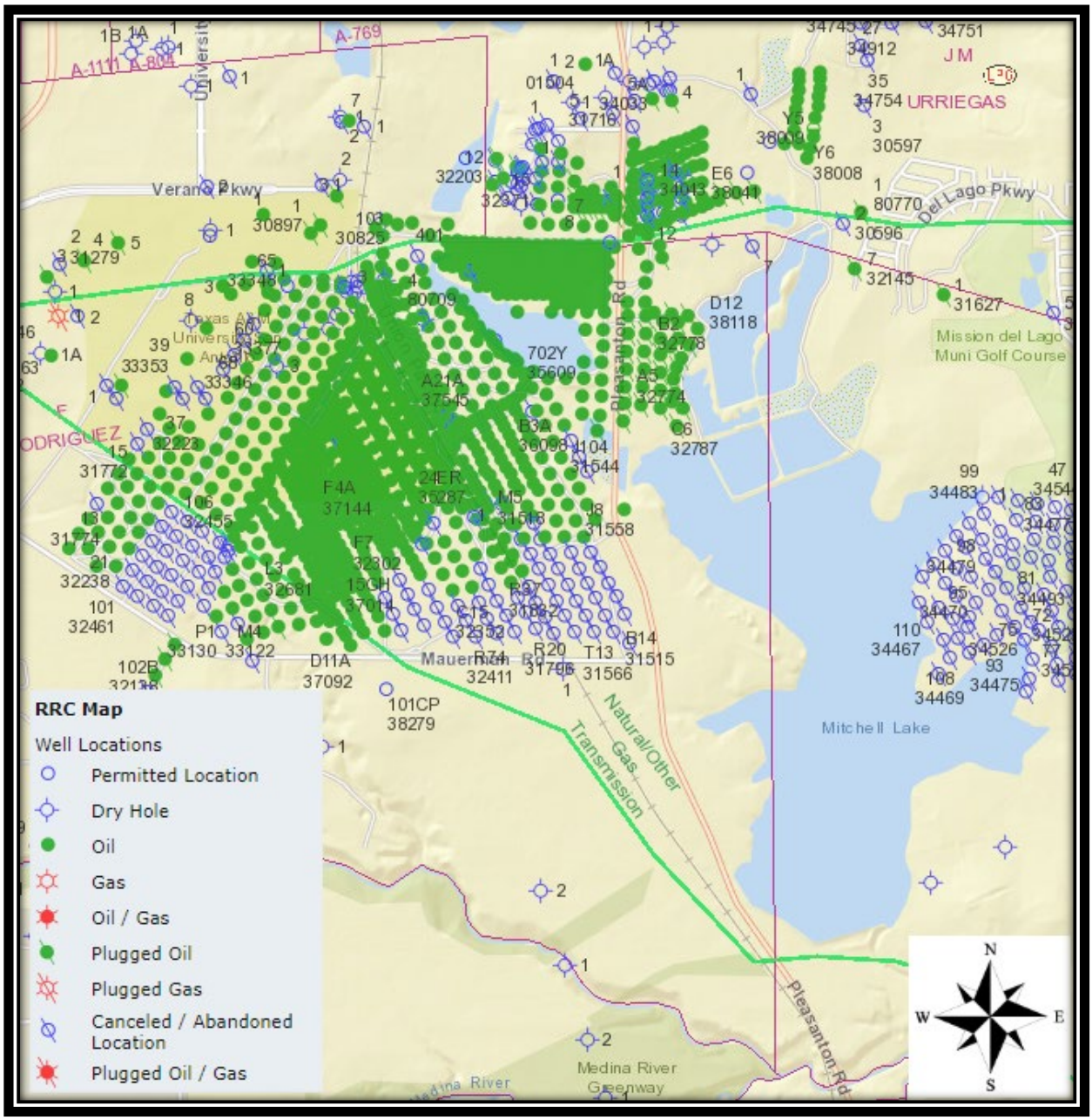

Figure 24 - Map of Local Oil and Gas Sites

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 dams or berms, dredging, etc.) site-specific soil sampling, laboratory tests, and an engineering analysis would be conducted.

2.5.1 General Geology

The City 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' 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 The City in Bexar County. The area is within the Balcones Fault Zone, an area characterized by numerous parallel and en 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 (Appendix I – Geotechnical Engineering, Section 2.2).

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 enhancement 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 1 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 HsB.

The next three major soil units are Miguel Fine Sandy Loam (CfB) which covers about 6%; Houston Black Gravelly Clay (HuB) which covers about 6.1% and Floresville Fine Sandy Loam (WeC2) which covers about 6.6% of the mapped AOI. Thus, for practical purposes, we can estimate that about 18 to 20% of the AOI are clayey soils and about 12 to 13% are sandy soils. With the lake surface added to these numbers, the minor soil components add up to about 50 to 55%; composed of about equal amounts of clayey soils and sandy soils.

The above generalization is anticipated as the soil sediments consist of both alluvial deposits and the native clayey strata (Appendix I – Geotechnical Engineering, Section 2.3).

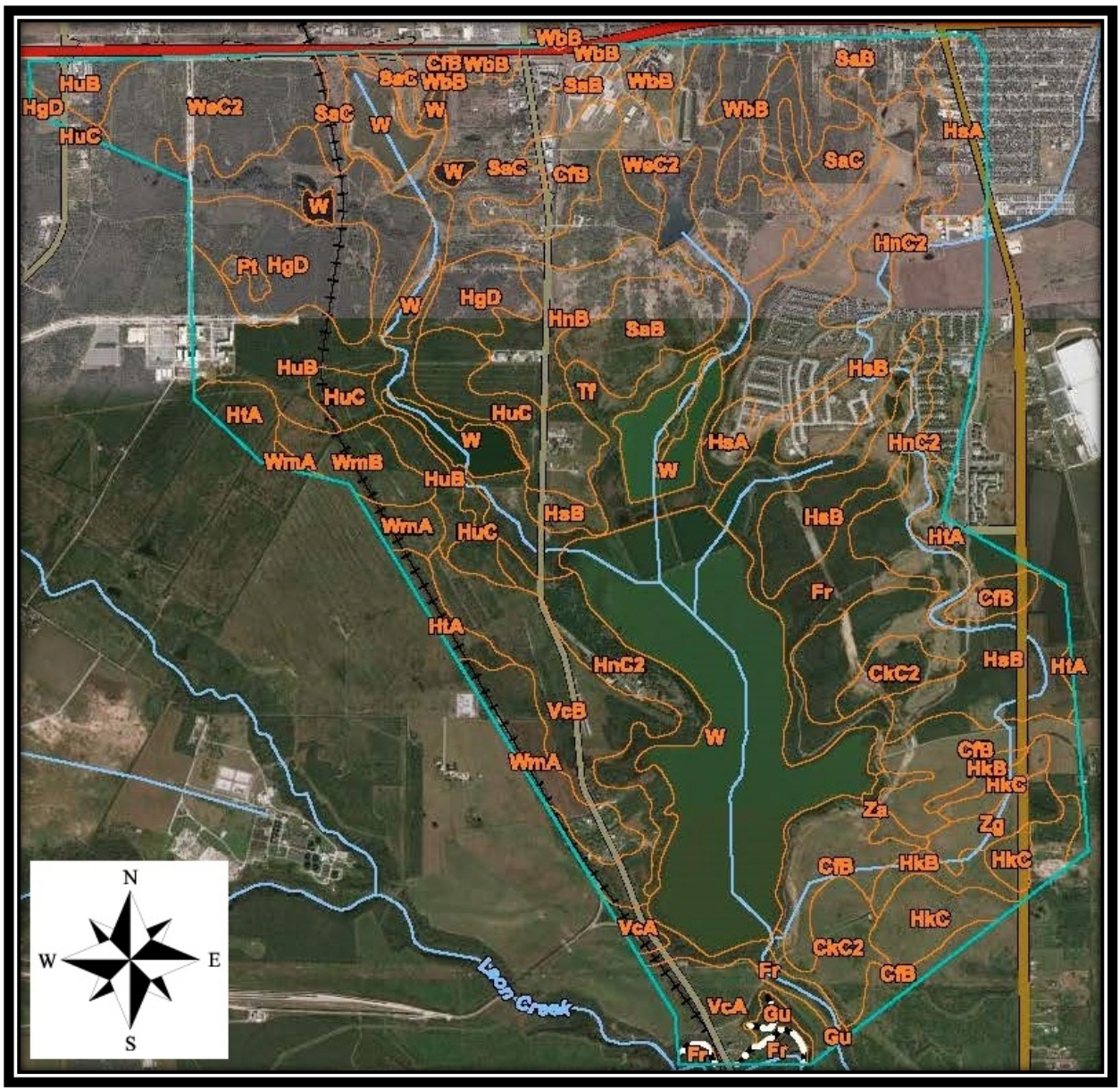

Figure 25 - Mitchell Lake Study Area with NRCS Soil Types

2.6 Socioeconomics

The socioeconomics of the communities surrounding Mitchell Lake are summarized in this section. Mitchell Lake is located in San Antonio, Bexar County, Texas. This section will describe the socioeconomics and demographics of the following AOIs: 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 (Appendix C – Environmental Resources, Section 3.10).

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 10 - 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

Table 11 - 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%
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.

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

Table 12 - 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.

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 the majority of the population. The Hispanic population accounts for 87% of the total population in the census tract surrounding the lake.

Table 13 - 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 the City, 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 14 - 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 – Step 2, Part 2

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 no 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 Sedimentation

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. The City and Bexar County have floodplain ordinances that limit stormwater runoff impacts of new development. The City‘s Unified Developed Code (UDC) and the Stormwater Design Criteria Manual give criteria for effective stormwater management and the mitigation of downstream impacts.

According to the City’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 would prevent increased downstream impacts and the possibility of overtopping of Mitchell Dam (Appendix A – H&H, Section 3).

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. Section 4.5 is a general description of the likely future conditions in the study area over the 50-year life of the project 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 were assisted with this process.

Unless stated otherwise, it is assumed the existing conditions will continue to persist and degrade in the FWOP scenario (Appendix C – Environmental Resources – Section 3, and Attachment H).

3.2.1 Climate

In Texas, temperatures are expected to increase by 4ºF by 2050 because of rising levels of carbon dioxide (CO_2) and other greenhouse gases in the atmosphere. The intensity of hurricanes and extreme storm events is expected to increase; however, these high precipitation pulsed periods are expected to be followed by increasingly long periods of drought. Although temperatures are expected to increase according to the latest climate models, future changes to precipitation in Texas resulting from climate change are highly variable and continue to have a high level of uncertainty (North et. al. 2011) (Appendix C – Environmental Resources, Section 3.1).

3.2.2 Geology and Topology

No change from the existing condition is expected (Main Report, Section 2.2.2).

3.2.3 Soils, Including Prime Farmlands

No change from the existing condition is expected (Main Report, Section 2.2.3).

3.2.4 Land Use

No change from the existing condition is expected (Main Report, Section 2.2.4).

3.2.5 Air Quality

No change from the existing condition is expected (Main Report, Section 2.2.5).

3.2.6 Noise

No change from the existing condition is expected (Main Report, Section 2.2.6).

3.2.7 Transportation

No change from the existing condition is expected (Main Report, Section 2.2.7).

3.2.8 Light

No change from the existing condition is expected (Main Report, Section 2.2.8).

3.2.9 Water Resources

Under the FWOP condition, there would be no measurable impacts to waters.

3.2.9.1 Surface Water

In the FWOP condition, the Mitchell Lake Water Management Plan is to decrease the surface water elevation from 519’ to 517’ amsl, thereby decreasing the open water surface area of the

lake (Appendix C – Environmental Resources, Section 5.11.1). Due to this condition, some of the metrics for the FWOP for the Marsh Wren Habitat Evaluation Procedure (HEP) were lowered based on the physical parameters of the life requisite variables (Appendix C – Environmental Resources, Section 4.2.3).

3.2.9.2 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 (Main Report, Section 2.2.9).

3.2.9.3 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. Therefore, under the FWOP conditions, the water quality at Mitchell Lake is expected to continue to degrade (Appendix C – Environmental Resources, Section 3.9.4).

3.2.9.4 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 the 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 and downstream would increase the water quality entering Cottonwood Creek (Appendix C – Environmental Resources, Section 5.11.1).

3.2.10 Visual Aesthetics

Under the FWOP conditions, the SAWS fenced property would remain the same as the existing conditions as the property is managed for wildlife habitat by the Mitchell Lake Audubon Center. However, the visual aesthetics of the areas adjacent to the SAWS property will be obstructed by residential and commercial development as urban sprawl continues in the City (Appendix C – Environmental Resources, Section 3.13).

3.2.11 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 26) (Appendix C – Environmental Resources, Section 3.15).

3.2.1 Vegetation

No change from the existing condition is expected. The marginal existing native vegetation will continue to provide very poor wildlife habitat quality (Appendix C – Environmental Resources, Section 5.16.1).

3.2.1 Wildlife

No change from the existing condition is expected (Appendix C – Environmental Resources, Section 3.16.2).

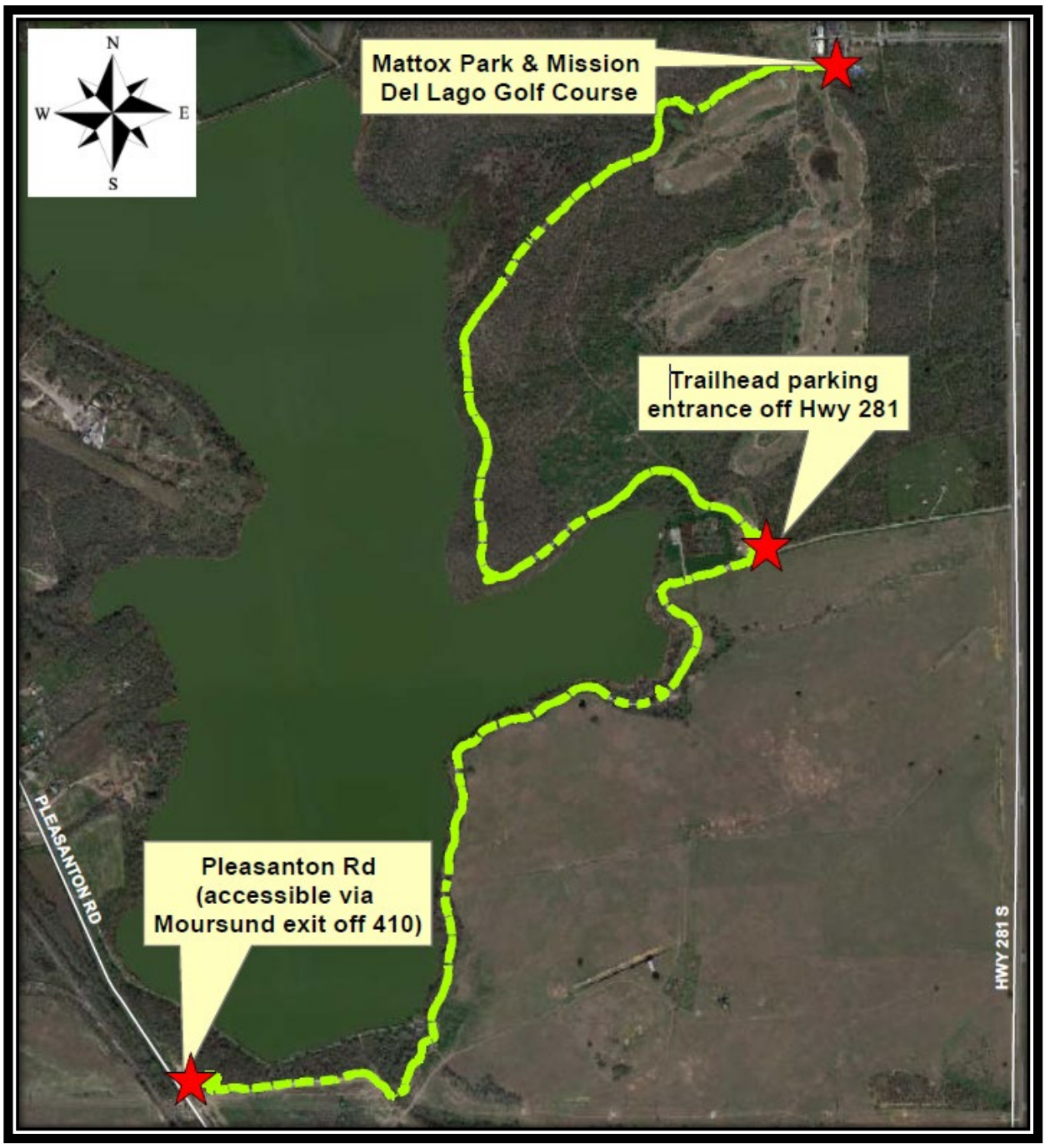

Figure 26 - Pleasanton Road and Mattox Park Trails

3.2.2 Federally Listed Threatened & Endangered Species

No change from the existing condition is expected (Appendix C – Environmental Resources, Section 3.16.3).

3.2.3 Migratory Birds

No change from the existing condition is expected (Appendix C – Environmental Resources, Section 3.16.5).

3.2.4 Invasive Species

The 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 (Appendix C – Environmental Resources, Section 3.16.6).

3.3 Cultural Resources

No change from the existing condition is expected. No known significant impact to cultural resources would occur (Appendix C – Environmental Resources, Section 5.12.1).

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, Section 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 C – Environmental Resources, Section 3.4)

3.6 Real Estate

To be completed prior to the ADM.

3.7 Socioeconomics

Under the No Action Plan, no changes would be made to the socioeconomic environment surrounding the Mitchell Lake study area (Appendix C – Environmental Resources, Section 5.12).

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4 Plan Formulation – Step 3

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 sufficient 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 sufficient 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 being the aim to restore degraded ecosystem structure, function, and dynamic processes.

To recap from Chapter 1,

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 Study Planning Objectives:

1. Increase the areal extent and quality of fish and wildlife habitat in the study area for the life of the project.
2. Increase the floral and faunal species diversity and richness in the study area for the life of the project.
3. Manage and control invasive species in the study area for the life of the project.

Specific Planning and Institutional Constraints

<u>Specific Planning Constraints:</u>

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

<u>Institutional Constraints:</u>

1. Avoid increasing flood risks
2. Plans must be consistent will existing Federal, State, and Local laws.

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, Section 4.1).

A resource agency kick-off meeting was held on 7 November 2018 with the USACE, the TPWD, the USFWS, and the TCEQ to develop a CEM for the study to depict the condition of the existing environment described in Chapter 3 and identify factors that have resulted in the degradation of the Mitchell Lake habitats. The resulting CEM is presented in Figure 27.

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:

- **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).

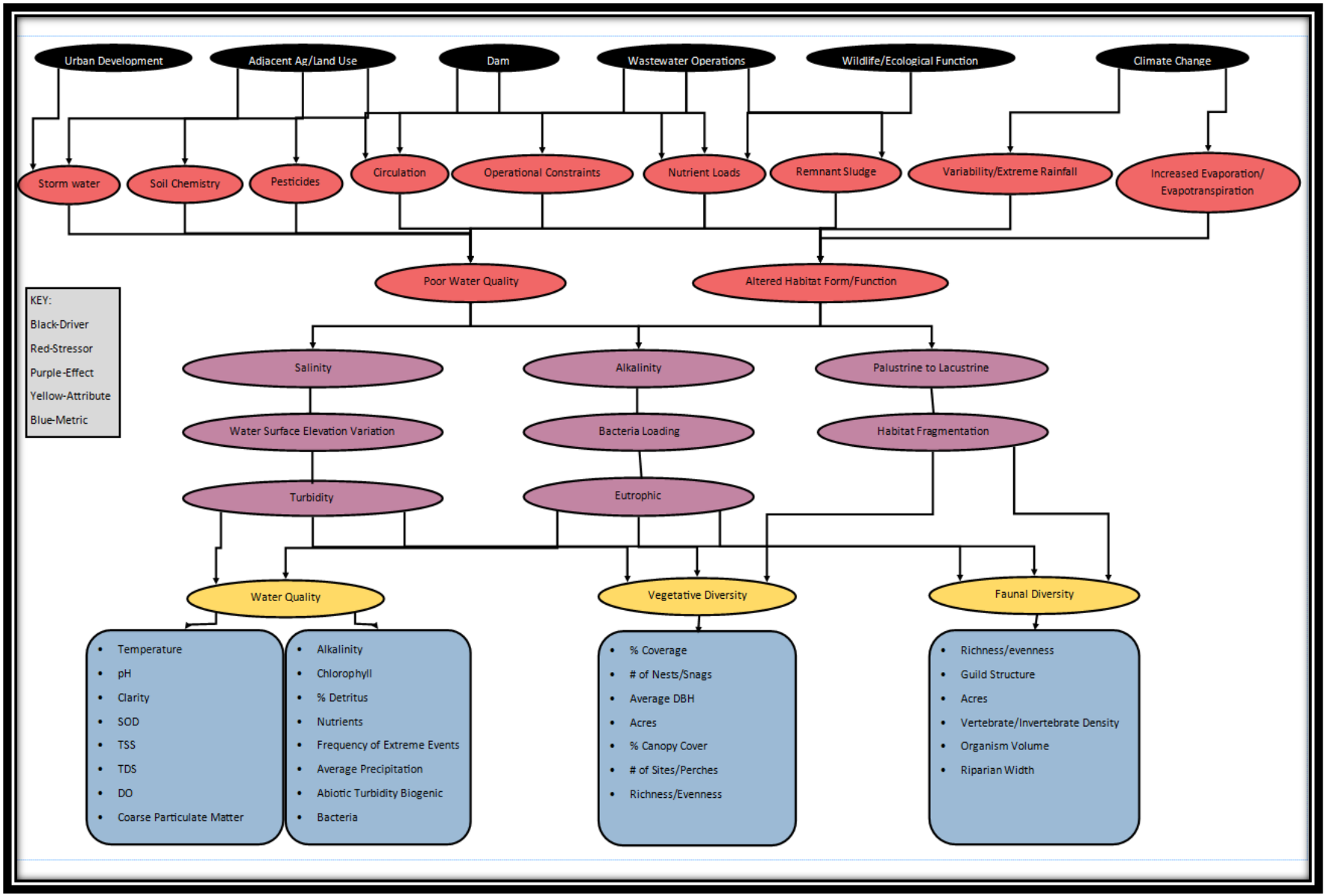

Figure 27 - Mitchell Lake Aquatic Ecosystem Restoration CEM

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 The City. This team met to finish developing the CEM, a list of environmental metrics, a suite of measures for the initial array of alternative plans to be considered, and to identify appropriate habitat models.

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 is to brainstorm both structural and non-structural management measures (measures) (Table 15).

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. Equal consideration was given to these two categories of measures during the Planning process.

Table 15 - Preliminary Management Measures

Measure Name	Non-Structural or Structural
Aeration	Non-Structural
Chemical Water Treatment	Non-Structural
Polder Operations Management	Non-Structural
Seasonal Water Pulses	Non-Structural
Sonification	Non-Structural
Berm Construction	Structural
Clearing / Excavation	Structural
Construction of Pools / Riffles / Runs / Glides	Structural
Dam Modification	Structural
Dam Removal	Structural
Dredging	Structural
Floating Vegetation Mats	Structural
Habitat Structure Augmentation	Structural
Installation of Bat and Bird Nest Boxes	Structural
Invasive Animal Management	Structural
Invasive Vegetation Management	Structural
Island Creation	Structural
Low Quality Vegetation Removal	Structural
Medina River Erosion Control Structures	Structural
Native Aquatic Plantings	Structural
Native Riparian Plantings	Structural
Native Wetland Species Planting	Structural
Pipeline and Pump Installation	Structural
Relocation of Leon Creek Discharge Outfall Structure and Pipe	Structural
Spillway Modification	Structural
Spillway Removal	Structural

4.2.1 Non-structural Measure

The P&G [2.1.4 Definitions] describes non-structural management measures as “A modification in public policy, an alteration in management practice, a regulatory change, or a modification in pricing policy that provides a complete or partial Plan for addressing water resources problems and opportunities”.

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. **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.
3. **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. The polder management would require the modification and / or construction of water control structures to facilitate the draining and filling of the polders.
4. **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 seasonal pulse measure would be dependent on either the measures for relocating the WWTP outfall structure and / or the construction of a pipeline from Mitchell Lake to the upstream portions of the study area. The measure would also include the construction or modification of water control structures to allow manipulation of the flows and inundation of the wetlands.
5. **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.

4.2.2 Structural Measures

The *IWR Report 10-R-4, Deep-Draft Navigation*, dated April 2010, defines structural measures as “Certain physical measures…designed by engineers.” Like non-structural measures, structural measures may be used in combination with other measures, or independently.

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

2. **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. **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.
4. **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.
5. **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.
6. **Dredging** - The dredging measure would entail the removal and disposal of the high nutrient load sediments in an effort to improve the water quality of Mitchell Lake. The dredged material would require appropriate disposal depending on the HTRW issues with the sediments.
7. **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 water birds.
8. **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.
9. **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.
10. **Invasive Animal Management** - Non-native invasive animals such as feral hogs and nutria cause significant damage to existing habitats due to grubbing and grazing foraging strategies. The removal and continual management of invasive animal would reduce the impacts these species have on the habitats in the study area and specifically the newly restored areas.
11. **Invasive Vegetation Management** - This measure includes the removal and management of invasive plant species to allow a native and diverse vegetative community to become established. Depending on the species, invasive species may be controlled by biological, mechanical, or chemical methods incorporating an integrated

pest management approach. Larger non-native invasive trees could be treated with herbicide and left standing to provide standing snag habitat for numerous wildlife species.

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. However, this plan has been screened out of the final CE-ICA process, due to lack of NFS support and 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.

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

14. **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.

15. **Native Aquatic Plantings** - Emergent and submerged vegetation typically thrive along the perimeter and shallow areas of lakes. This measure entails the establishment of emergent and submerged aquatic 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 wetlands.

16. **Native Riparian Plantings** - This measure entails increasing the vegetative structure and species diversity of riparian habitats along the Cottonmouth Creek below the Mitchell Lake Dam and along specified coves within Mitchell Lake. It would include

planting a diverse community of high quality native tree and shrub species, including mast producers, bald cypress, and other species native to the San Antonio area.

17. **Native Wetland Species Planting** - The core areas of the existing wetland habitats are dominated by cattails or willow baccharis fringed by a single species of spike sedge. This measure entails the planting of native high quality wetland species to increase the diversity and sustainability of the wetland vegetation community.
18. **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.
19. **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.
20. **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.
21. **Spillway Removal** - This measure would entail the complete removal of the Mitchell Lake spillway.
22. **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 28). 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. Measure success is dependent upon site conditions at Mitchell Lake.

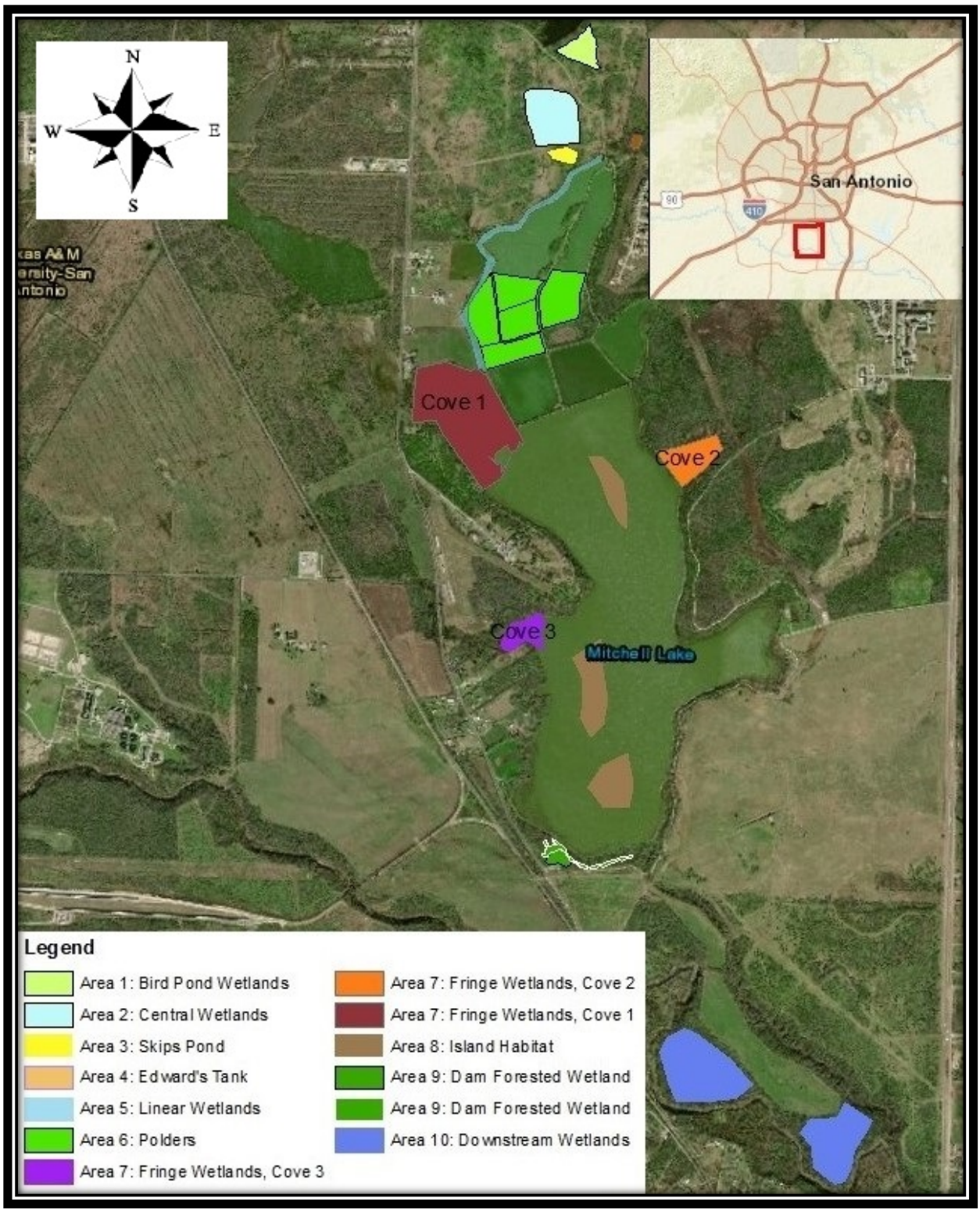

Figure 28 - Initial Areas for Plan Formulation for Ecosystem Restoration

Area 1: Bird Pond Wetland - Area 1 is located at the northern extent of the study area adjacent to Bird Pond near the Mitchell Lake Audubon Center (Figure 29). The small existing wetland is located east of the levee/road on the downstream end of Bird Pond. Area 1 has limited habitat value due to the shallow surface water (<6") and a monoculture of cattails.

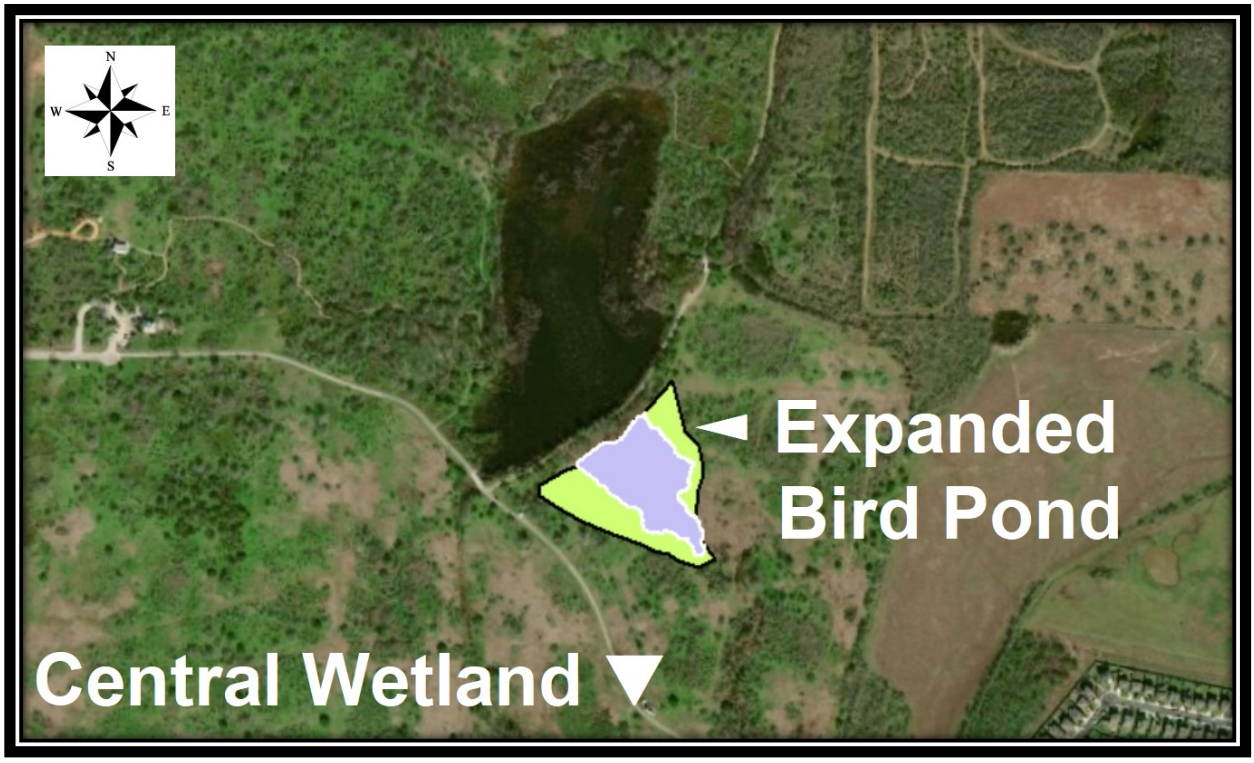

Figure 29 - Area 1: Bird Pond Wetlands [Existing Wetlands Highlighted in white and Expanded Wetlands outlined in black]

<u>Area 2: Central Wetland</u> - Area 2 is south of Area 1 Bird Pond Wetland (Figure 29). 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 (Figure 30). Central Wetland is part of the same wetland complex as Area 3 Skip's Pond, but is separated from that area by a 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.

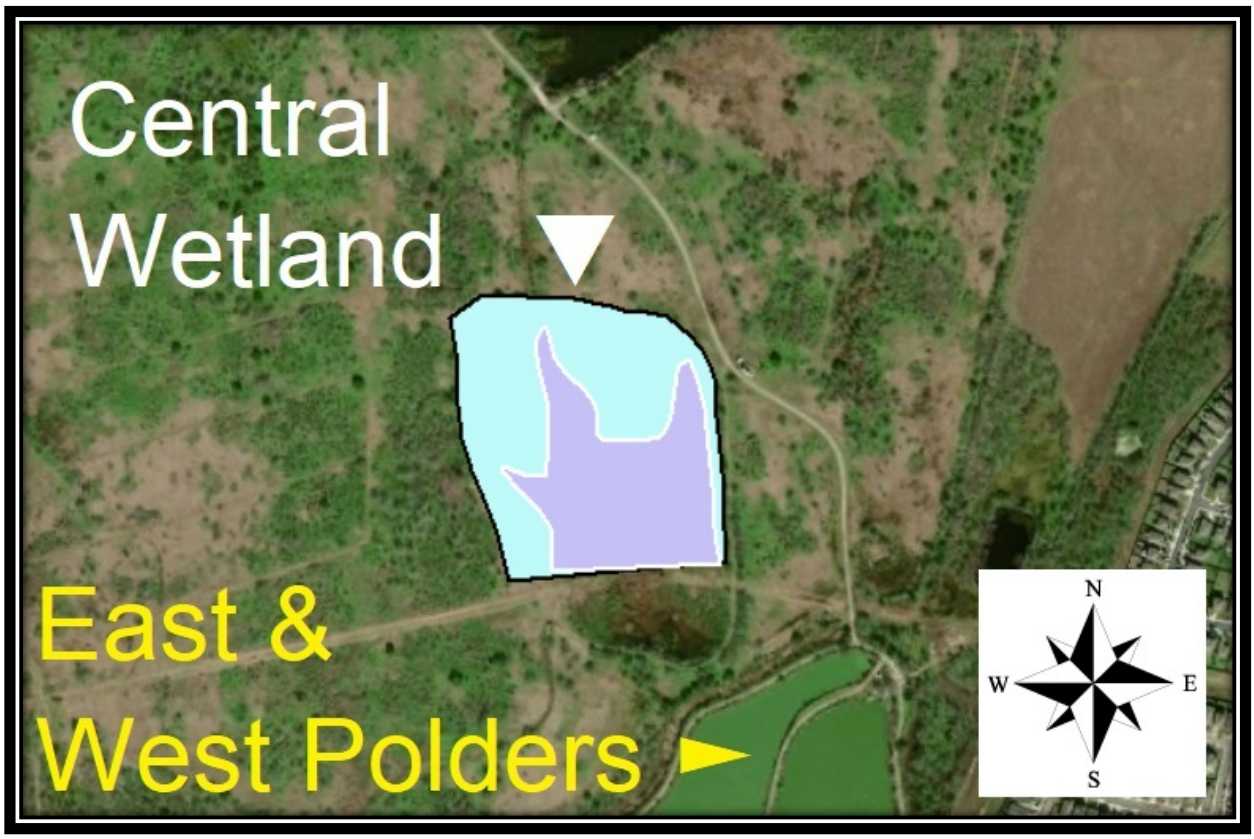

Figure 30 - Area 2: Central Wetland [Existing Wetlands Highlighted in white and Expanded Wetlands outlined in black]

<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 31). Area 3 is comprised of deeper water wetlands, up to 2' in depth. It supports different vegetation than Area 2. Therefore, Skip's Pond was separated from the Central Wetland complex.

Figure 31 - 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 32). 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 32 - Areas 1 through 4 in relation to each other

<u>Area 5: Linear Wetlands</u> – Area 5 is hydraulically linked to Areas 1 Bird Pond, 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 33). *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.*

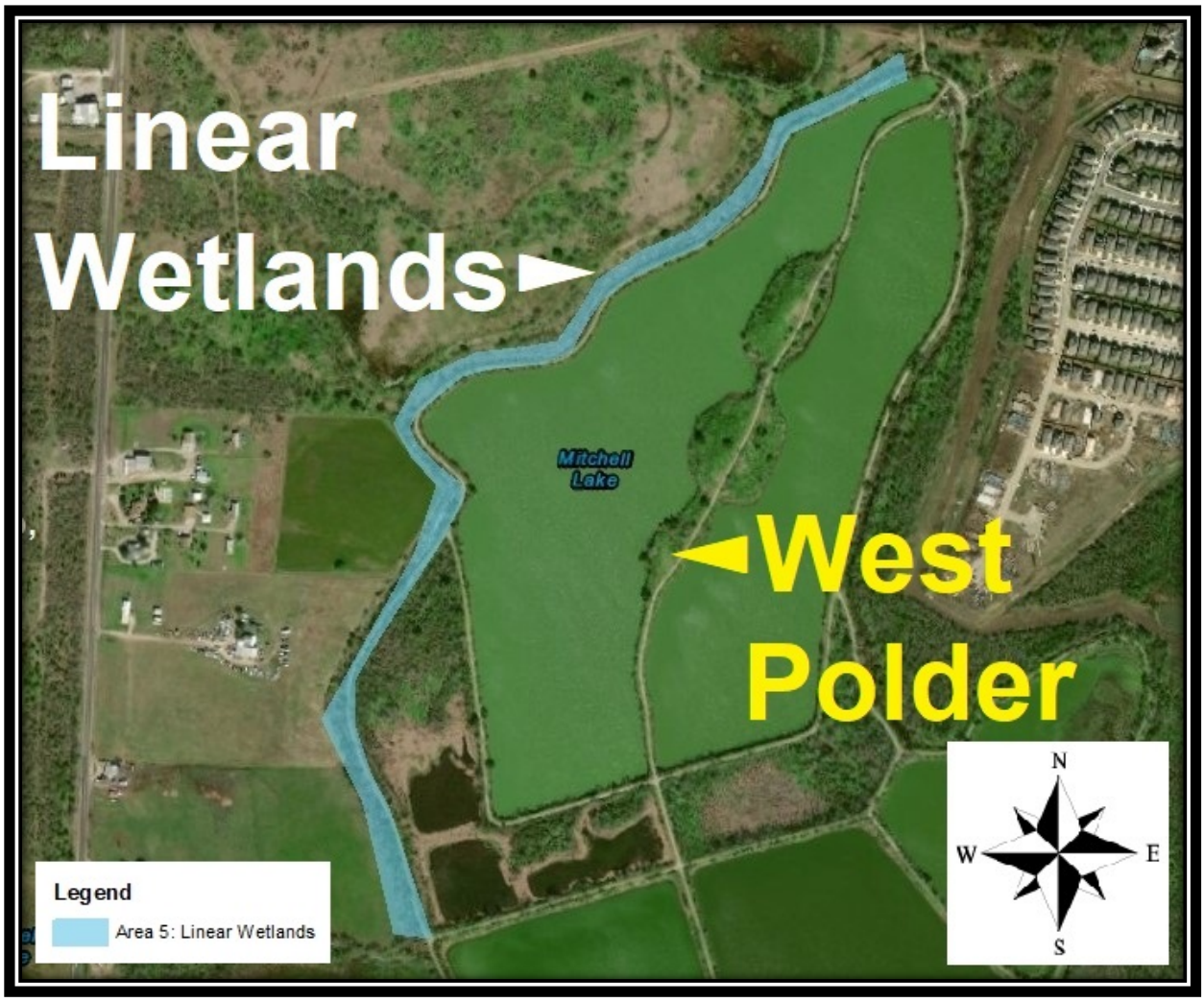

Figure 33 - Area 5: Linear Wetlands on west side of West Polder [light blue]

<u>Area 6: Polders</u> - This plan is focused on the structural modification and operational management of the water within the polder cells. Managing the water distribution within the polders (Figure 34), the creation of mud flat habitats would result in restoration opportunities for this area.

Figure 34 – Area 6: Mitchell Lake Polder System

Area 7: Fringe Wetlands / Coves 1 - 3 - Area 7 includes the restoration of fringe emergent and submergent wetland habitats within three coves of Mitchell Lake (Figure 35).

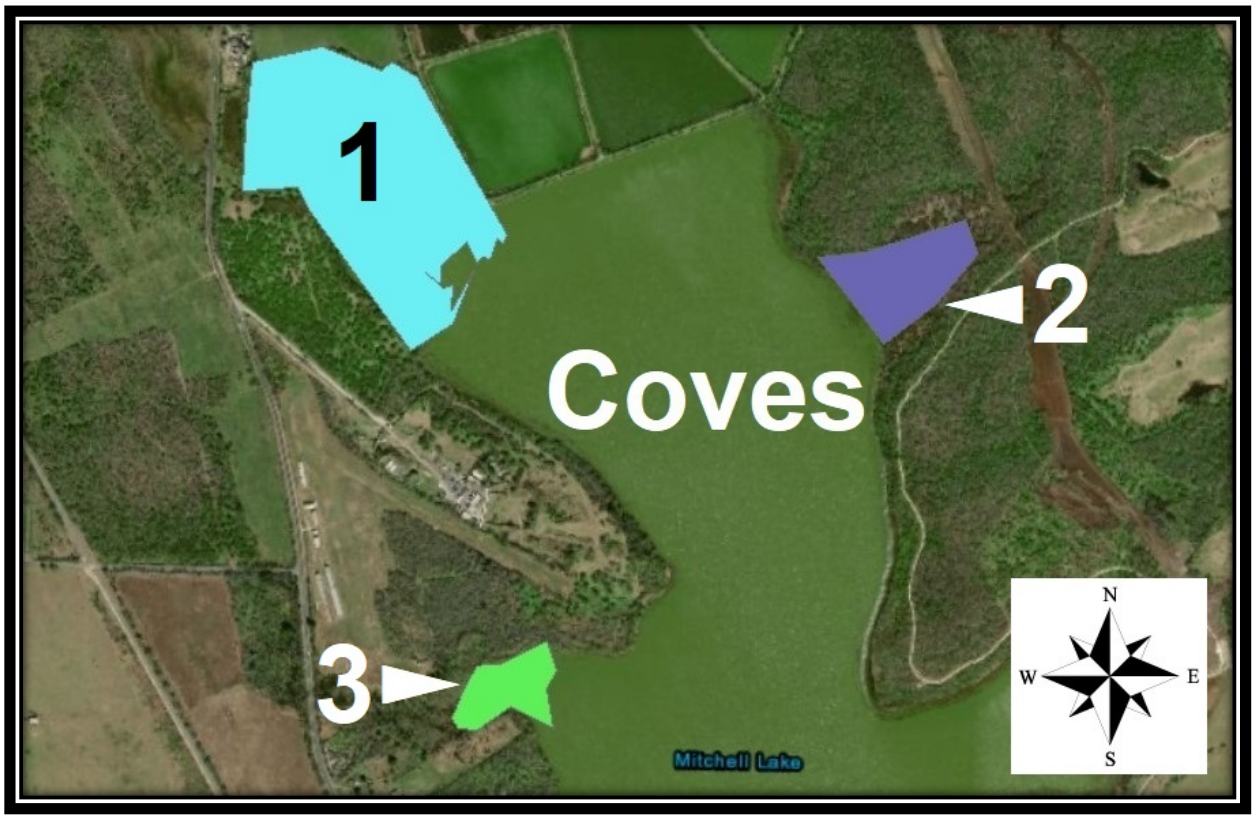

Figure 35 - Area 7: Fringe Wetlands, [Cove 1 is in blue, Cove 2 is in purple, and Cove 3 is in green]

Area 8: Islands - This plan entails the construction of island habitats within Mitchell Lake (Figure 36). 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 infeasibility (Section 4.1.2 Structural Measures).

Figure 36 - 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 37). 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 37 - Area 9: Dam Forested Wetlands [bright green]

<u>Area 10: Downstream Wetlands</u> - The Area 10 restoration plan entails the construction of a wetland complex adjacent to the proposed water-quality treatment wetlands that would be constructed by the SAWS (Figure 38). 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 water quality of water from the treatment wetlands.

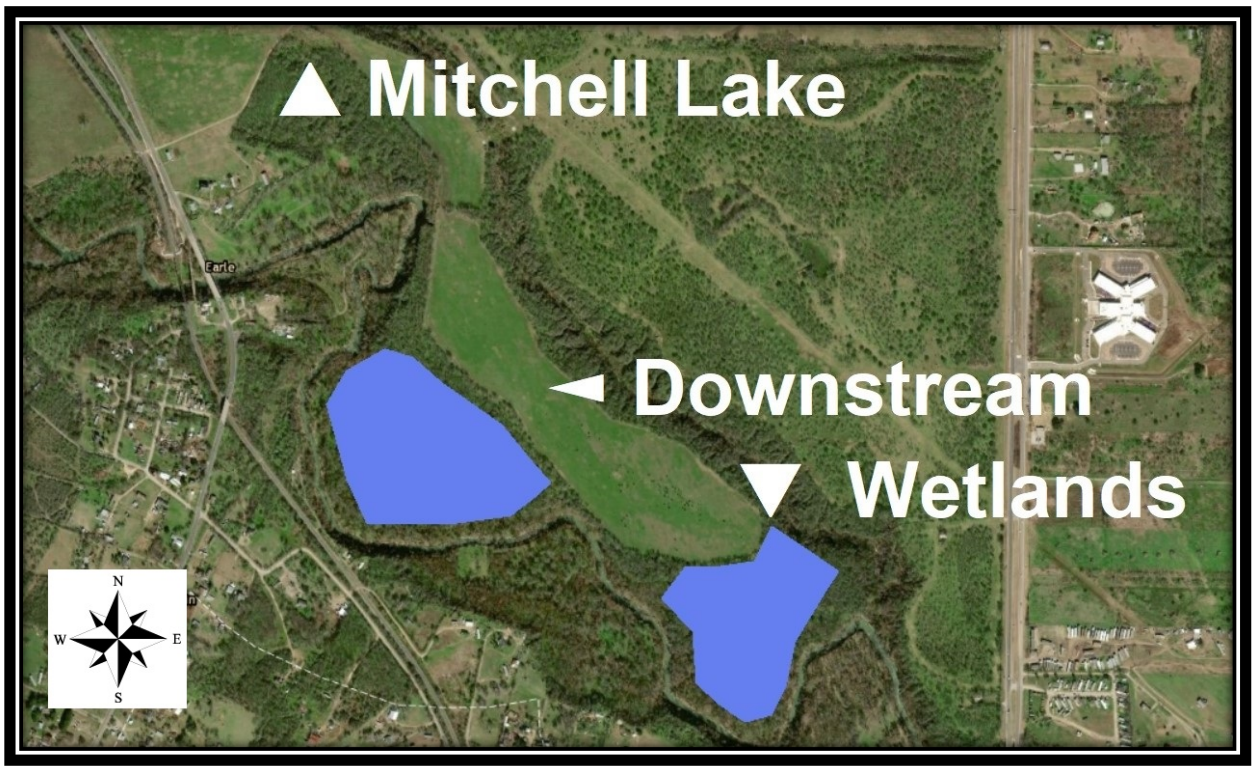

Figure 38 - Area 10: Downstream Wetlands [in blue]

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 16 – 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 infeasibility.**

4.2.5 Restoration Areas Remaining

Table 17 - Restoration Areas Remaining for Plan Formulation (Figure 39)

Restoration Areas Remaining for Plan Formulation (Figure 39)	
Area 1: Bird Pond Wetland	**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	

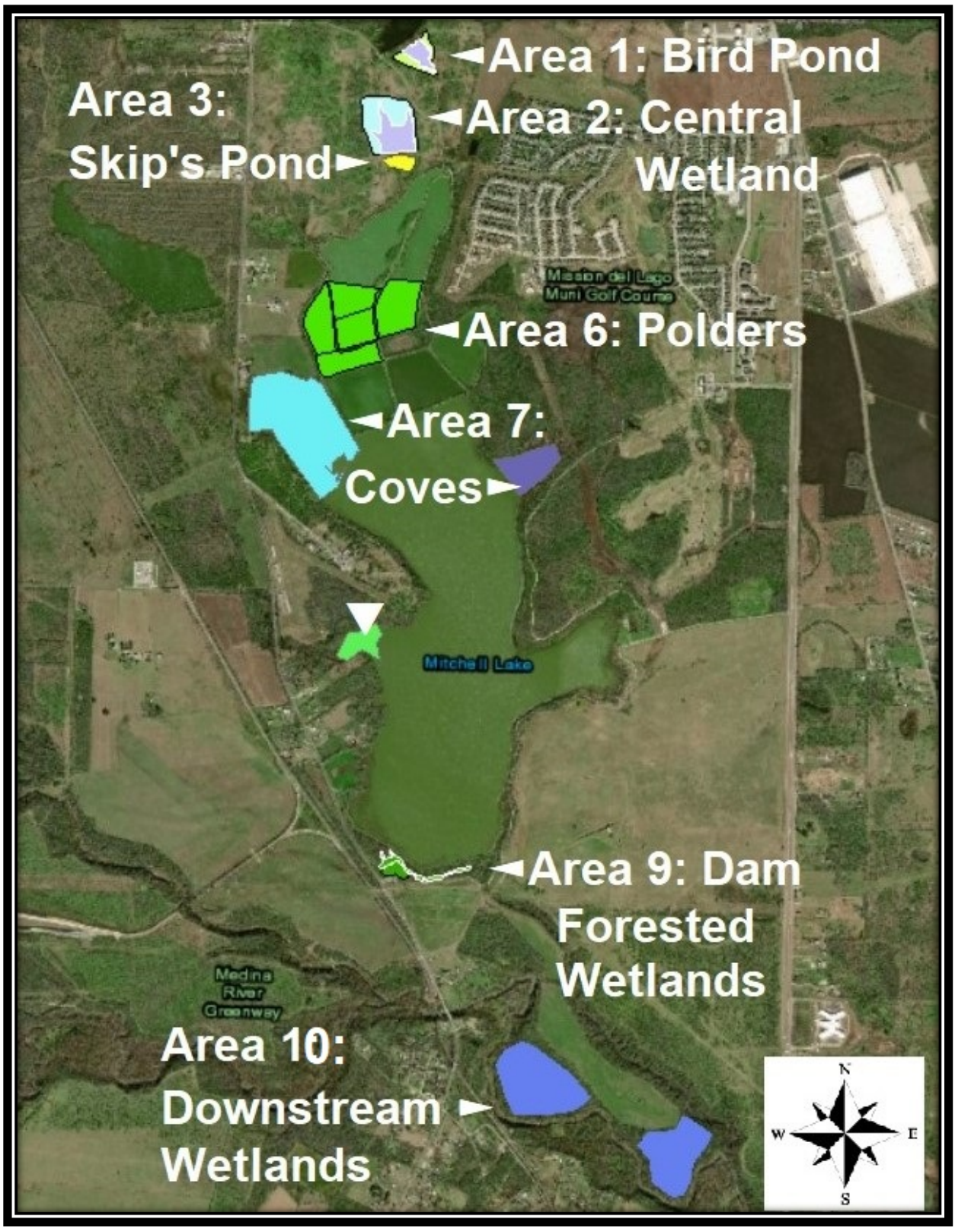

Figure 39 - Areas remaining for further study

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 life of the project.
2. Increase the floral and faunal species diversity and richness in the study area for the life of the project.
3. Manage and control invasive species in the study area for the life of the project.

First, each measure was identified as either meeting a specific study objective (**Yes**) or failing to meet a specific planning objective (**No**) (Table 18). All measures met study objectives, and no measures were removed from further consideration at this time.

Table 18 – Screening of Preliminary Management Measures with the Planning Objectives

Measure Name	Planning Objectives		
	1	2	3
Aeration	Yes	Yes	Yes
Chemical Water Treatment	Yes	Yes	Yes
Polder Operations Management	Yes	Yes	Yes
Seasonal Water Pulses	Yes	Yes	Yes
Sonification	Yes	Yes	Yes
Berm Construction	Yes	Yes	Yes
Clearing / Excavation	Yes	Yes	Yes
Construction of Pools / Riffles / Runs / Glides	Yes	Yes	Yes
Dam Modification	Yes	Yes	Yes
Dam Removal	Yes	Yes	Yes
Dredging	Yes	Yes	Yes
Floating Vegetation Mats	Yes	Yes	Yes
Habitat Structure Augmentation	Yes	Yes	Yes
Installation of Bat and Bird Nest Boxes	Yes	Yes	Yes
Invasive Animal Management	Yes	Yes	Yes
Invasive Vegetation Management	Yes	Yes	Yes
Island Creation	Yes	Yes	Yes
Low Quality Vegetation Removal	Yes	Yes	Yes
Medina River Erosion Control Structures	Yes	Yes	Yes
Native Aquatic Plantings	Yes	Yes	Yes
Native Riparian Plantings	Yes	Yes	Yes
Native Wetland Species Planting	Yes	Yes	Yes
Pipeline and Pump Installation	Yes	Yes	Yes
Relocation of Leon Creek Discharge Outfall Structure and Pipe	Yes	Yes	Yes
Spillway Modification	Yes	Yes	Yes
Spillway Removal	Yes	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.

Table 19 - 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 20).

Table 20 - 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. Because 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 does not have NFS support.
Dam Removal	Removal of the dam would result in uncontrolled release of contaminated sediments into Cottonmouth Creek and the Medina River.
Invasive Animal Management	Invasive animal management is currently provided by the Audubon Society and the 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 screened out of further review.
Relocation of Leon Creek Discharge Outfall Structure and Pipe	Because Mitchell Lake is permitted as a wastewater treatment facility, this measure would require additional permitting to change/add a new outfall location. Because of the additional permitting requirements, the SAWS is unwilling to move forward with this measure.
Spillway Modification	The SAWS will implement their own spillway modifications in the FWOP.
Spillway Removal	The SAWS will implement their own spillway modifications in the FWOP.

The non-structural measures, Polder Management and Seasonal Pulses, were retained for further plan formulation of Plans.

4.5 Preliminary Management Measures Carried Forward for Further Study

Table 21 - Preliminary Management Measures Carried Forward for Further Study

Measure Name	Non-Structural or Structural
Polder Operations Management	Non-Structural
Seasonal Water Pulses	Non-Structural
Berm Construction	Structural
Clearing / Excavation	Structural
Habitat Structure Augmentation	Structural
Installation of Bat and Bird Nest Boxes	Structural
Invasive Vegetation Management	Structural
Island Creation	Structural
Low Quality Vegetation Removal	Structural
Native Aquatic Plantings	Structural
Native Riparian Plantings	Structural
Native Wetland Species Planting	Structural
Pipeline and Pump Installation	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 areas (Section 4.1.3 Initial Ecosystem Restoration Areas).

4.6.1 Area 1: Bird Pond Wetland

All measures were included in alternative formulation for Area 1 – Bird Pond Wetland except:

Measure	Reason for Exclusion
Native Riparian Planting	Site does not include stream habitat
Polder Operational Management	No polders in this area
Berm Construction	No polders in this area

4.6.2 Area 2: Central Wetland

All measures were included in alternative formulation for Area 2 – Central Wetland except:

Measure	Reason for Exclusion
Native Riparian Planting	**Site does not include stream habitat**
Polder Operational Management	**No polders in this area**
Berm Construction	**No polders in this area**

4.6.3 Area 3: Skip's Pond

All measures were included in alternative formulation for Area 3 – Skip's Pond except:

Measure	Reason for Exclusion
Native Riparian Planting	**Site does not include stream habitat**
Polder Operational Management	**No polders in this area**
Berm Construction	**No polders in this area**

4.6.4 Area 6: Polders

All measures were included in alternative formulation for Area 6 – Polders except:

Measure	Reason for Exclusion
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 Wetland Species Planting	**Polders would be managed as mud flats and open water.**
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.**
Pipeline and Pump Installation	**Existing water control structures in place.**

4.6.5 Area 7: Fringe Wetlands / Coves 1 - 3

All measures were included in alternative formulation for Area 7 – Fringe Wetlands except:

Measure	Reason for Exclusion
Clearing / Excavation	**No 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 consistently between 517'- 519'.**
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 already provided by polders through a pump station.**

4.6.6 Area 9: Dam Forested Wetland

All measures were included in alternative formulation for Area 9 – Dam Forested Wetland except:

Measure	Reason for Exclusion
Polder Operational Management	**No polders in this area**
Berm Construction	**Not applicable**
Pipeline and Pump Installation	**Redundant with dam modifications.**

4.6.7 Area 10: Downstream Wetlands

All measures were included in alternative formulation for Area 10 – Downstream Wetland except:

Measure	Reason for Exclusion
Native Riparian Planting	**Area does not include stream habitat.**
Invasive Vegetation Management	**Any existing invasive species within Area 10 would be upland species and would be removed during excavation of the wetlands. However, invasive species are usually the first species to be established; therefore, management of invasive species is critical to the establishment of island vegetation communities.**
Low Quality Vegetation Removal	**All of 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 the 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.

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 feasibility 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 Wetland Alternatives

The restoration goal for Area 1 is the enhancement of 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.

As documented in Table 2 above, the Area 1 Alternatives incorporate Clearing/Excavation, Installation of Pipeline, Seasonal Pulses, Native Wetland Species Plantings, Invasive Species Management, Low Quality Vegetation Removal, Habitat Structure Augmentation, and the Installation of Bat/Nest Boxes measures. With the exception of 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. In an effort to minimize the establishment the establishment of invasive species after the final grading of the wetlands, management, and control of invasive species would be required to ensure establishment of the diverse planted vegetation. An integrated Invasive Species Management Plan would be developed and implemented utilizing chemical, mechanical, and / or biological control.

Table 22 - Area 1: Bird Pond Measures and Alternatives 1A and 1B

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 Wetland Species Planting	The planting of native, site-specific plant species are key to the establishment of a resilient, self-sustaining 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.
Installation of Pipeline	Installation of a pipeline to Area 1 would enhanced the wetland, ensure longer periods of inundation and provide resilience for the wetland.
Scaled Alternatives	
Alternative 1A	Enhancing the footprint of the existing 3.17-acre wetland
Alternative 1B	Expanding the existing wetland to form a 6.42-acre wetland

4.7.2 Area 2: Central Wetland Alternatives

The Area 2 alternatives would be identical to the combination of measures to those described for Area 1 above. The main difference between the Area 1 alternative and Area 2 is the location of the pipeline outfall structure (Figure 40).

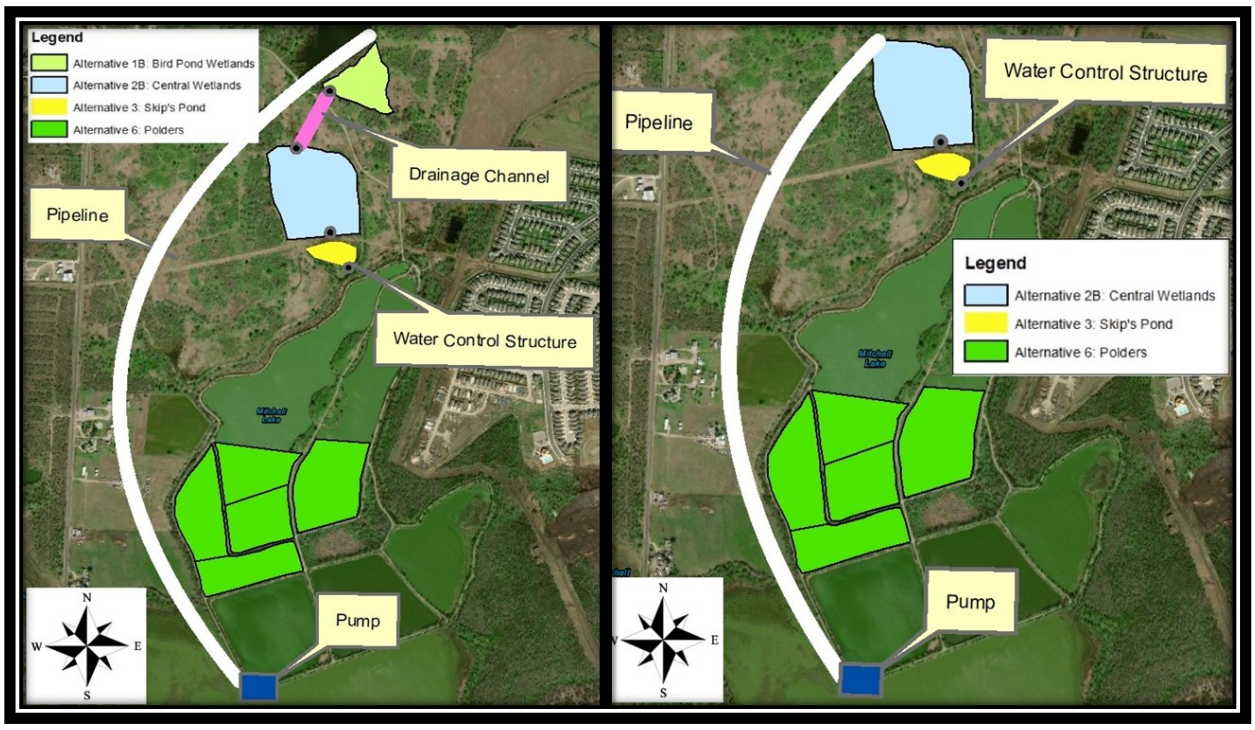

Figure 40 - Map showing Pipeline Differences for Areas 1 & 2

For Plans that combine Areas 1 and 2, the location of the pipeline would be the same as the location for Area 1. Since the existing drainage connects Areas 1 and 2, flows from the pipeline above Area 1 would reach Area 2 with no additional water supply requirements. However, for Plans that include Area 2, but not Area 1, the pipeline outfall would be located at the upstream end of Area 2. An iterative CE-ICA would be conducted to account for the differing costs between the constructions of each pipeline to account for the cost differences between the Plans.

Table 23 - Area 2: Central Wetland Measures and Alternatives 2A and 2B

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 Wetland Species Planting	The planting of native, site-specific plant species are key to the establishment of a resilient, self-sustaining 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.
Installation of Pipeline	Installation of a pipeline to Area 2 would enhanced the wetland, ensure longer periods of inundation and provide resilience for the wetland.
Scaled Alternatives	
Alternative 2A	Enhancing the footprint of the existing 10.46-acre wetland
Alternative 2B	Expanding the existing wetland to form a 18.37-acre wetland

4.7.3 Area 3 – Skip's Pond Alternative

Similar to Areas 1 and 2 above, Area 3 would incorporate the same measures and scales as described above, with the exception of the Installation of the Pipeline measure. Due to the location of the petroleum pipeline separating Area 2 from Area 3, 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 Area 3 are dependent on the inclusion of Area 2 in that Plan.

Table 24 - Area 3: Skip's Pond Measures and Alternative 3

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	**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 Wetland Species Planting	**The planting of native, site-specific plant species are key to the establishment of a resilient, self-sustaining 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.**
Installation of Pipeline	**Installation of a pipeline to Area 3 would enhanced the wetland, ensure longer periods of inundation and provide resilience for the wetland.**
Unscaled Alternative	
Alternative 3	**Enhancing the footprint of the existing 2.18-acre wetland**

4.7.4 Area 6 – Polders Alternative

The creation of mudflats within Area 6 requires the implementation of two measures: Construction of Berms and Polder Operational Management. Similar to 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.

The Area 6 alternative 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. 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. Because the East and West Polders are relatively large, the Construction of Berms measure would segment these polders to more manageable cells (Figure 68). 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.

Table 25 - Area 6: Polder Measures and Alternative 6

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.**
Unscaled Alternative	
Alternative 6	**Management/Modification of Existing 49.52 Polders/Basins**

4.7.5 Area 7 – Fringe Wetlands / Coves 1 – 3 Alternatives

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 517'. The Area 7 alternatives 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 Area 7 are documented in Table 6 above.

Once the SAWS implements the 517' water surface elevation, the shoreline within the coves would be planted with native emergent and aquatic plant species (Native Wetland Species Planting). 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 Area 7 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 the Area 7 alternatives.

Table 26 - Area 7: Fringe Wetlands / Coves 1 - 3 Measures and Alternatives 7A through 7G

Measure	Comments
Native Riparian Planting	The 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.
Invasive Vegetation Management	Non-native and native (noxious) invasive emergent and aquatic species occur in the study area. Their removal will be necessary to ensure the sustainability of a diverse system
Native Wetland Species Planting	The planting of native, site-specific plant species are key to the establishment of a resilient, self-sustaining wetland habitat and is a key component of wetland restoration.
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	Enhancing 53.68 acre Cove 1 alone
Alternative 7B	Enhancing 11.84 acre Cove 2 alone
Alternative 7C	Enhancing 6.84 acre Cove 3 alone
Alternative 7D	Enhancing 65.52 acres of Coves 1 & 2
Alternative 7E	Enhancing 60.52 acres of Coves 1 & 3
Alternative 7F	Enhancing 18.68 acres of Coves 2 & 3
Alternative 7G	Enhancing 72.36 acres of Coves 1 – 3

4.7.6 Area 9: Dam Forested Wetlands Alternatives

Measures appropriate for Area 9 are the same measures identified for Areas 1 and 2 above, 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 27 - Area 9: Dam Forested Wetlands Measures and Alternatives 9A and 9B

Measure	Comments
Native Riparian Planting	**This area is the equivalent of a bottomland hardwood in the San Antonio region. Riparian plantings would be 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 Wetland Species Planting	**The planting of native, site-specific plant species are key to the establishment of a resilient, self-sustaining 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	**Enhancement of the existing 2.55 acre wetland footprint**
Alternative 9B	**Expanding the existing wetland to form a 4.48 acre wetland**

4.7.7 Area 10 – Downstream Wetlands Alternative

The Area 10 wetlands would be created utilizing the same measures identified in the Area 1 and 2 alternatives, with the exception of the pipeline water supply. The water supply for the Area 10 wetlands would be provided by the outflow of the SAWS treated wetlands. The inclusion of the remaining measures identified in Table 9 is consistent with Areas 1 and 2.

Table 28 - Area 10: Downstream Wetlands Measures and Alternative 10

Measure	Comments
Clearing/Excavation	**Large-scale excavation will be required to convert upland habitats to wetlands.**
Native Wetland Species Planting	**Wetland plantings are necessary for the success of this plan. This area will require new vegetation once the wetland cells are developed.** **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**
Unscaled Alternative	
Alternative 10	**Creation of 51.32 acres of wetlands**

4.8 Modeling

For the purpose of this report, plans mentioned and described will only include those that were used during the Cost Incremental and Benefit Analysis (CE-ICA). During the plan formulation process, other measures and areas were considered and later screened out before the analysis, due to lack of constructability and feasibility of the project (Appendix C – Environmental Resources, Section 4).

To recap, the areas screened out of plan formulation are listed below:

- Area 4: Edward's Tank – This area is hydrologically disconnected from the remaining restoration areas, thereby limiting any synergistic benefits resulting from its restoration
- Area 5: Linear Wetlands – This area 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.
- Area 8: Islands – This area was screened out due to lack of Non-Federal Sponsor support and feasibility.

Seven areas remaining (Figure 39):

- Area 1: Bird Pond,
- Area 2: Central Wetland,
- Area 3: Skip's Pond,
- Area 6: Polders,
- Area 7: Fringe Wetlands,
- Area 9: Dam Forested Wetlands, and
- Area 10: Downstream Wetlands

4.8.1 Habitat Classification

4.8.1.1 Model Selection

Resource agencies and the USACE Ecosystem Restoration Planning Center of Expertise (ECO-PCX) were utilized to assist the USACE in selection of ECO-PCX certified species' HSI models that would best represent the Mitchell Lake study area habitats to evaluate existing conditions and habitat response to proposed restoration measures. The models were chosen based on geographic and cover type appropriateness. Other factors include economic or ecologic value to the surrounding habitat and/or community.

The TPWD Ecological Mapping System was utilized and refined using the ArcGIS mapping tool (Figure 41). A large array of habitat types were listed, but were further narrowed into seven major types for analysis purposes before conducting fieldwork. These habitat types include:

- Upland,
- Shrubland,
- Grassland,
- Emergent Wetland,
- Riparian,
- Aquatic, and
- Riverine habitat.

Models initially included during plan formulation and habitat assessment include: the Marsh Wren and Bullfrog HSI to assess emergent wetland habitat; the Barred Owl, Fox Squirrel, Gray Squirrel, and Shelterbelt HSI to assess riparian forest habitat. Upland forest was assessed with the Fox Squirrel and Gray Squirrel HSI; grassland habitat with the Meadowlark and Cottontail HSI; and shrubland with the Cottontail and Brown Thrasher HSI. The Avian Index of Biological Integrity (IBI) was used to assess riparian forest and aquatic habitat during the habitat survey.

The Qualitative Habitat Evaluation Index (QHEI) was utilized for riverine habitat. The Shorebird Migration Model, described in Appendix C – Environmental Resources - Section 4.2.2, was added after the habitat assessment was complete. This model was utilized to project benefits that would directly apply to the polders within the Mitchell Lake study area.

Although all of the models were utilized during the habitat assessment, the Avian IBI, the QHEI, the Shelterbelt HSI, the Meadow Lark HSI, the Cottontail HSI, the Brown Thrasher HSI, and the Fox Squirrel HSI were not needed to determine the FWOP and Future With-Project (FWP) conditions. Hereafter, these models will not be mentioned in this report. The final models utilized for analysis can be seen in Table 29.

Table 29 - Final Array of Models Used for the Mitchell Lake Feasibility Study

Model	Cover Type
Barred Owl HSI	Riparian Forest
Gray Squirrel HSI	Riparian Forest
Marsh Wren HSI	Emergent Wetland
Bullfrog HSI	Emergent Wetland
Shorebird Migration Model	Mudflat

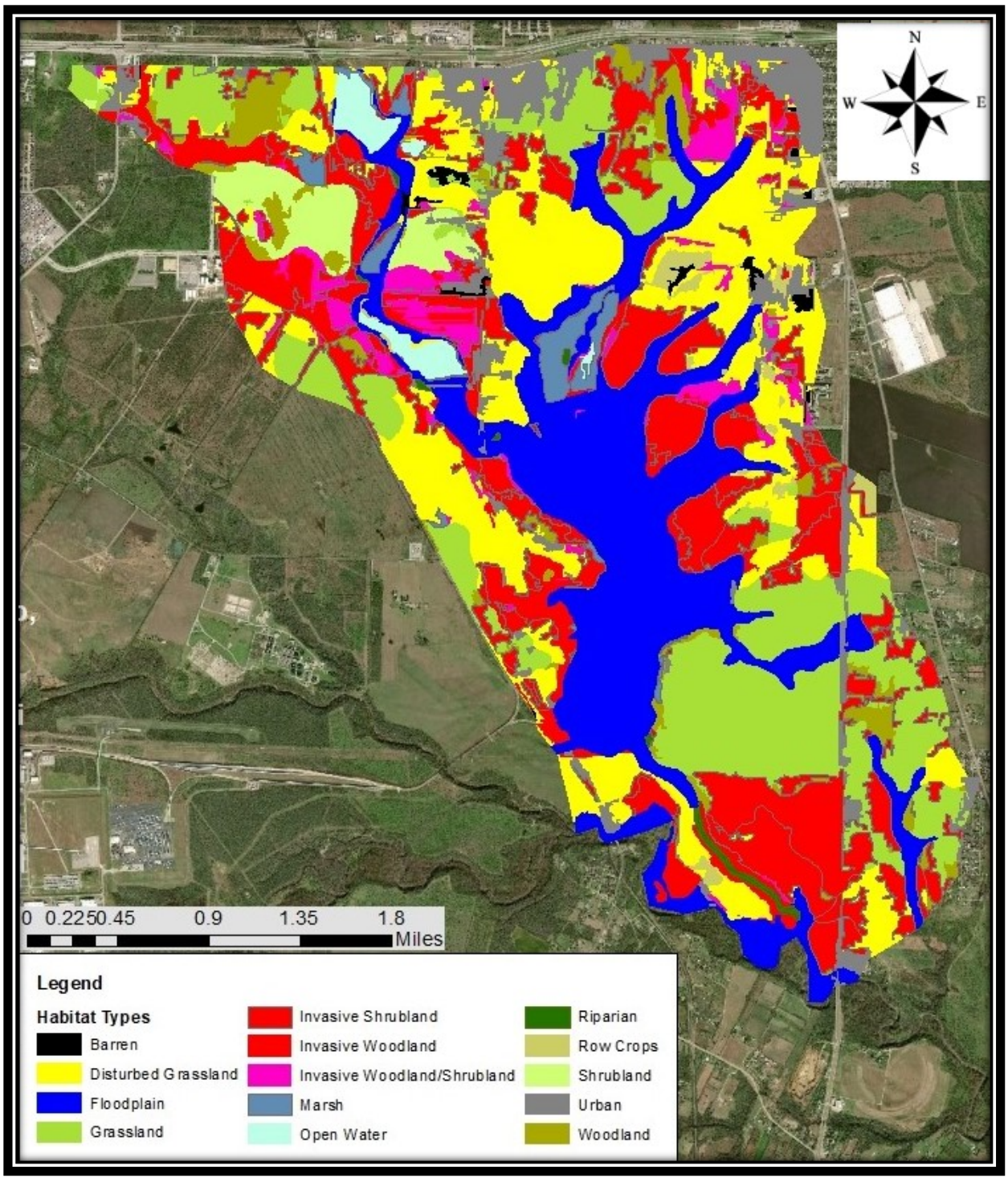

Figure 41 - Habitat Type Groupings (TPWD 2019)

4.8.1.2 Shorebird Migration Model

The Shorebird Migration Model was initially developed in 2002 (USACE 2018). The framework and associated environmental relationships were developed using peer-reviewed and published information from the literature for shorebird habitat in the North American Northern Plains/Prairie Pothole Region. The model was developed to cover all shorebirds found in the region because shorebird community management, rather than single species management, is the primary goal. Both migration seasons are included in the model because both are important for shorebird populations.

The model format combines procedures from Missouri's Wildlife Habitat Appraisal Guide and the USFWS' standards for developing the HSI models. The model framework includes the spring and fall migration season and variables and suitability index relationships to represent the three functional habitat groups of migration habitat – food, security, and predictability. The model outcome is an HSI with a value from zero to one (1 representing optimal habitat).

The Shorebird Migration Model and methodology (Table 30Table 15) are consistent with USACE policies and accepted procedures for ecosystem restoration planning. The model does not incorporate, facilitate, or encourage the use of non-ecosystem parameters or values. The model uses established principles of plans evaluation to produce outputs consistent with identification of the NER plan.

Table 30 - Shorebird Migration Model

Species	Life Requisite Suitability Indices (LRSI)	HSI Formula
Shorebird Migration Model	Food, Security, Predictability	
	Spring Life Requisite Variables	
	S1A	Water Depths
	S1B	Availability
	S_2	Aquatic Invertebrates (in accessible habitat)
	S_3	Vegetative Cover
	S_4	Disturbance
	S_5	Hydrologic Conditions
	S_6	Management Capabilities
	Fall Life Requisite Variables	
	F1A	Water Depths and Availability
	F1B	Timing for Water Depths and Availability
	F_2	Aquatic Invertebrates (in accessible habitat)
	F_3	Vegetative Cover
	F_4	Disturbance
	F_5	Hydrologic Conditions
	F_6	Management Capabilities

4.8.1.3 Habitat Evaluation Process

A baseline assessment using the HEP was required before any habitat impacts to the study area could be identified. HEP involves defining the study area, delineating habitats (i.e. cover types) within the study area, selecting the HSI models and/or evaluation species, and characterizing the study area based on the results of the HEP.

The HEP was developed by the USFWS in order to quantify the impacts of habitat changes resulting from land or water development projects (USFWS 1980). HEP is based on suitability models that provide a quantitative description of the habitat requirements for a species or group of species. HSI models use measurements of appropriate variables to rate the habitat on a scale from 0.0 (unsuitable) to 1.0 (optimal).

Habitat quality is estimated using species models developed specifically for each habitat type(s). Each model consists of a list of variables that are considered important in characterizing fish and wildlife habitat; a Suitability Index graph for each variable, which defines the assumed relationship between habitat quality and different variable values; and a mathematical formula that combines the Suitability Index for each variable into a single value for habitat quality. The single value is referred to as the HSI.

The Suitability Index graph is a graphic representation of how fish and wildlife habitat quality or "suitability" of a given habitat type is predicted to change as values of the given variable change. It also allows the model user to describe numerically, through the Suitability Index, the habitat quality of an area for any variable value. The Suitability Index ranges from 0.1 to 1.0, with 1.0 representing optimal condition for the variable in question (Tables 31 - 34).

After a Suitability Index has been developed, a mathematical formula that combines all Suitability Indices into a single HSI value is constructed. Because the Suitability Indices range from 0.1 to 1.0, the HSI also ranges from 0.1 to 1.0, and is a numerical representation of the overall or "composite" habitat quality of the particular habitat being evaluated. The HSI formula defines the aggregation of Suitability Indices in a manner that is unique to each species depending on how the formula is constructed.

Table 31 - Life Requisite Suitability Indices for Barred Owl

Species	(LRSI	HSI Formula
Barred Owl	Reproduction	Equal to the reproduction suitability index $HSI = SIR = \sqrt[2]{SIV_1 \text{x} SIV_2} \text{x} SIV_3$
	Life Requisite Suitability Index (LRSI) Formulas & Variables	
	SIV1	The relationship between the number of trees ≥51 centimeters (cm) Diameter at Breast height (dbh)/0.4 ha and reproductive habitat quality for barred owls.
	SIV2	The relationship between mean dbh of over story trees and reproductive habitat quality for barred owls
	SIV3	The relationship between percent canopy cover of over-story trees and reproductive habitat quality for barred owls.

Table 32 - Life Requisite Suitability Indices for Gray Squirrel

Species	LRSI	HSI Formula
Gray Squirrel	Winter Food and Cover/Reproduction	Equal to the lowest value calculated for either life requisite $\sum_{i=1}^{n} \frac{HSI_i A_i}{A_i}$ where n = number of stands HSI_i = HSI of stand i A_i = area of stand i
	LRSI Formulas & Variables	
	SIV1	Proportion of the total tree canopy cover that is hard mast producing trees ≥25 cm dbh
	SIV2	Number of hard mast tree species
	SIV3 SIV4	Percent canopy cover of trees Mean dbh of over story trees

Table 33 - Life Requisite Suitability Indices for Marsh Wren

Species	LRSI	HSI Formula
Marsh Wren	Cover and Reproduction	$HSI = \sqrt[3]{SIV_1 \text{x} SIV_2 \text{x} SIV_3} \text{x} SIV_4$
	LRSI Formulas & Variables	
	SIV1	Growth form of emergent hydrophytes
	SIV2	Percent canopy cover of emergent herbaceous vegetation
	SIV3 SIV4	Mean water depth Percent canopy cover of woody vegetation

Table 34 - Life Requisite Suitability Indices for Bull Frog

Species	LRSI	HSI Formula
Bullfrog	Food, Winter Cover, Reproduction, and Interspersion	$HSI = \sqrt[3]{SIF \text{x} SIWC \text{x} SIR \text{x} SII}$
	LRSI Formulas & Variables	
	SIV1	Mean distance from shore to water >1.5 m deep
	SIV2	Percent canopy cover of aquatic vegetation in the littoral zone
	SIV3 SIV4 SIV5 SIV6 SIV7 SIV8 SIV9 SIV10 SIV11	Percent shoreline cover Mean water transparency Maximum water depth greater than maximum ice depth Percent silt in substrate Mean current velocity at mid-depth during summer (cm/s) pH Mean water temperature at mid-depth during summer (ºC) Frequency of water level fluctuations >2 m Distance to permanent water (m)

4.8.1.4 Habitat Units and Annualization of Habitat Quality

The values assessed during the field visits were used to identify the habitat impacts for the proposed ecosystem restoration objective. The HSI scores were multiplied by the net change in acreages of the impacted areas to calculate the net change in HUs. HUs represent a numerical combination of quality (i.e. HSI) and quantity (acres) existing at any given point in time.

This formula was developed to calculate precisely cumulative HUs when either HIS, area, or both change over a time interval, which is common when dealing with the unevenness found in nature (USFWS 1980). HU gains or losses are annualized by summing the cumulative HUs calculated using the above equation across all target years in the period of analysis and dividing the total (cumulative HUs) by the number of years in the planning horizon (i.e. 50 years). This calculation results in the AAHUs.

The impact of a project can be quantified by subtracting the FWP scenarios benefits/impacts from FWOP benefits/impacts. The difference in AAHUs between the FWOP and the FWP represents the net impact attributable to the project in terms of habitat quantity and quality.

4.8.1.1 Institute for Water Resources Planning Suite II

The Institute for Water Resources Planning Suite II is a water resources, investment decision, support tool originally built for the formulation and evaluation of ecosystem restoration alternatives; however, it is now more widely used by all USACE business lines for evaluation of actions involving monetary and non-monetary cost and benefits.

The purpose of the IWR Planning Suite II is to assist with the formulation and comparison of plans for Ecosystem Restoration and Mitigation Plans. It has the capability of performing the Cost Effectiveness–Incremental Cost Analysis (CE-ICA), which is further described in Appendix B. The IWR Planning Suite II can also perform calculations resulting in the average annual NER benefits and the average annual equivalent NED costs and benefits.

The IWR Planning Suite II was utilized to annualize the HUs of each alternative for the Mitchell Lake Aquatic ER Feasibility Study. This is the only USACE certified tool for annualizing NER outputs. In addition to the IWR Planning Suite II, ECO-PCX annualization spreadsheets were utilized to verify the average annual benefit outputs for each plan.

$$\int_0^T HU\ dt = (T_2 - T_1)\left[\left(\frac{A_1H_1 + A_2H_2}{3}\right) + \left(\frac{A_2H_1 + A_1H_2}{6}\right)\right]$$

Where:

$$\int_0^T HU\ dt = Cumulative\ HUs$$

T1= first target year of time interval

T2 = last target year of time interval

A1 = area of available habitat at beginning of time interval

A2= area of available habitat as the end of time interval

H1 = HSI at the beginning of time interval

H2 = HSI at the end of time interval

3 and 6 = constants derived from integration of HSI x Area for the interval between any two target years

Figure 42 - Habitat Unit Formula

4.8.1.2 Target Years

Target Year (TY) Zero habitat conditions are represented by the existing, or baseline, habitat conditions. The field and desktop collected data were used to describe the habitat and quantify HUs. Target Year 0 conditions serve as a basis of comparison for both FWOP and FWP scenarios. Additional TYs were identified based on when implemented measures would be expected to elicit community responses represented by changes in the projected habitat variables.

Target Year 1 is used as a standard comparison year to identify and capture changes in habitat conditions that occur within one year after measures have been constructed. Amount of wetted area, reduction in invasive species, and water regimes are likely variables that may improve within this period.

Target Year 5 was selected to allow enough time to review natural plant establishment. Aquatic vegetative abundance and diversity are key variables to assess community response at this target year.

Target Year 10 is used as a point after the initial growth of vegetation and the likely increase in size and benefits plantings have sustained.

Similarly, TY 25 was selected to capture the growth of emergent wetland and riparian habitats. Riparian plant abundance and diversity are also key response variables for this target year.

Target Year 50 is the planning life span of the project and is used as the last projected TY for the study. Restoration measures should produce mature habitat by this target year and represent the habitat types within the study area.

4.8.2 Data Collection

The habitat assessment for the Mitchell Lake Aquatic Ecosystem Restoration Feasibility Study was conducted from 12 March to 14 March 2019 at the Mitchell Lake study area in the City. Although 48 sites were preselected before the field work was conducted, some points were added and/or removed from the assessment (Figure 43). Points added to the assessment were EM1, 22-Polder, EM2, EM3, EM4, and SH1. However, due to the large study area and time constraints on field visits, some of the points selected before fieldwork were not applicable for this study. Points removed from further evaluation included 7, 9, 10, 17, 25-27, 30-35, and 47-48.

The points associated with the species and habitat models that were screened out of further use were not included in the HSI model metric projections or annualization of Alternatives. The Shorebird Migration model was added after fieldwork and metrics for this model were estimated through a desktop exercise and familiarity with the site conditions. . Habitat assessment photos and the field data sheets used during the habitat assessment can be found in Attachments F and G, respectively.

A second field visit was conducted by USACE team members to determine the size and location of any existing wetlands within the study area. Existing wetlands were recorded by GPS, and mapped in Figure 44.

Figure 43 - Habitat Assessment Survey Points (July 2019)

Figure 44 - Existing Wetland Survey Map (July 2019)

4.9 Evaluation and Comparison of Plans – Step 4

This section analyzes the impacts associated with implementation of the final array of alternatives, including the No Action Plan. The No Action Plan assesses the future impacts to the study area resources that would occur under the FWOP condition. The presentation of the No Action Plan helps the decision maker understand the FWOP conditions in the absence of the TSP. How implementation of the plan may alter that future condition. Because the environmental benefits have been calculated over a 50-year period of analysis, the environmental consequences are evaluated over the same timeframe.

For each plan, impacts to the resources resulting from the construction and operation are addressed. However, when impacts are relatively equal between plans, the discussion of the impacts are grouped where appropriate. Because the proposed plan entails improvements to fish and wildlife habitats, no compensatory mitigation is required or proposed for any of the plans.

Environmental restoration benefits are calculated by subtracting the FWOP AAHUs from the FWP condition AAHU. The resulting benefits are then used, along with annual costs, to identify cost effective plans and perform incremental cost analyses.

4.9.1 Direct vs. 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 considered one year or less. Long-term impacts are described as lasting beyond one 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.

4.9.2 Significance Criteria and Impact Characterization Scale

In accordance with the 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 with regard to 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:

- The balance of beneficial and adverse impacts, in a situation where an action has both;
- The degree to which the action affects public health or safety;
- The 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;
- The degree to which the effects on the quality of the human environment are likely to be controversial;
- The 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;
- The 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;
- The 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;
- The 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; and;
- 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

4.9.3 FWOP and FWP Conditions by Area

Seven areas will be discussed (Figure 39):

- Area 1: Bird Pond,
- Area 2: Central Wetland,
- Area 3: Skip's Pond,
- Area 6: Polders,
- Area 7: Fringe Wetlands,
- Area 9: Dam Forested Wetlands, and
- Area 10: Downstream Wetlands

4.9.3.1 Area 1: Bird Pond Wetland FWOP

The existing emergent wetland is ~3.17 acres, also known as Area 1A (Figure 45).

The Marsh Wren HSI scores for Alternative 1A were equal to zero at all target years (Table 20). The main contributing factor was the life requisite variable related to growth form of emergent hydrophytes. Because this area lacked vegetative diversity during the habitat assessment, the team lowered the value of metric, resulting in an overall low HSI value for each target year. Lack of the species such as cattails, cord grasses, and bulrushes can contribute to the factors that make a wetland an unsuitable habitat in regards to cover/reproduction requirements for marsh wren. This trend was assumed through all target years.

The limiting factors for the baseline of the Bullfrog HEP model were percent shoreline cover and percent silt in substrate. Suitability for winter cover is a heavily weighted life requisite metric for the HSI. A low percent silt in substrate lowered the total HSI score.

The final AAHUs calculated for Marsh Wren and Bullfrog were then averaged together, so the FWOP AAHUs for Area 1A is 0.86.

Area 1B is an expansion upon the existing wetlands of Area 1A. The total acreage upon execution of the project would be 6.42 acres.

Although this area is in close proximity to existing wetlands, it is dominated by grassland and shrubland species. The HSI scores for the Marsh Wren and Bullfrog HEP are equal to zero, because Area 1B does not contain any existing wet areas or wetland vegetation.

It should be noted that the Area 1B acreage in

Table 35 does not reflect the actual acreage for Area 1, but rather the acreage that was used to calculate the benefits. To reflect the site conditions, the additional acreage was subtracted from the total acreage of Area 1A. The benefits of Area 1B were then added to the benefits of Alternative 1A to incorporate the area acreage.

The final AAHUs calculated for Marsh Wren and Bullfrog were then averaged together; therefore, the FWOP AAHU score for Alternative 1B is 0.86.

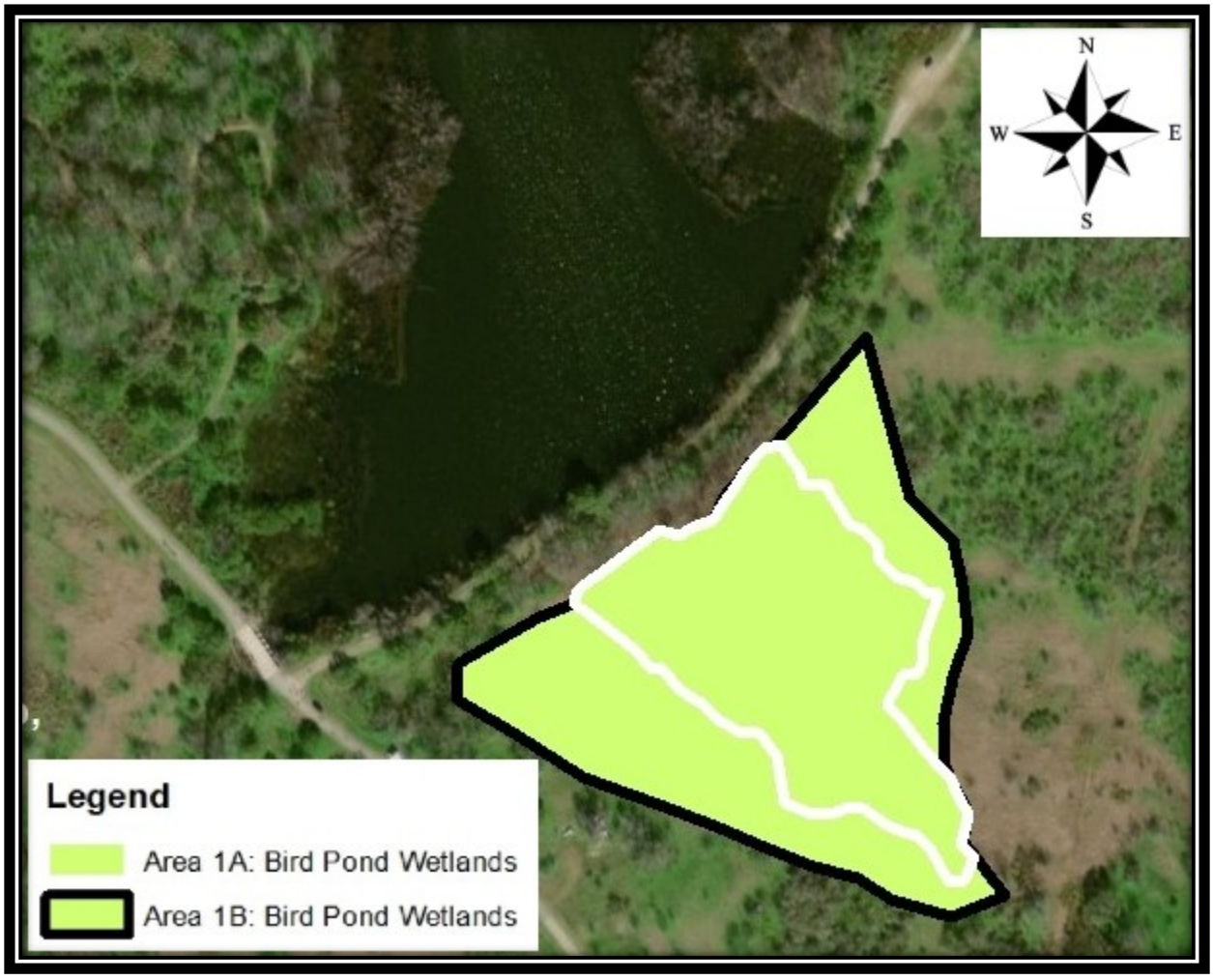

Figure 45 - Area 1: Bird Pond with Alternative Scales 1A and 1B

Table 35 – FWOP HSIs and HUs for Area 1: Bird Pond

Evaluation Method		Target Year											
		0		1		5		10		25		50	
	Acres	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU
Marsh Wren Area 1A	3.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bullfrog Area 1A	3.17	0.58	1.85	0.57	1.79	0.55	1.72	0.54	1.71	0.54	1.71	0.54	1.71
Marsh Wren Area 1B	3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bullfrog Area 1B	3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.9.3.2 Area 1: Bird Pond Wetland FWP

The Area 1A and 1B FWP conditions incorporate the following measures:

- Clearing/Excavation,
- Installation of Pipeline,
- Seasonal Pulses,
- Native Wetland Species Plantings,
- Invasive Species Management,
- Low Quality Vegetation Removal,
- Water Control Structures
- Habitat Structure Augmentation, and
- Installation of Bat/Nest Boxes measures.

With the exception of 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.

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. In an effort to minimize the establishment the establishment of invasive species after the final grading of the wetlands, management, and control of invasive species would be required to ensure establishment of the diverse planted vegetation. An integrated Invasive Species Management Plan would be developed and implemented utilizing chemical, mechanical, and / or biological control.

Table 27 below depicts the increase of the HSI scores beginning at Year 1. The Marsh Wren HSI scores stay relatively low due to the amount of woody vegetation that has been projected to cover the area. However, enhancement of the area from for Alternative 1A and expansion of wetlands for Alternative 1B will result in above average HSI scores for the Bullfrog HEP and increased the Marsh Wren HEP score FWOP HSI from 0 to 0.40 in Target Year 50.

Table 36 - FWP HSIs and HUs for Area 1: Bird Pond

Evaluation Method	Target Year												
		0		1		5		10		25		50	
	Acres	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU
Marsh Wren Area 1A	3.17	0.00	0.00	0.99	3.14	0.90	2.85	0.75	2.38	0.40	1.27	0.40	1.27
Bullfrog Area 1A	3.17	0.57	1.80	0.92	2.93	0.96	3.04	0.97	3.07	0.97	3.09	0.97	3.09
Marsh Wren Area 1B	3.25	0.00	0.00	0.46	1.50	0.85	2.76	0.71	2.31	0.38	1.24	0.38	1.24
Bullfrog Area 1B	3.25	0.00	0.00	0.85	2.77	0.90	2.93	0.95	3.08	0.97	3.14	0.97	3.17

4.9.3.3 Area 2: Central Wetland FWOP

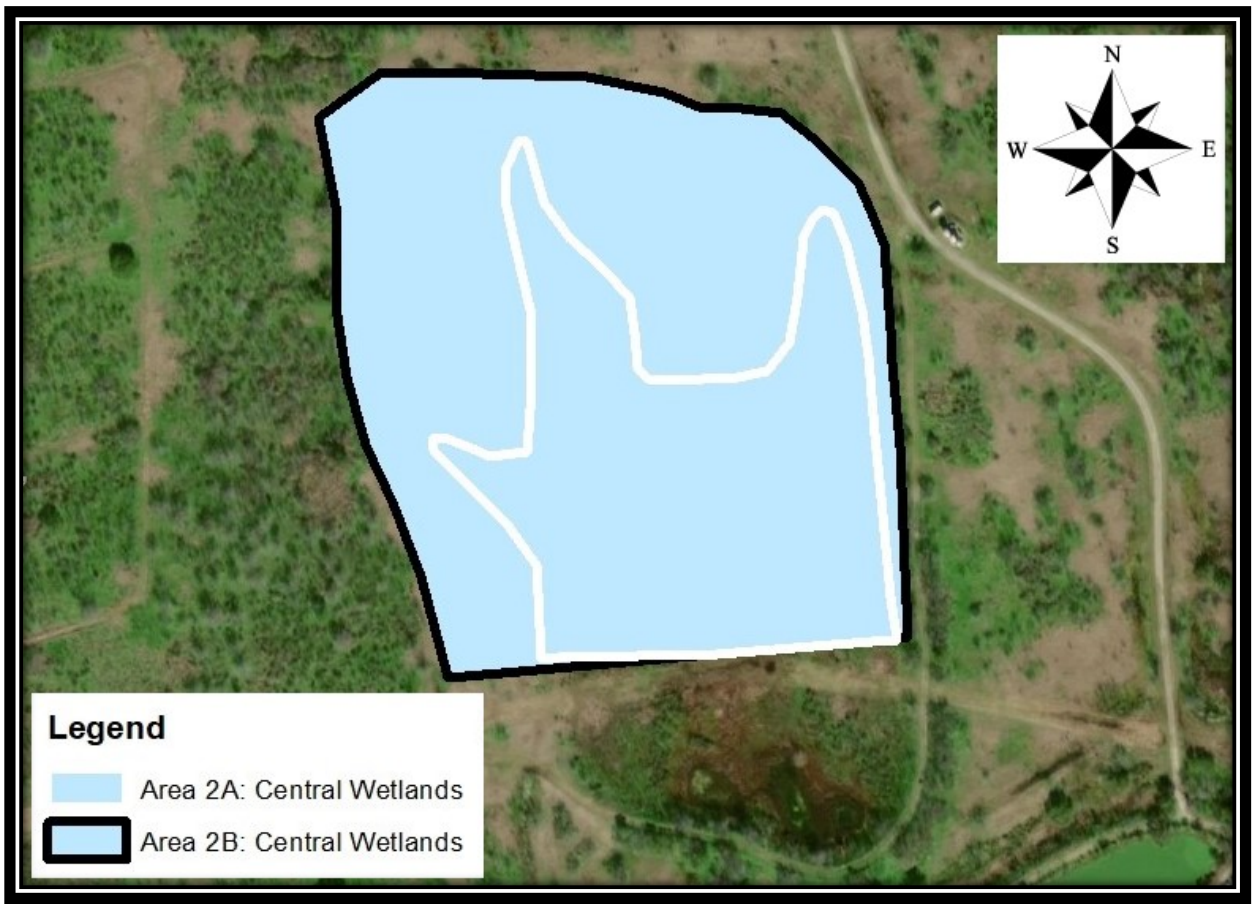

Figure 46 - Area 2: Central Wetland with Alternative Scales 2A and 2B

This area did have some aspects of suitability in regards to the Marsh Wren and Bullfrog models; however, the current site conditions are low quality. The life requisite variable for growth form of emergent hydrophytes brought down the overall HSI score for Marsh Wren, while Bullfrog HSI score was once again lowered by the percent silt in substrate life requisite variable (Table 21). The final AAHU score for Area 2A is 2.85 in the FWOP.

Area 2B includes the area of expansion around the existing Central Wetlands (Area 1A). 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.

Similarly, to Area 1B, it should be noted that the acreage in the table below does not reflect the total acreage for the plan, but rather the acreage that was used to calculate the benefits of Area 2B. Please refer to the section for Area 1B for the methods.

The final AAHU score for Area 2B is 2.85.

Table 37 - FWOP HSIs and HUs for Area 2: Central Wetland

Evaluation Method	Target Year												
		0		1		5		10		25		50	
	Acres	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU
Marsh Wren Area 2A	10.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bullfrog Area 2A	10.46	0.58	6.12	0.57	5.92	0.55	5.70	0.54	5.68	0.54	5.68	0.54	5.68
Marsh Wren Area 2B	7.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bullfrog Area 2B	7.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.9.3.4 Area 2: Central Wetland FWP

The Area 2 measures would be identical to the combination of measures listed for Area 1 above, thus the Central Wetlands will follow the same trend for these HSI scores as the Bird Pond Wetlands. The rise in HUs compared to Area 1 is due to the difference in acreage.

The Area 2A and 2B FWP conditions incorporate the following measures:

- Clearing/Excavation,
- Installation of Pipeline,
- Seasonal Pulses,
- Native Wetland Species Plantings,
- Invasive Species Management,
- Low Quality Vegetation Removal,
- Water Control Structures
- Habitat Structure Augmentation, and
- Installation of Bat/Nest Boxes measures.

Table 38 - FWP HSIs and HUs for Area 2: Central Wetland

Evaluation Method		Target Year											
		0		1		5		10		25		50	
	Acres	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU
Marsh Wren Area 2A	10.46	0.00	0.00	0.99	10.36	0.90	9.41	0.75	7.85	0.40	4.18	0.40	4.18
Bullfrog Area 2A	10.46	0.57	5.95	0.92	9.66	0.96	10.01	0.97	10.15	0.97	10.19	0.97	10.19
Marsh Wren Area 2B	7.91	0.00	0.00	0.46	3.64	0.85	6.72	0.71	5.62	0.38	3.01	0.38	3.01
Bullfrog Area 2B	7.91	0.00	0.00	0.85	6.74	0.90	7.12	0.95	7.49	0.97	7.64	0.97	7.71

4.9.3.5 Area 3: Skip's Pond FWOP

This area consists of vegetation such as buttercup (*Ranunculus spp*.), alligator weed, and bedstraw. The existing wetland does not hold high quality vegetation, which led to a negative impact on the Marsh Wren HSI score for overall suitability. The Bullfrog HSI scores were relatively average, because of the percent in silt in substrate metric.

The total AAHUs for this site was 0.59.

Figure 47 - Area 3: Skip's Pond with the Single Alternative Site 3

Table 39 - FWOP HSIs and HUs for Area 3: Skip's Pond

Evaluation Method		Target Year											
		0		1		5		10		25		50	
	Acres	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU
Marsh Wren	2.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bullfrog	2.18	0.58	6.12	0.57	5.92	0.55	5.70	0.54	5.68	0.54	5.68	0.54	5.68

4.9.3.6 Area 3: Skip's Pond FWP

Area 3 would incorporate the same measures and scales as described above for Areas 1 and 2 with the exception of the installation of a pipeline due to a petroleum pipeline separating the Central Wetlands from Skip's Pond. Due to the probable increase in woody vegetation, the Marsh Wren score is negatively affected beginning in Year 25 (Table 29).

The Area 3A and 3B FWP conditions incorporate the following measures:

- Clearing/Excavation,
- Seasonal Pulses,
- Native Wetland Species Plantings,
- Invasive Species Management,
- Low Quality Vegetation Removal,
- Water Control Structure (only needed if Area 2 measures are implemented)
- Habitat Structure Augmentation, and
- Installation of Bat/Nest Boxes measures.

Table 40 - FWP HSIs and HUs for Area 3: Skip's Pond

Evaluation Method	Target Year												
		0		1		5		10		25		50	
	Acres	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU
Marsh Wren	2.18	0.00	0.00	0.99	2.16	0.90	1.96	0.75	1.64	0.40	0.87	0.40	0.87
Bullfrog	2.18	0.57	1.24	0.92	2.01	0.96	2.09	0.97	2.11	0.97	2.12	0.97	2.12

4.9.3.7 Area 6: Polders FWOP

The plan for this area is focused on structural modification and operational management of the water within the polder cells. Common species found along the levees of the polders and basins included: sugarberry, western ragweed, hedge parsley, bedstraw, spiny hackberry, and Palo verde. The areas within the polders and basin had little to no vegetation or consisted of open water habitat. Vegetative diversity within this area is incredibly low and consists of low quality wildlife habitat.

Suitability for migrating shorebirds is above average, however a few limiting factors such as water depths and availability and timing for water depths and availability lowered the total HSI score (Table 23). The polders and basins are continually dry or have depths greater than 18 cm with little useable shoreline. The AAHU for FWOP is 30.21.

Figure 48 - Area 6: Polders with the Single Alternative Site 6

Table 41 - FWOP HSIs and HUs for Area 6: Polders

Evaluation Method	Target Year												
		0		1		5		10		25		50	
	Acres	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU
Shorebird Migration Model	49.52	0.61	30.21	0.61	30.21	0.61	30.21	0.61	30.21	0.61	30.21	0.61	30.21

4.9.3.8 Area 6: Polders FWP

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 FWP (Table 30).

The Area 6 FWP conditions incorporate the following measures:

- Polder Operational Management,
- Installation of Bat/Nest Boxes, and
- Construction of Berms.

Table 42 - FWP HSIs and HUs for Area 6: Polders

Evaluation Method	Target Year												
		0		1		5		10		25		50	
	Acres	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU
Shorebird Migration Model	49.52	0.61	30.21	0.98	48.53	0.98	48.53	0.98	48.53	0.98	48.53	0.98	48.53

4.9.3.9 Area 7: Fringe Wetlands FWOP

Area 7 is characterized by its proximity to the border of the open water habitat of Mitchell Lake. Future management of Mitchell Lake will result in the adjustment of the water surface elevation to 517', lowering the water levels will effectively decrease the amount of emergent and submergent wetland habitat. Plant growth is negatively impacted by the varying DO and pH levels within Mitchell Lake.

The Fringe Wetlands are separated into coves, which can all be implemented as stand-alone alternatives or included in combination with each other (Figure 18). 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.

The borders of the lake have very limited plant diversity; lack of diversity affects the overall Marsh Wren HSI score. Other limiting factors for all of the coves include percent cover of emergent herbaceous vegetation and mean water depth.

The limiting life requisite variables for the Bullfrog HEP model were percent shoreline cover and percent silt in substrate. Percent silt in substrate affected the suitability of the area for winter cover.

The difference in AAHUs for each cove can be accounted for by their difference in size. There are no assumed differences between each of the coves in regards to suitability.

Cove 1 FWOP AAHU is 13.43, Cove 2 is 2.96, and Cove 3 is 1.71.

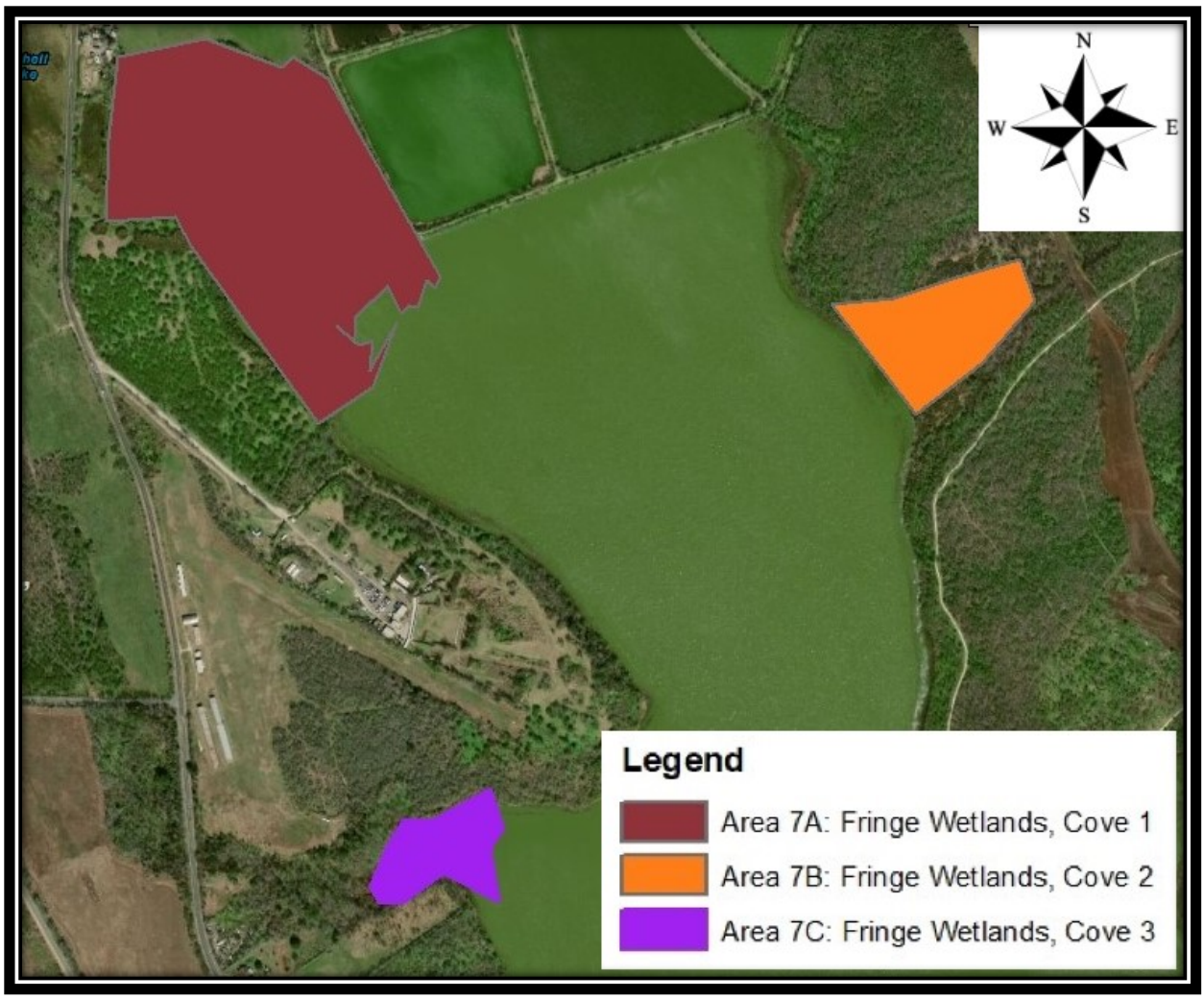

Figure 49 - Area 7: Fringe Wetlands with the Three Sites 7A, 7B, and 7C

Table 43 - FWOP HSIs and HUs for Area 7: Fringe Wetlands (Coves 1 – 3)

Evaluation Method	Target Year												
		0		1		5		10		25		50	
	Acres	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU
Marsh Wren Cove 1	53.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bullfrog Cove 1	53.68	0.52	28.12	0.47	25.34	0.47	25.34	0.49	26.16	0.50	26.93	0.52	28.12
Marsh Wren Cove 2	11.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bullfrog Cove 2	11.84	0.52	6.20	0.47	5.59	0.47	5.59	0.49	5.77	0.50	5.94	0.52	6.20
Marsh Wren Cove 3	6.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bullfrog Cove 3	6.84	0.52	3.58	0.47	3.23	0.47	3.23	0.49	3.33	0.50	3.43	0.52	3.58

4.9.3.10 Area 7: Fringe Wetlands FWP

Implementation of the Proposed Action would involve invasive species management/removal and the planting of native emergent, submergent, and riparian species. Three coves have been identified as part of the Area 7 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.

Table 44 - FWP HSIs and HUs for Area 7: Fringe Wetlands (Coves 1 – 3)

Evaluation Method	Target Year												
		0		1		5		10		25		50	
	Acres	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU
Marsh Wren Cove 1	53.68	0.00	0.00	0.00	0.00	0.44	23.62	0.81	43.48	0.76	40.80	0.76	40.80
Bullfrog Cove 1	53.68	0.56	30.24	0.87	46.80	0.90	48.56	0.92	49.58	0.93	49.84	0.93	49.84
Marsh Wren Cove 2	11.84	0.00	0.00	0.00	0.00	0.44	5.21	0.81	9.59	0.76	9.00	0.76	9.00
Bullfrog Cove 2	11.84	0.56	6.67	0.8	10.32	0.90	10.71	0.92	10.93	0.93	10.99	0.93	10.99
Marsh Wren Cove 3	6.84	0.00	0.00	0.00	0.00	0.44	3.01	0.81	5.54	0.76	5.20	0.76	5.20
Bullfrog Cove 3	6.84	0.56	3.85	0.87	5.96	0.90	6.19	0.92	6.32	0.93	6.35	0.93	6.35

The Area 7 FWP conditions incorporate the following measures for Coves 1, 2, and 3:

- Native Wetland Species Plantings,
- Invasive Species Management,
- Habitat Structure Augmentation, and
- Installation of Bat/Nest Boxes.

4.9.3.11 Area 9: Dam Forested Wetlands FWOP

The Dam Forested Wetlands are maintained by seepage through the dam and are dominated by hackberry woodlands (Figure 50. An existing drainage channel resulting from dam seepage has created low-lying wet areas in relative depths, which has resulted in a linear series of in-channel emergent and forested wetlands with several ponded areas along the upstream section of the drainage. There are two analyses of benefit and cost for this area.

Figure 50 - Area 9: Dam Forested Wetlands with Alternative Scales 9A and 9B

Area 9A is characterized by the existing low areas below the dam, while Area 9B is the expansion of the existing forested wetlands. The limiting factors for Barred Owl in this area include the number of trees greater than 20”es per acre and the mean dbh of over story trees until Target Year 10.

Area 9A FWOP AAHUs is 0.71 and 9B is 1.25.

Table 45 - Future Without-project Habitat Conditions for Area 9.

Evaluation Method		Target Year											
		0		1		5		10		25		50	
	Acres	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU
Barred Owl Area 9A	2.55	0.22	0.55	0.22	0.55	0.25	0.64	0.33	0.84	0.47	1.19	0.69	1.76
Gray Squirrel Area 9A	2.55	0.10	0.25	0.10	0.25	0.10	0.24	0.10	0.25	0.10	0.24	0.10	0.24
Barred Owl Area 9B	4.48	0.22	0.97	0.22	0.97	0.25	1.12	0.33	1.48	0.47	2.09	0.69	3.09
Gray Squirrel Area 9B	4.48	0.10	0.44	0.10	0.44	0.10	0.43	0.10	0.43	0.10	0.43	0.10	0.43

4.9.3.12 Area 9: Dam Forested Wetlands FWP

The FWP condition would entail the thinning of hackberry trees for use as structural habitat and the creation of standing snags.

Although the HSI scores rise through the years, due to the measures implemented, the impacts are minimal and yield low results in regards to HUs due to the amount of acreage involved with this area.

The Alternative 9A and 9B FWP conditions incorporate the following measures:

- Clearing/Excavation,
- Native Riparian Plantings,
- Seasonal Pulses,
- Native Wetland Species Plantings,
- Invasive Species Management,
- Low Quality Vegetation Removal,
- Water Control Structures
- Habitat Structure Augmentation, and
- Installation of Bat/Nest Boxes measures.

Table 46 - Future With-project Habitat Conditions for Area 9

Evaluation Method	Target Year												
		0		1		5		10		25		50	
	Acres	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU
Barred Owl Area 9A	2.55	0.22	0.55	0.11	0.28	0.16	0.41	0.26	0.65	0.52	1.32	0.58	1.47
Gray Squirrel Area 9A	2.55	0.10	0.25	0.32	0.81	0.32	0.81	0.32	0.81	0.55	1.40	0.71	1.80
Barred Owl Area 9B	4.48	0.22	0.97	0.11	0.49	0.16	0.73	0.26	1.14	0.52	2.31	0.58	2.59
Gray Squirrel Area 9B	4.48	0.10	0.44	0.32	1.42	0.32	1.42	0.32	1.42	0.55	2.45	0.71	3.17

4.9.3.13 Area 10: Downstream Wetlands FWOP

In order to determine the benefits for this plan, the FWOP conditions were projected with the current existing conditions, i.e. upland within the respective model metrics for emergent wetland habitat. The habitat within this area is assumed upland, due to the surrounding areas. See Figure 20 for the Downstream Wetlands approximate location. Due to its status as upland habitat, it produced below average scores in the emergent wetland habitat models.

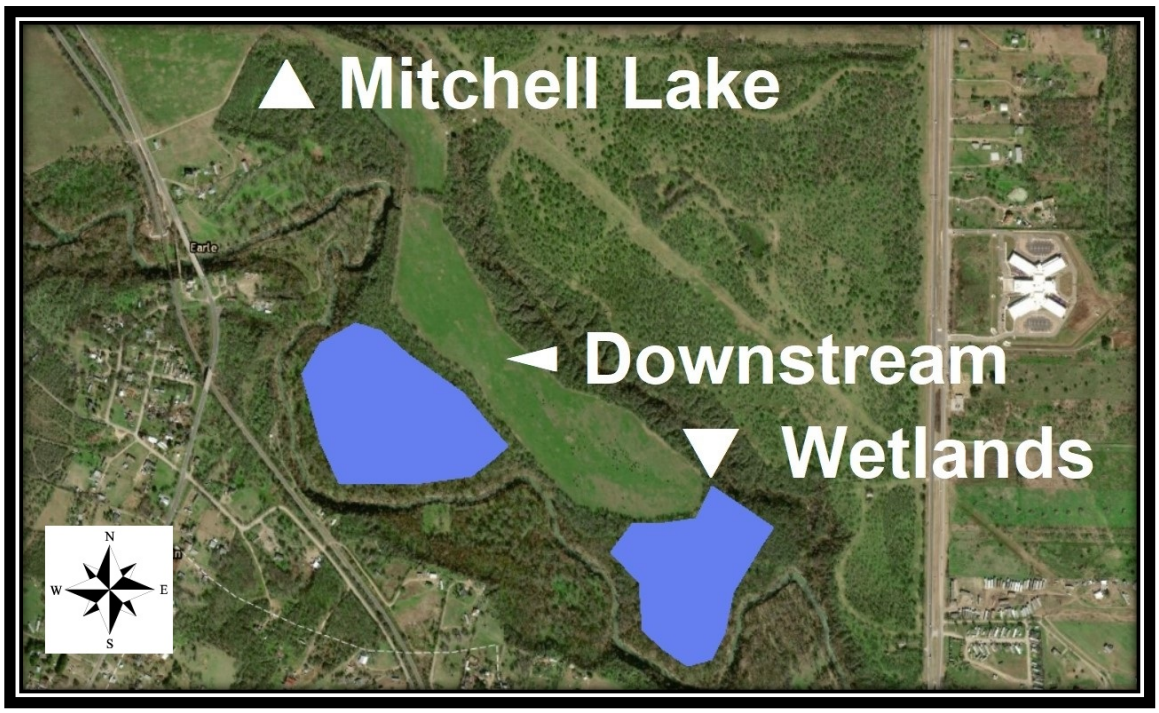

Figure 51 - Area 10: Downstream Wetlands Single Scale

Table 47 - Future With-Project Habitat Conditions for Area 10

Evaluation Method		Target Year											
		0		1		5		10		25		50	
	Acres	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU
Marsh Wren	51.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bullfrog	51.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4.9.3.14 Area 10: Downstream Wetlands FWP

Native wetland species plantings, seasonal pulses, and habitat structure augmentation have a large impact on this area, which have resulted in average to above average HSI scores throughout the Target Years.

The Alternative 10 FWP would implement the following measures:

- Clearing/Excavation,
- Native Wetland Species Planting,
- Seasonal Pulses,
- Habitat Structure Augmentation,
- Water Control Structures
- Installation of Bat/Nest Boxes, and
- Construction of Berms.

Table 48 - Future With-project Habitat Conditions for Area 10

Evaluation Method		Target Year											
		0		1		5		10		25		50	
	Acres	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU	HSI	HU
Marsh Wren	51.32	0.00	0.00	0.46	23.61	0.85	43.62	0.71	36.44	0.38	19.50	0.38	19.50
Bullfrog	51.32	0.00	0.00	0.85	43.71	0.90	46.21	0.95	48.62	0.97	49.55	0.97	50.00

4.9.4 Future Average Annual Habitat Units

Environmental restoration benefits are calculated by subtracting the FWOP AAHU from the FWP AAHU. Although the measures for most of the areas are similar, there are vast differences between the amounts of AAHUs gained for each alternative due to the varying acreage of each area.

Table 49 - Average Annual Habitat Benefits by Alternative

Project Area	Alternatives	FWOP AAHU	FWP AAHU	Annual Benefits AAHU	FWP Acres
Area 1: Bird Pond Wetlands	1A: Enhancement of Existing Wetlands	0.86	2.39	1.53	3.17
	1B: Expansion/Enhancement of Existing Wetlands and Enhancement of Additional Wetlands	0.86	4.71	3.85	6.42
Area 2: Central Wetland	2B: Enhancement of Existing Wetlands	2.85	7.88	5.03	10.46
	2B: Expansion/Enhancement of Existing Wetlands and Enhancement of Additional Wetlands	2.85	13.54	10.69	18.37
Area 3: Skip's Pond	3: Enhancement 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: Enhancement of Cove 1 (Wetland/Riparian Plantings)	13.43	43.33	29.9	53.68
	7B: Enhancement of Cove 2 (Wetland/Riparian Plantings)	2.96	9.56	6.6	11.84
	7C: Enhancement 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: Enhancement of Existing Wet Riparian Habitat	0.71	1.19	0.47	2.55
	9B: Expansion/Enhancement of Existing Wet Riparian Habitat and Enhancement of Additional Riparian Habitat	1.25	2.08	0.83	4.48
Area 10: Downstream Wetlands	10: Creation of Wetlands Downstream of Mitchell Lake	0	36.73	36.73	51.32

The greatest AAHU benefit based on existing conditions and the FWP conditions is in the Area 10: Downstream Wetlands Alternatives. The conversion of this area from shrubland/upland habitat to emergent/submergent wetland habitat has a high probability of improving conditions for wildlife utilizing emergent wetland habitat (Appendix C – Section 4.7).

For this study, FWOP conditions are assumed the same as existing conditions, given the existing habitat quality.

4.10 Comparison of the Scales / Sizes of Plans – Step 5

4.10.1 Costs

Total project economic costs were annualized using the annualizer tool in IWR Planning Suite. 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 52provides a summary of total and annual costs, including Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R). Construction first cost includes construction cost and plantings. Real estate cost is not included in construction first cost, because all real estate is owned by the sponsor with the exception of some land for Plan 10, the downstream wetlands. This land is not considered a project first cost, because it would be purchased in the future without-project condition. 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.

4.10.2 Cost Engineering

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). The project had multiple flood risk management and mitigation options.

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

Figure 52 - Cost Inputs for IWR Planning Suite CE-ICA Analysis

4.10.3 Cost Effective–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 (Table 50). This resulted in 1,728 Plans.

Table 50 - 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: Enhancement of Existing Wetlands	1.53	$29.98
	1B: Expansion/Enhancement of Existing Wetlands and Enhancement of Additional Wetlands	3.85	$40.57
Area 2: Central Wetland	2A: Enhancement of Existing Wetlands	5.03	$47.28
	2B: Expansion/Enhancement of Existing Wetlands and Enhancement of Additional Wetlands	10.69	$72.48
Area 3: Skip's Pond	3: Enhancement 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: Enhancement of Cove 1 (Wetland/Riparian Plantings)	29.9	$164.94
	7B: Enhancement of Cove 2 (Wetland/Riparian Plantings)	6.6	$36.38
	7C: Enhancement 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: Dam Forested Wetlands	9A: Enhancement of Existing Wet Riparian Habitat	0.47	$28.73
	9B: Expansion/Enhancement of Existing Wet Riparian Habitat and Enhancement of Additional Riparian Habitat	0.83	$34.59
Area 10: Downstream Wetlands	10: Creation of Wetlands Downstream of Mitchell Lake	36.73	$173.07

4.10.4 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 1,728 Plans (including various scales), 29 were identified as cost effective Plans, including the No Action Plan (Figure 53).

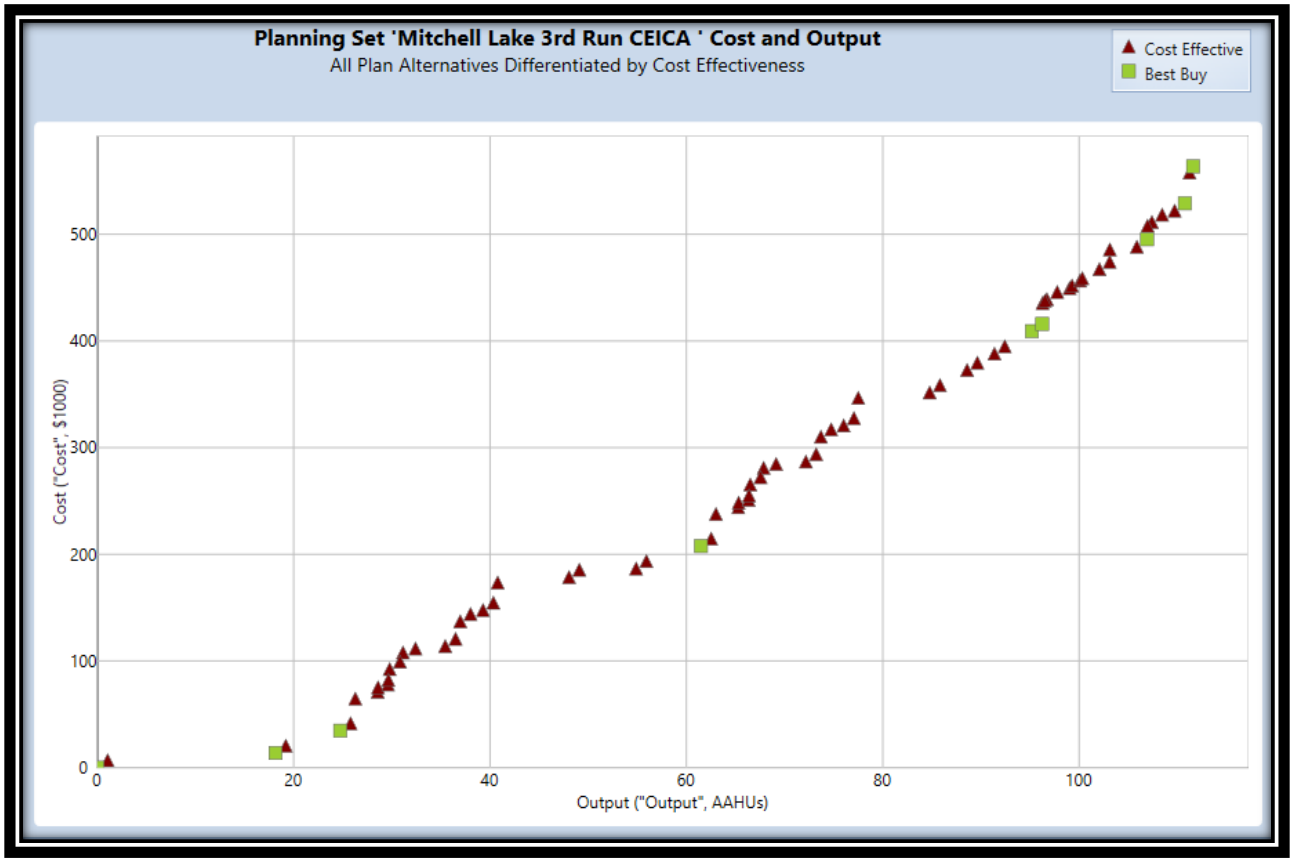

Figure 53 - Graph showing Cost Effective [red triangles] and Best Buy Plans [green squares]

4.10.5 Best Buy Plans

From the 29 cost effective Plans, nine were identified as “Best Buy” Plans, including the No Action Plan (Figure 53). The result of the analysis is shown graphically in Figure 54.

- Plan 1: No Action
- Plan 2: Polders (Alternative 6 alone)
- Plan 3: Polders (6) + Cove 3 (7C)
- Plan 4: Polders (6) + Cove 3 (7C) + Downstream Wetlands (10)
- Plan 5: Polders (6) + Coves 1 – 3 (7G) + Downstream Wetlands (10)
- Plan 6: Skip's Pond (3) + Plan 5 (Alternatives 6 + 7G + 10)
- Plan 7: Central Wetland (2B) + Plan 6 (Alternatives 3+ 6 + 7G + 10)
- Plan 8: Bird Pond Wetland (1B) + Plan 7 (Alternatives 2B + 3+ 6 + 7G + 10)
- Plan 9: Dam Forested Wetlands (9B) + Plan 8 (Alternatives 1B + 2B + 3+ 6 + 7G + 10)

Specific Study Planning Objectives:

1. Increase the areal extent and quality of fish and wildlife habitat in the study area for the life of the project.
2. Increase the floral and faunal species diversity and richness in the study area for the life of the project.
3. Manage and control invasive species in the study area for the life of the project.

First, each measure was identified as either meeting a specific study objective (**Yes**) or failing to meet a specific planning objective (**No**) (Table 51). All but one Plan met study objectives.

Table 51 – Screening of Plans with the Planning Objectives

Plan Name	Planning Objectives		
	1	2	3
Plan 1: No Action	**No**	**No**	**No**
Plan 2: Polders (Alternative 6 alone)	Yes	Yes	Yes
Plan 3: Polders (6) + Cove 3 (7C)	Yes	Yes	Yes
Plan 4: Polders (6) + Cove 3 (7C) + Downstream Wetlands (10)	Yes	Yes	Yes
Plan 5: Polders (6) + Coves 1 – 3 (7G) + Downstream Wetlands (10)	Yes	Yes	Yes
Plan 6: Skip's Pond (3) + Plan 5 (Alternatives 6 + 7G + 10)	Yes	Yes	Yes
Plan 7: Central Wetland (2B) + Plan 6 (Alternatives 3+ 6 + 7G + 10)	Yes	Yes	Yes
Plan 8: Bird Pond Wetland (1B) + Plan 7 (Alternatives 2B + 3+ 6 + 7G + 10)	Yes	Yes	Yes
Plan 9: Dam Forested Wetlands (9B) + Plan 8 (Alternatives 1B + 2B + 3+ 6 + 7G + 10)	Yes	Yes	Yes

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

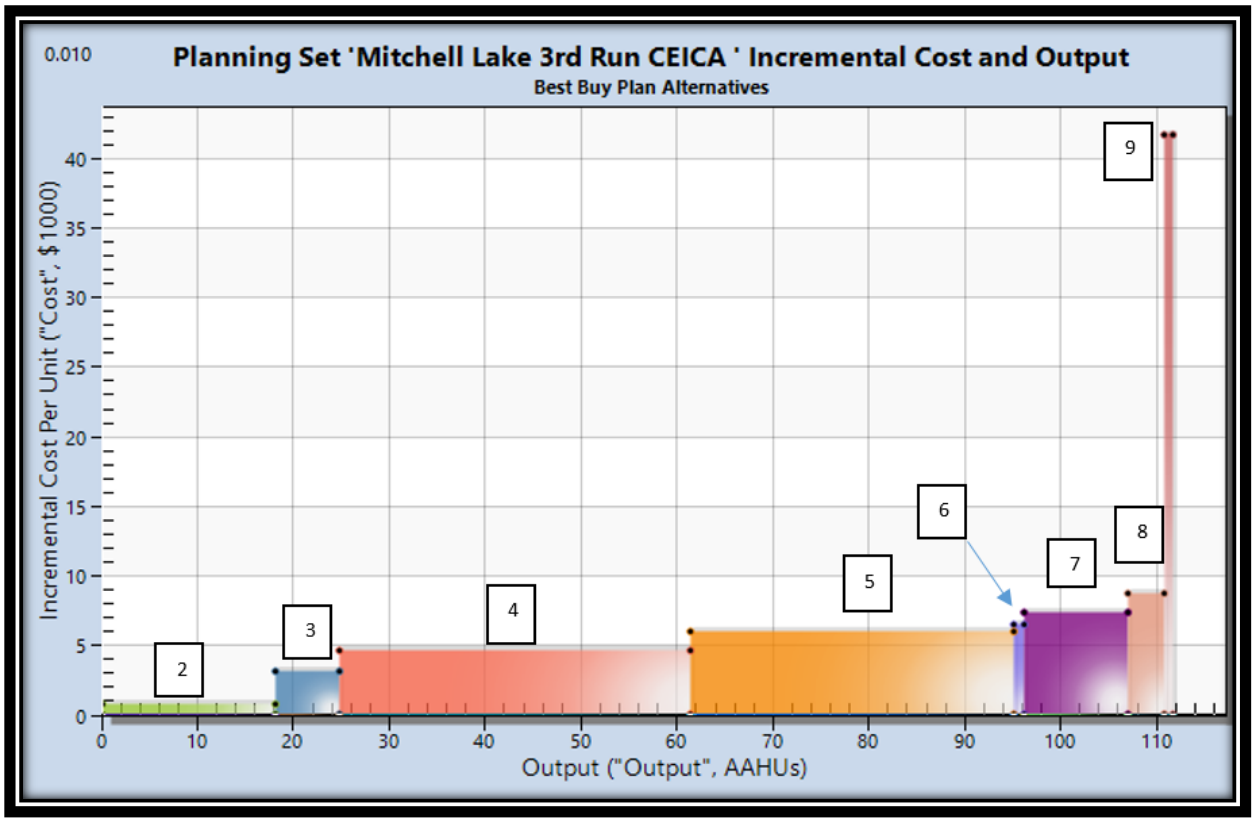

Figure 54 - Bar Chart comparing Best Buy Plans Benefits vs. Costs for Implementation

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, water birds, 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 a large number of migratory birds due to its attractive aquatic environments, the low quality habitat and low habitat diversity cannot adequately support the energy needs of the migratory birds the lake attracts. Therefore, migratory birds must expend additional, limited energy resource in search of food resources elsewhere. Therefore, Plan 1 is not an acceptable alternative to improve habitat for the nationally significant migratory bird populations at Mitchell Lake.

Plan 2: Polders (Alternative 6 alone)

Plan 2 entails the restoration of mud flats habitats that would have been interspersed throughout the historical wetland complex prior to the impoundment of Mitchell Lake. The Plan would result in the restoration of five mudflat cells within the existing polder complex comprising a total of 49.5 acres of mudflat habitat (Figure 55). Details of the ecological benefits of the mudflat restoration are provided in Chapter 5 of Appendix C – Environmental Resources.

Under the existing condition, the polders are managed for open water. They provide essentially no foraging habitat for migrating shorebirds. Therefore, the creation of the mudflats would create 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 average annual cost of $13,680. Plan 2 encompasses 23.7% 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 55 - Plan 2: Polders (Alternative 6 alone)

Plan 3: Polders + Cove 3 (Alternatives 6 + 7C)

Plan 4 includes the mudflat restoration included in Plan 2 and adds the restoration of 6.84 acres of emergent and submerged aquatic vegetation within Cove 3 of Mitchell Lake (Figure 2). The restoration of the fringe wetlands along the shoreline and shallows of the cove provides significant resting and foraging habitat for migrating water birds and waterfowl. Details of the ecological benefits of the emergent/submergent wetland habitats are provided in Section 5.11.2.1 of Appendix C – Environmental Resources.

Plan 3 adds 6.6 AAHU of emergent and submergent wetland habitat to the 18.1 AAHU of mudflat habitat. Because the mudflat and emergent/submergent 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 2 would provide 24.7 AAHU; this comprises 4% of the output of that captured by the largest Plan (Plan 9). The incremental cost per incremental output of Plan 3 is $3,190 with a first cost of $336,300. Plan 3 would restore 26.9% of the total area identified for restoration under this study.

Plan 3 includes the restoration of shorebird habitat attributed to the polders and adds habitat for water birds (another group of birds experiencing significant declines in population sizes) and waterfowl (a nationally managed resource). Because Plan 3 increases the habitat value for two additional groups 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.

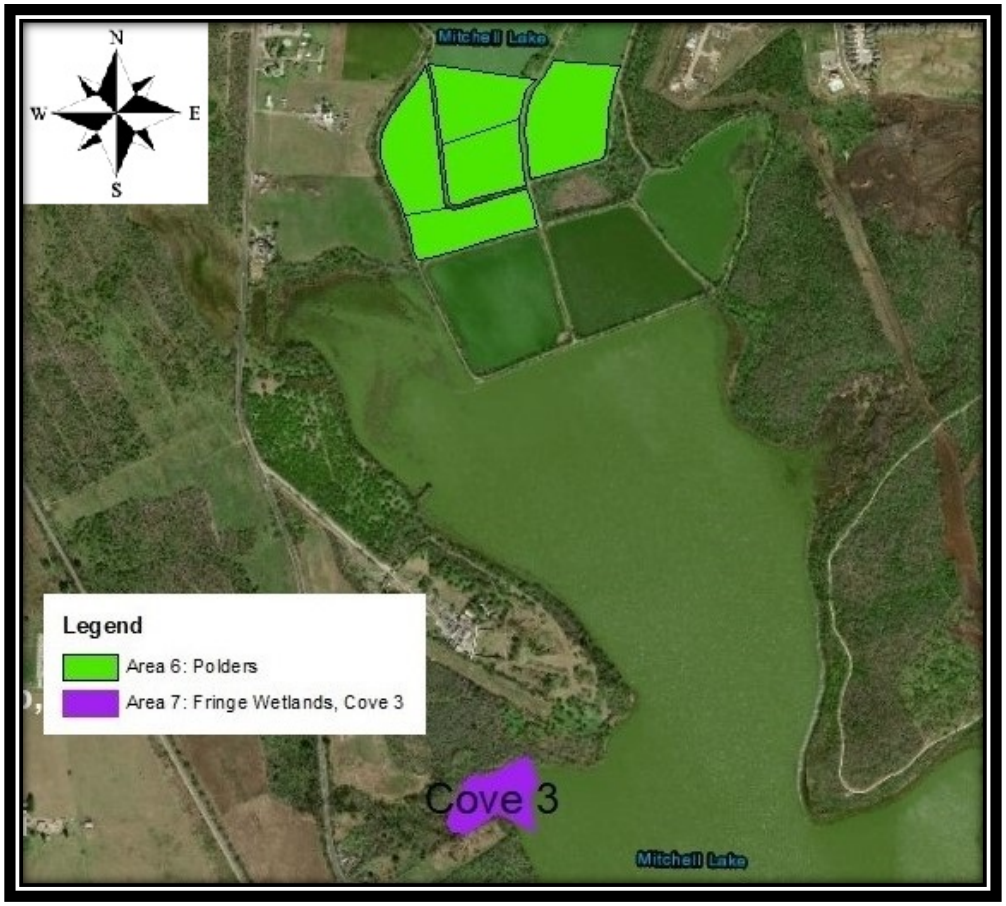

Figure 56 - Plan 3: Polders + Cove 3 (Alternatives 6 + 7C)

Plan 4: Polders, Cove 3, and Downstream Wetlands (Alternatives 6 + 7C + 10)

Plan 4 includes the restoration of the mud flats and emergent/submergent wetlands that were included in Plan 3 and adds the restoration of 51.32 acres of emergent wetlands located downstream of the Mitchell Lake Dam. The downstream emergent wetlands provide cover and foraging habitat for temperate and Neotropical migrant songbirds and water birds. Neotropical migrant songbirds attracted to emergent wetlands include the Marsh Wren (Cistothorus palustris), Sedge Wren (C. platensis), Bobolink (Dolichonyx oryzivorus), rails, egrets, and herons. Similar to shorebirds and water birds, the population trends for Neotropical migrant songbirds are also in decline.

Plan 4 adds 36.7 AAHU of emergent wetland habitat to the 18.1 AAHU of mudflat and 6.6 AAHU of emergent/submergent 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 AAHU or 9.8% of the total potential AAHUs available for the study. The incremental cost per incremental output for Plan 4 is $4,710 with a first cost of $1,851,969. Plan 4 would restore 51.5% of the total area identified for restoration under this study.

The addition of the downstream wetlands 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 water birds, and the emergent wetlands benefit water birds and temperate and Neotropical migrant songbirds. 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.

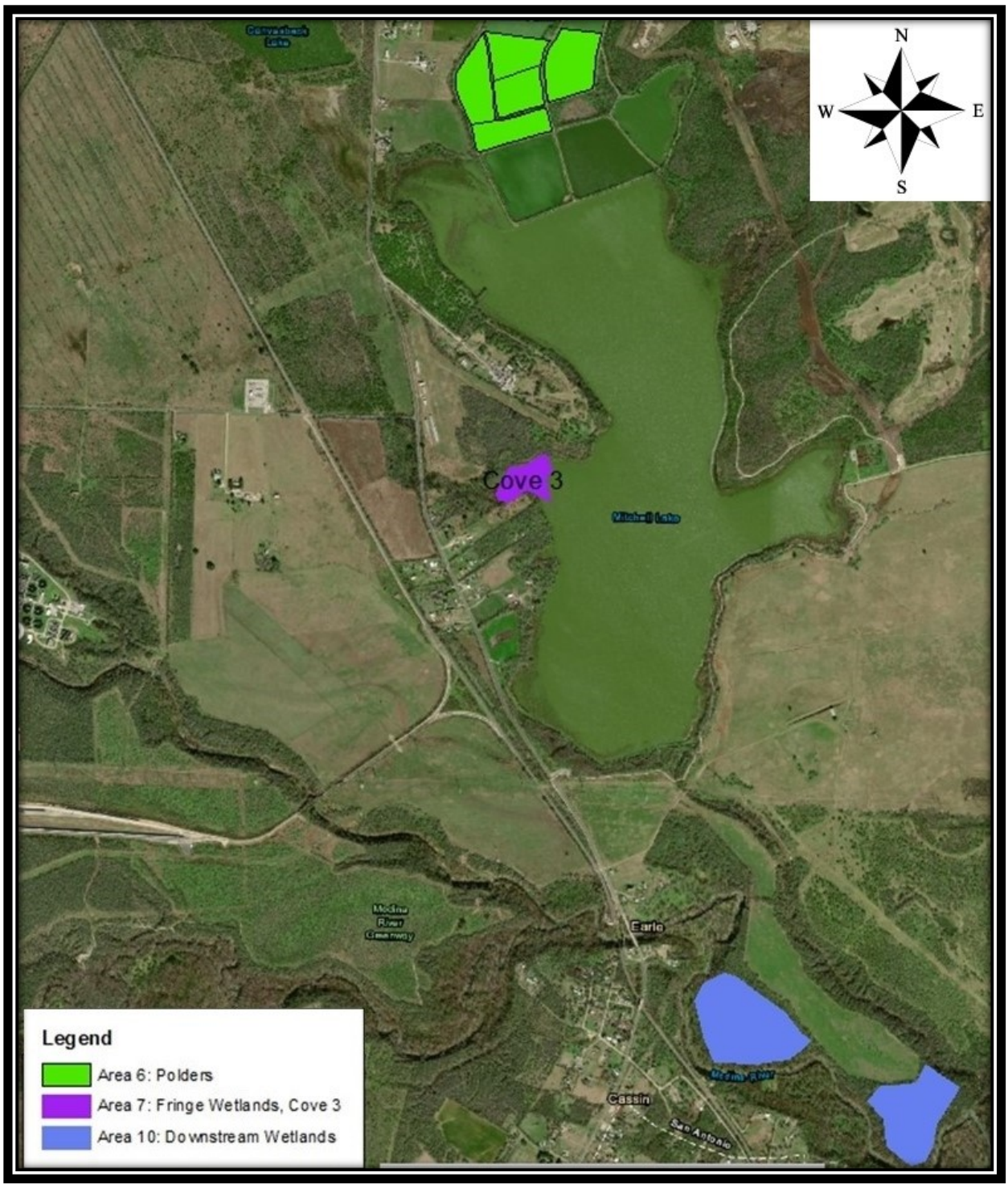

Figure 57 - Plan 4: Polders, Cove 3, and Downstream Wetlands (Alternatives 6 + 7C + 10)

Plan 5: Polders, Coves 1 - 3, and Downstream Wetlands (Alternatives 6 + 7G + 10)

Plan 5 adds the restoration of emergent and submergent wetlands to those restoration features included in Plan 4. In addition to the restoration of 49.52 acres of mudflats associated with the polders, 6.84 acres of emergent/submergent wetlands associated with Cove 3, and 61.32 acres of emergent wetlands associated with the downstream wetlands, Plan 5 adds emergent/submergent wetland habitat restoration in two additional covers of Mitchell Lake (Figure 4). Restoration would include 53.68 acres of restoration in Cove 1 located at the northwest end of the lake and 11.84 acres of restoration in a cove at the eastern edge of the lake. The additional 65.52 Acres of emergent/submergent wetland provided by Plan 5 would result in 72.36 total acres of restoration in the coves of Mitchell Lake.

Plan 5 adds 33.7 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 95.2 total AAHUs captured by this Plan can be broken down for each habitat type:

1. 49.52 acres and 18.1 AAHUs of mudflat habitat
2. 72.36 acres and 40.3 AAHUs of emergent/submergent wetland habitat
3. 51.32 acres and 36.7 AAHUs of emergent wetland habitat

The incremental cost per incremental output for Plan 5 is $5,973 with a first cost of $3,686,529. Plan 5 would restore 82.8% of the total area identified for restoration under this study.

Plan 5 would increase the area of emergent/submergent wetlands restored by an order of magnitude, significantly increasing water bird and waterfowl habitat in Mitchell Lake. As previously mentioned, this habitat is highly valuable for nationally significant resources such as water birds and waterfowl. Each year, these birds migrate through the area and settle on Mitchell Lake. The addition to 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 additional energy in search of additional habitat. The incremental cost per incremental output of including the Cove 3 wetlands into Plan 3 was $3,190 compared to the $5,973 incremental cost per incremental output for the Cove 1 and Cove 2 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.

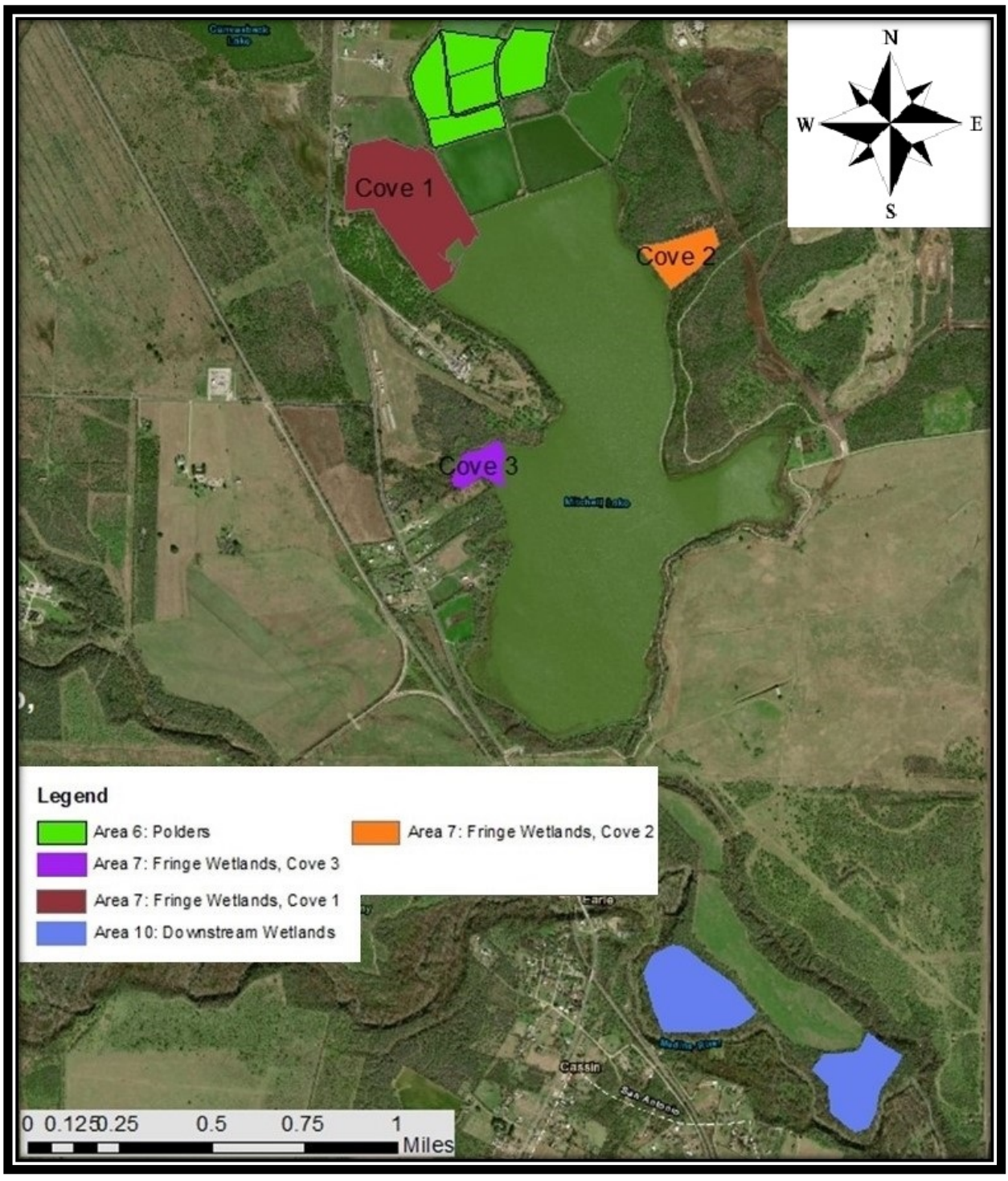

Figure 58 - Plan 5: Polders, Coves 1 - 3, and Downstream Wetlands (Alternatives 6 + 7G + 10)

Plan 6: Skip's Pond + Plan 5 (Alternatives 3+ 6 + 7G + 10)

In addition to the restoration features included in Plan 5, Alternative 6 adds restoration measures to improve the habitat quality of Skip's Pond. 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, and control non-native, invasive species. The Skip's Pond restoration would add 2.18 acres of submergent / emergent wetlands and 1.0 AAHUs to the previous Plan (Figure 59).

96.2 AAHUs are provided by Plan 6; the allocation of the AAHUs is provide below:

1. 49.52 acres and 18.1 AAHUs of mudflat habitat
2. 74.54 acres and 41.4 AAHUs of emergent/submergent wetland habitat
3. 51.32 acres and 36.7 AAHUs of emergent wetland habitat

The incremental cost per incremental output for Plan 6 is $6,571 with a first cost of $3,749,480, a first cost increase of ~$63,000 over Plan 5. Plan 6 would restore 83.9% 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 from 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 of the addition of the Skip's Pond wetlands provides habitat that has not been included in the previous Plans and that habitat provides resources for another distinct group/guild of birds; absorbing the increased incremental cost to incremental output ratio resulting from moving from Plan 5 to Plan 6 and the marginal increase in the first cost, Plan 6 is worth the Federal and local investment.

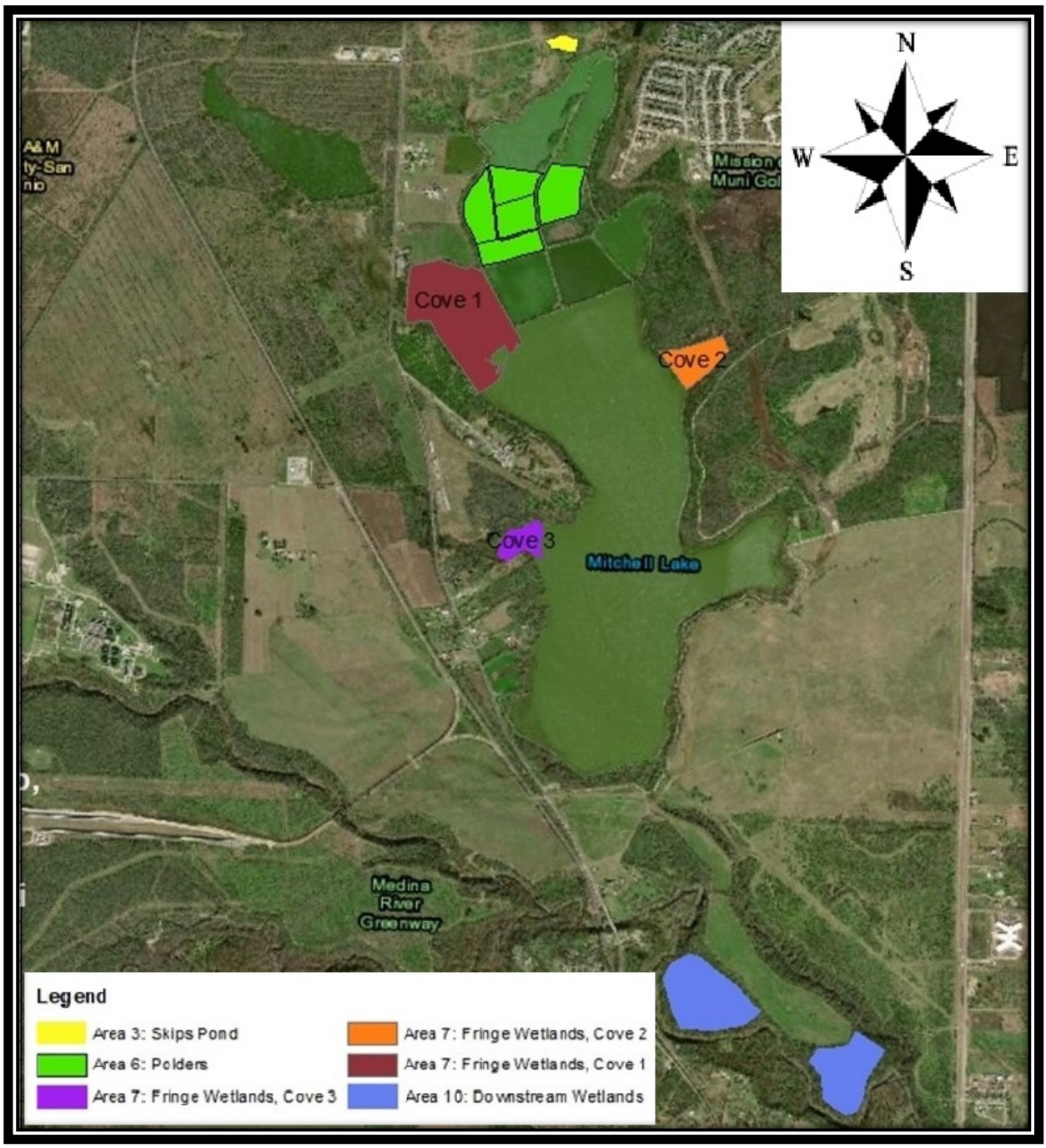

Figure 59 - Plan 6: Skip's Pond + Plan 5 (Alternatives 3+ 6 + 7G + 10)

Plan 7: Central Wetland (2B) + Plan 6 (Alternatives 2B + 3+ 6 + 7G + 10)

Plan 7 includes the restoration features included in Plan 6 and adds the restoration an expansion of the Central Wetland (Figure 60). The Central Wetland 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.

106.9 AAHUs are provided by Plan 7; the allocation of the AAHUs is provide below:

1. 49.52 acres and 18.1 AAHUs of mudflat habitat
2. 74.54 acres and 41.4 AAHUs of emergent/submergent wetland habitat
3. 69.69 acres and 47.4 AAHUs of emergent wetland habitat

The incremental cost per incremental output for Plan 7 is $7,411 with a first cost of $4,643,224, a first cost increase of ~$894,000 over Plan 6. Plan 7 would restore 92.6% of the total area identified for restoration under this study.

Thus far, Plans 2 through 6 have included restoration areas that realize benefits in isolation, albeit with cumulative benefits across the spread across the study area. With the addition of the Central Wetland, Plan 7 begins linking restoration areas from the previous Plans resulting in synergistic benefits to fish and wildlife habitat. Plan 7 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 Wetland. 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 higher quality than the water entering them. Once the water is filtered through the Central Wetland, the water flows through Skip's Pond further filtering 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 through the linear wetland and Cove 1 of Mitchell Lake (Figure 60).

Although the incremental cost per incremental output for restoring the Central Wetland is slightly higher than the incremental ratio of the Downstream Wetlands, the Central Wetland complex has a relatively flat topography and supports an extensive ecotone with transitional habitats between the wetland and upland 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. In effect, the Central Wetland would have proportionately larger areas of transitional habitat than the Downstream Wetlands. Although the modeled target year benefits of the habitat quality between the two wetlands is projected to be equal, the uncaptured benefits of the ecologically significant transitional habitats was not captured in the analysis. Although the captured benefits more than justifies each of these emergent wetland areas, the cumulative captured and uncaptured benefits of the Central Wetland is significantly higher than the Downstream Wetlands.

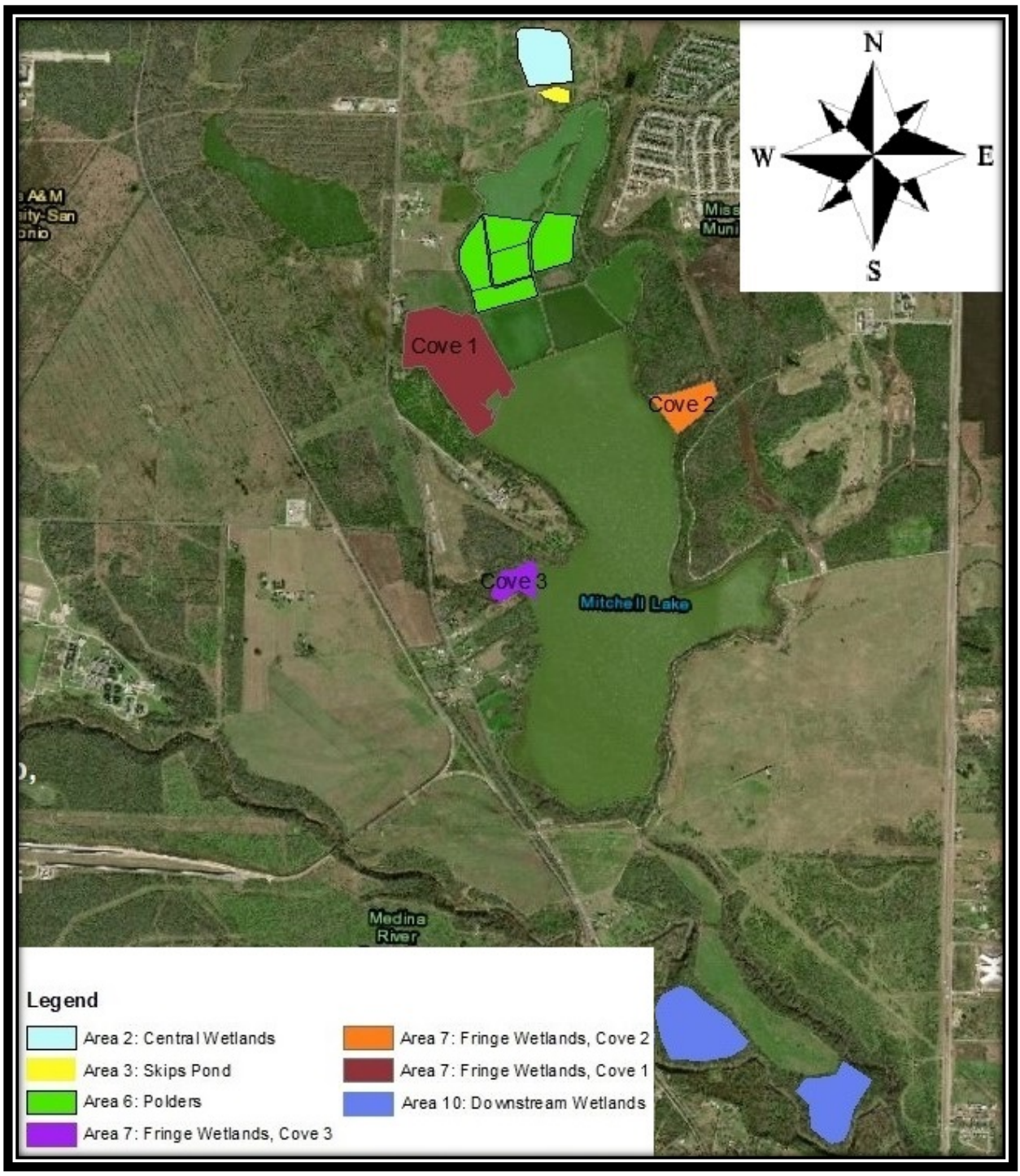

Figure 60 - Plan 7: Central Wetland (2B) + Plan 6 (Alternatives 2B + 3+ 6 + 7G + 10)

Plan 7 is worth the Federal and local investment because of:

- The connectivity the Central Wetlands provide to Skip's Pond, the linear wetlands, and Cove 1;

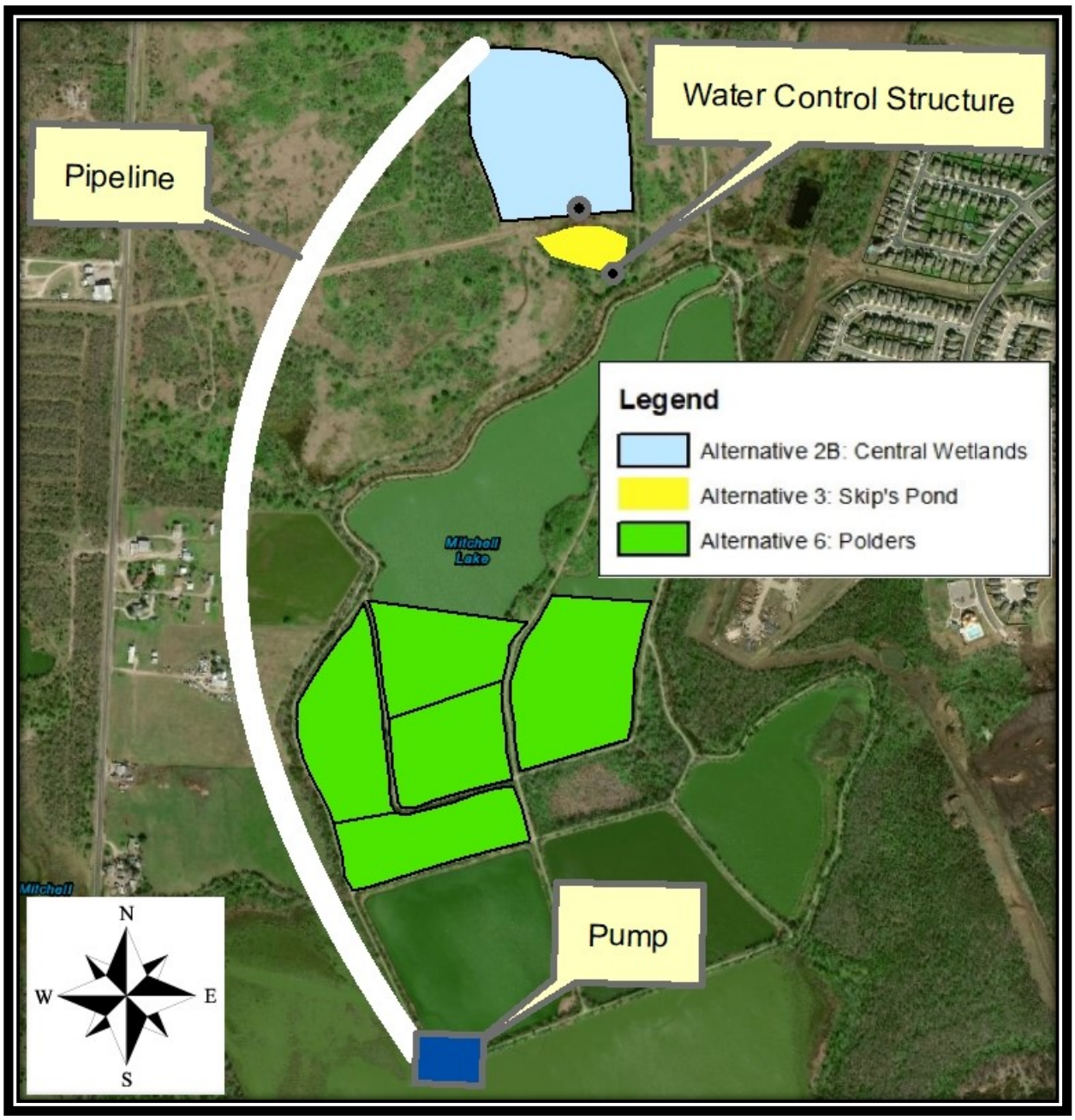

Figure 61 - Plan 7 Features

- The synergistic captured and uncaptured benefits attributed resulting from the connected system;
- The connection of the existing transitional habitats to the Central Wetland;
- The increased incremental cost to incremental output ratio resulting from moving from Plan 6 to Plan 7; and
- The marginal increase in the first cost.

Plan 8: Bird Pond Wetlands (1B) + Plan 7 (Alternatives 1B + 2B + 3+ 6 + 7G + 10)

Plan 8 includes the restoration features included in Plan 7 and adds the restoration and expansion of the Bird Pond Wetland (Figure 8). The Bird Pond Wetland is an existing wetland located east of Bird Pond and upslope of the Central Wetland. 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 Wetland. Instead of placing the pipeline outfall structure at the north end of the Central Wetland (Plan 7), 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 3.9 AAHUs to the previous Plan.

110.8 AAHUs are provided by Plan 8; the allocation of the AAHUs is provide below:

1. 49.52 acres and 18.1 AAHUs of mudflat habitat
2. 74.54 acres and 41.4 AAHUs of emergent/submergent wetland habitat
3. 76.11 acres and 51.3 AAHUs of emergent wetland habitat

The incremental cost per incremental output for Plan 8 is $8,787 with a first cost of $5,115,007, a first cost increase of ~$472,000 over Plan 7. Plan 8 would restore 95.7% of the total area identified for restoration under this study.

Plan 8 increases the synergistic water quality benefits of the previous Plan by adding the nutrient filtering function of the Bird Pond Wetlands and the channel to the Central Wetland/Skip's Pond/Linear Wetland/Cover 3 system (Figure 62).

The Bird Pond Wetland provide the same core target habitat benefits as the Central Wetland and Downstream Wetlands and provide the same uncaptured benefits as the Central Wetland 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.

Although the incremental cost per incremental output for restoring the Bird Pond Wetland is slightly higher than the incremental ratio of the Central Wetland, 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.

Plan 8 is worth the Federal and local investment 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;
- The relatively small increase in incremental cost to incremental output ratio; and
- The increase in first cost resulting from moving from Plan 7 to Plan 8.

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 enhanced/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.

Additional information regarding Plans will be added to the CEICA Appendix to describe relation to project significance.

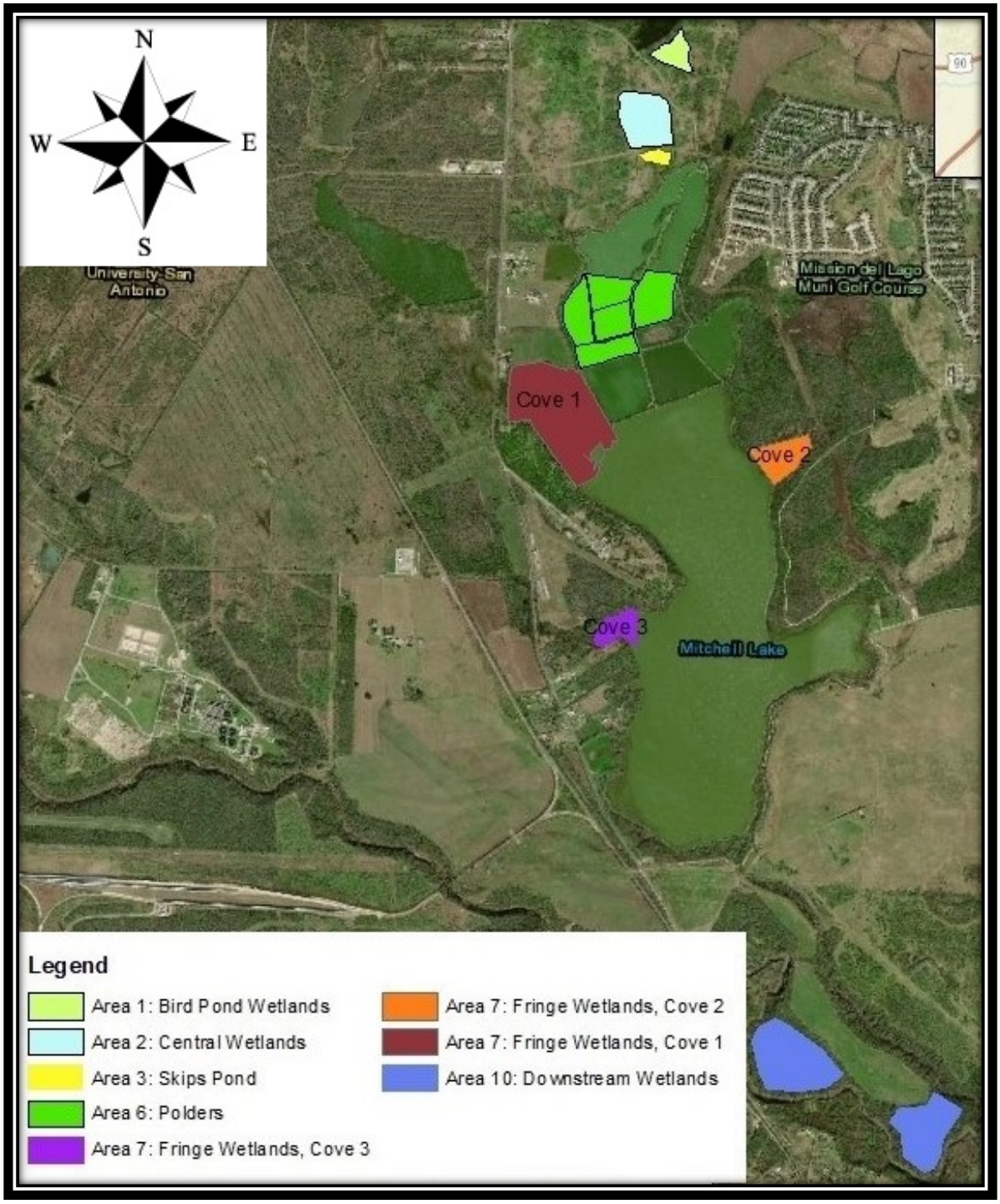

Figure 62 - Plan 8: Bird Pond Wetlands (1B) + Plan 7 (Alternatives 1B + 2B + 3+ 6 + 7G + 10)

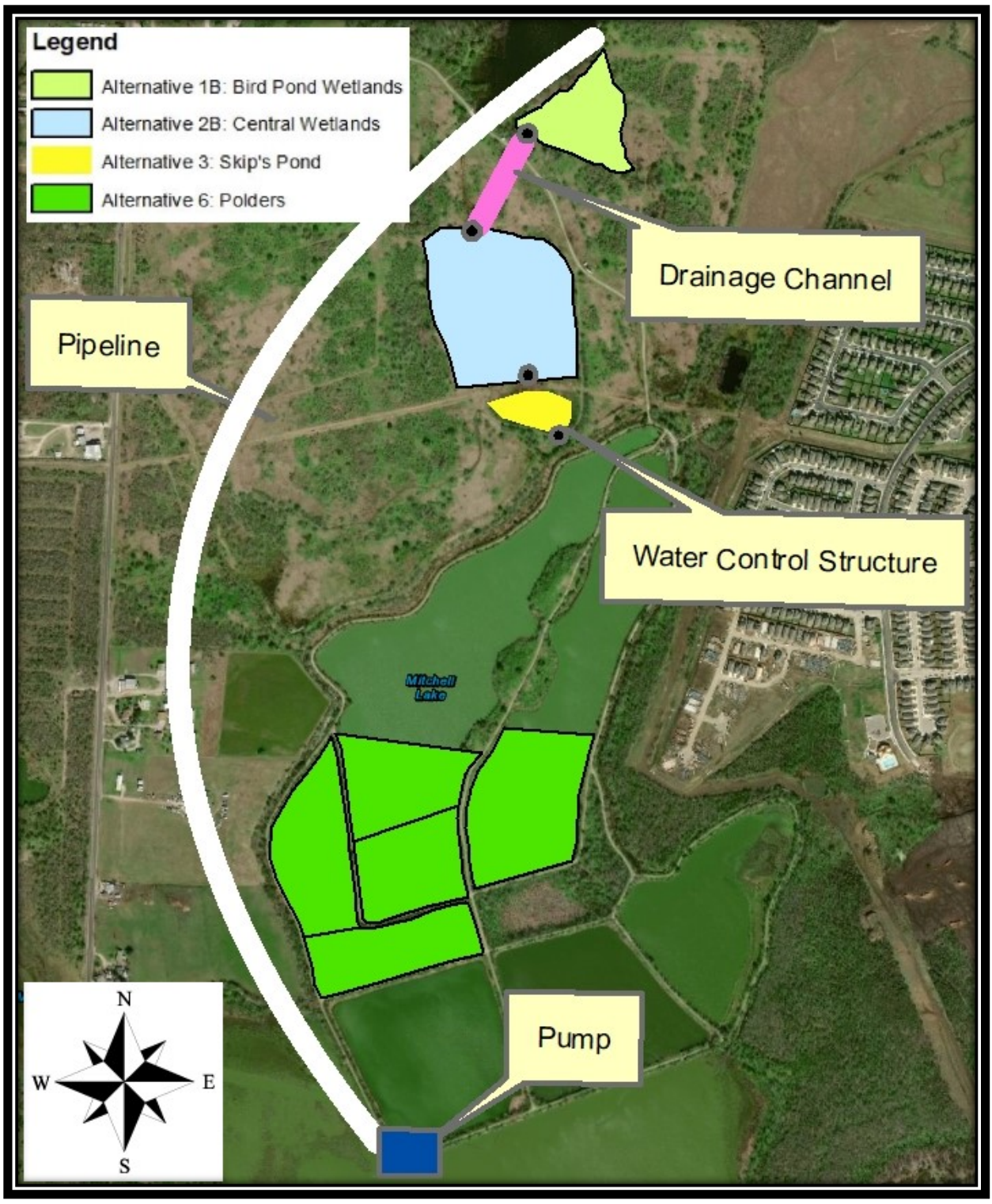

Figure 63 - Plan 8 Features

Plan 9: Forested Wetlands below the Dam + Plan 8 (Alternatives 1B + 2B + 3+ 6 + 7G + 9B + 10)

Plan 9 includes the restoration features included in Plan 8 and adds the restoration of a forested wetland complex south of the Mitchell lake Dam (Figure 64). 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 2.55 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.

111.6 AAHUs are provided by Plan 9; the allocation of the AAHUs is provided below:

1. 49.52 acres and 18.1 AAHUs of mudflat habitat
2. 74.54 acres and 41.4 AAHUs of emergent/submergent wetland habitat
3. 76.11 acres and 51.3 AAHUs of emergent wetland habitat
4. 2.55 acres and 0.8 AAHUs of forested wetland habitat

The incremental cost per incremental output for Plan 9 is $41,675 with a first cost of $5,762,219, a first cost increase of ~$647,000 over Plan 8. Plan 9 would restore all areas identified for restoration under this study.

Plan 9 would introduce a fourth habitat type into the proposed restoration alternatives – 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 alternatives combined. Therefore, the expenditure of Federal and local funds to implement Plan 9 is not justified.

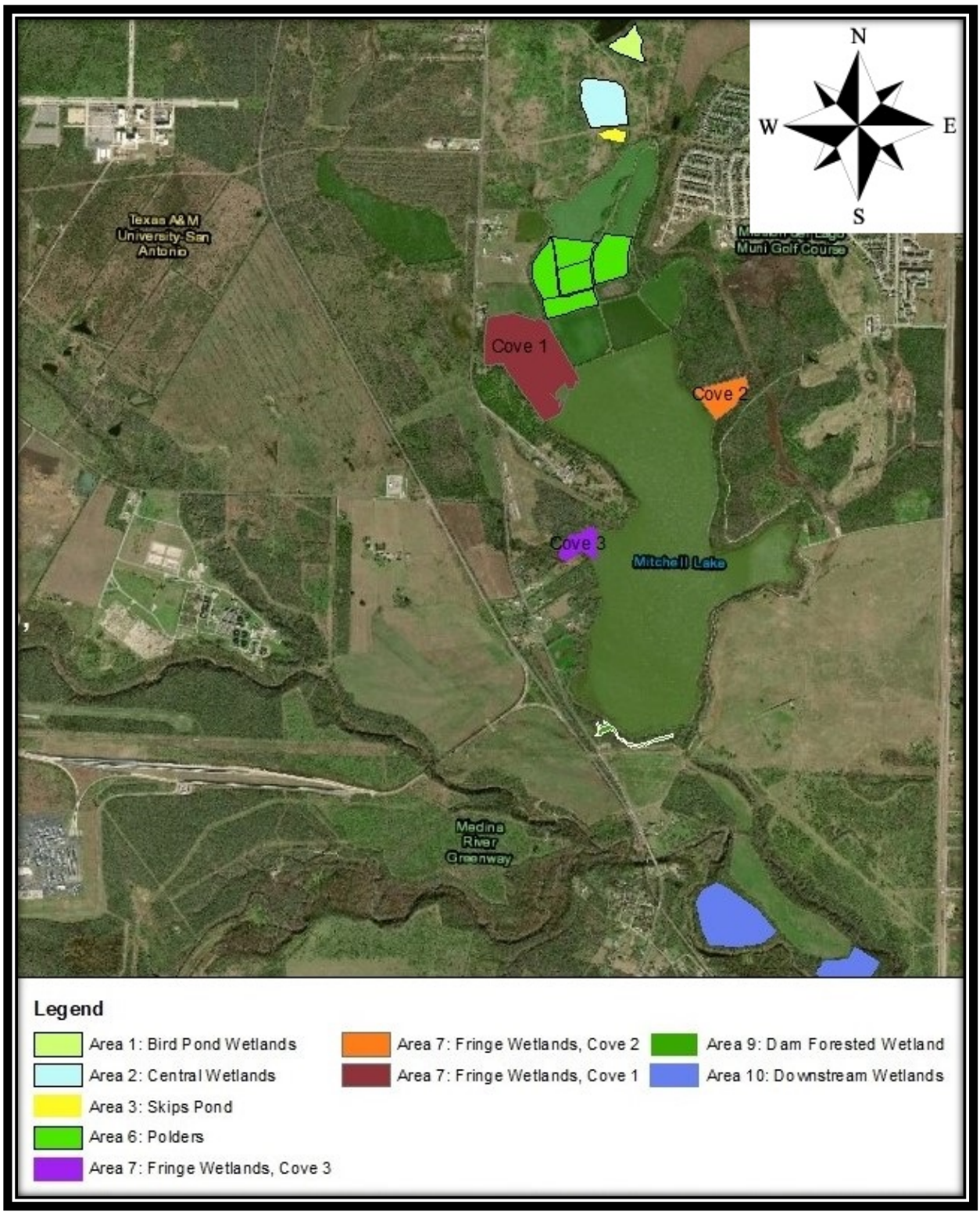

Figure 64 - Plan 9: Forested Wetlands below the Dam + Plan 8 (Alternatives 1B + 2B + 3+ 6 + 7G + 9B + 10)

4.11 Selection of the Tentatively Selected Plan – Step 6

4.11.1 Plan 8: Bird Pond Wetlands (1B) + Plan 7 (Alternatives 1B + 2B + 3+ 6 + 7G + 10)

Best Buy Plan 8 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. Plan 8 is worth the Federal and local investment because of:

1. The increased diversity of bird species benefiting from the restoration,
2. The increased water quality function resulting from adding the Bird Pond Wetland to the Plan,
3. The relatively small increase in incremental cost to incremental output ratio, and
4. The increase in first cost resulting from moving from Plan 7 to Plan 8.

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 enhanced/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.

Additional information regarding Plans will be added to the CEICA Appendix to describe relation to project significance.

4.11.2 NER Plan

Migratory birds are the primary resource of national significance identified within the study area. Based on historical descriptions of the study area, the large wetland complex that occupied the study area prior to the impoundment of Mitchell Lake would have acted as extremely valuable stopover habitats 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 8 is the recommended NER plan. This Plan provides:

1. Three distinct habitat types (emergent wetlands, submergent / emergent wetlands, and mudflats) out of the four targeted habitat types;
2. Resilient habitat for migratory birds;
3. The creation of a complex of wetlands that can be managed to improve water quality as an ancillary benefit;
4. The restoration of 95.7% of the proposed restoration areas;
5. An incremental cost per incremental output of $8,787 over Plan 7;
6. An approximate first cost of $5.2 million.

The NER Plan, Plan 8, provides 110.8 AAHUs. The allocation of the AAHUs is provided below:

1. 49.52 acres and 18.1 AAHUs of mudflat habitat
2. 74.54 acres and 41.4 AAHUs of emergent/submergent wetland habitat
3. 76.11 acres and 51.3 AAHUs of emergent wetland habitat

The incremental cost per incremental output for Plan 8 is $8,787, with a first cost of $5,115,007; a first cost increase of ~$472,000 over Plan 7. Plan 8 would restore 95.7% of the total area identified for restoration under this study.

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 with regard to the following four criteria:

1. **Completeness** – Does the Plan include all necessary parts and actions to produce the desired results?
2. **Effectiveness** – Does the Plan substantially meet the objectives? How does it measure up against constraints?
3. **Efficiency** – Does the Plan maximize net NER benefits?
4. **Acceptability** – Is the Plan acceptable and compatible with laws and policies?

Table 52 - Principles and Guidelines Four Criteria Evaluation

	Complete?	Effective?	Efficient?	Acceptable?
Plan 8	**YES**	**YES**	**YES**	**YES**

1. **Completeness –** Plan 8 provides and accounts for all necessary investments, addresses the problems, and ensures the realization of the planning objectives.
2. **Effectiveness –** Plan 8 contributes to the achievement of the planning objectives and avoids all constraints.
3. **Efficiency –** Plan 8 is the NER plan and the most cost effective means of achieving the objectives of all of this study's alternatives, plans, and scales of Plans.
4. **Acceptability –** Plan 8 is acceptable in terms of all known applicable laws, regulations, and public policies.

4.12 Description of the TENTATIVELY SELECTED PLAN at DRAFT REPORT

Economic analyses indicated that Plan 8; Bird Pond Wetlands (1B) + Plan 7 (Alternatives 2B + 3+ 6 + 7G + 10) is the NER Plan, or TSP. It was the plan that reasonably maximized net economic benefits consistent with protecting the Nation's environment.

4.12.1 General Engineering

The following descriptions are taken from Appendix G – 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) 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 Wetland 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 wetland and the Bird Pond creek (Figure 65).

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: 1,570 cubic yards (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 allowed to drain 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.

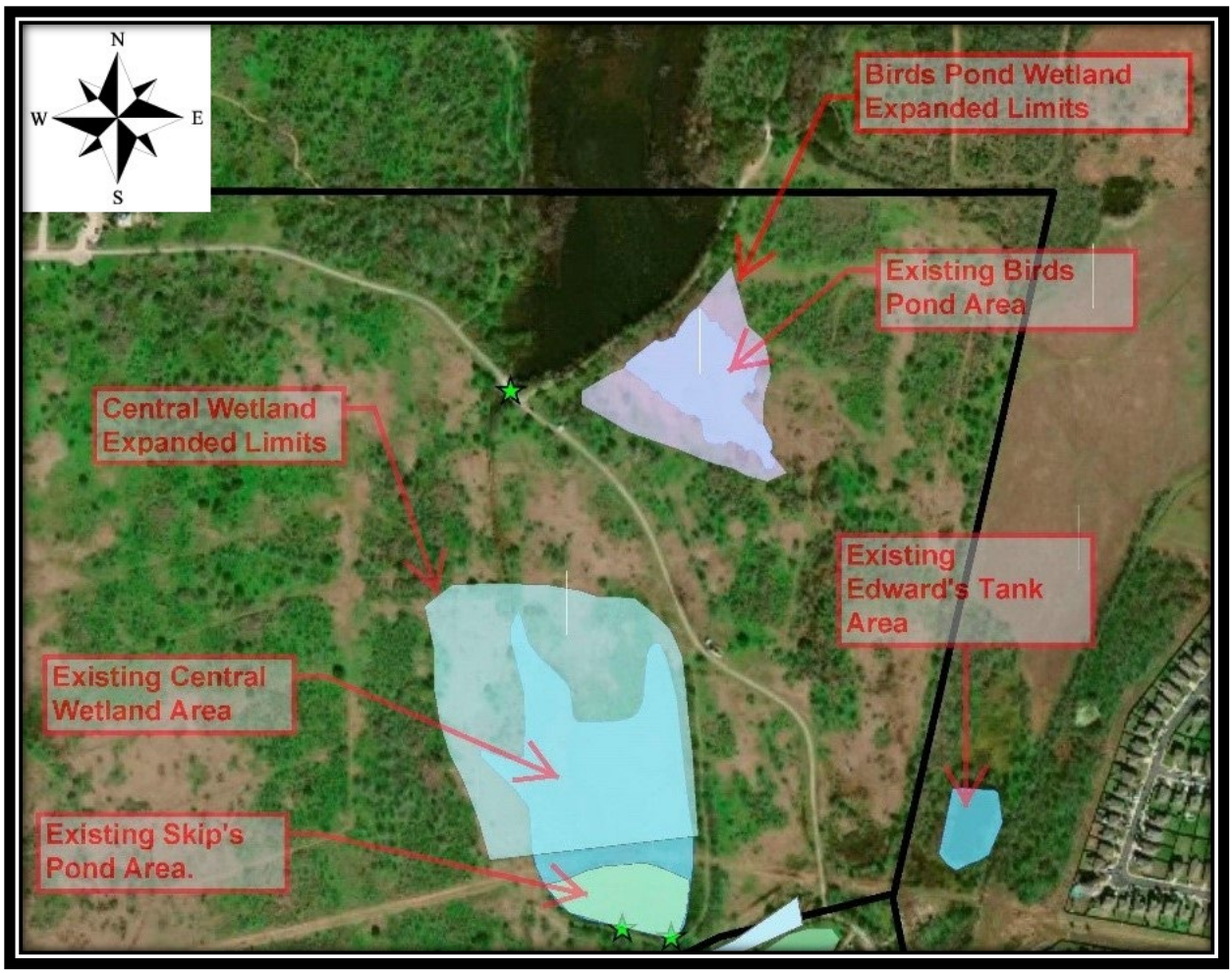

Figure 65 – Area 1: Bird Pond [purplish pink and blue], Area 2: Central Wetland [bluish], and Area 3: Skip's Pond [green with stars]

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 Skips Pond (Figure 66).

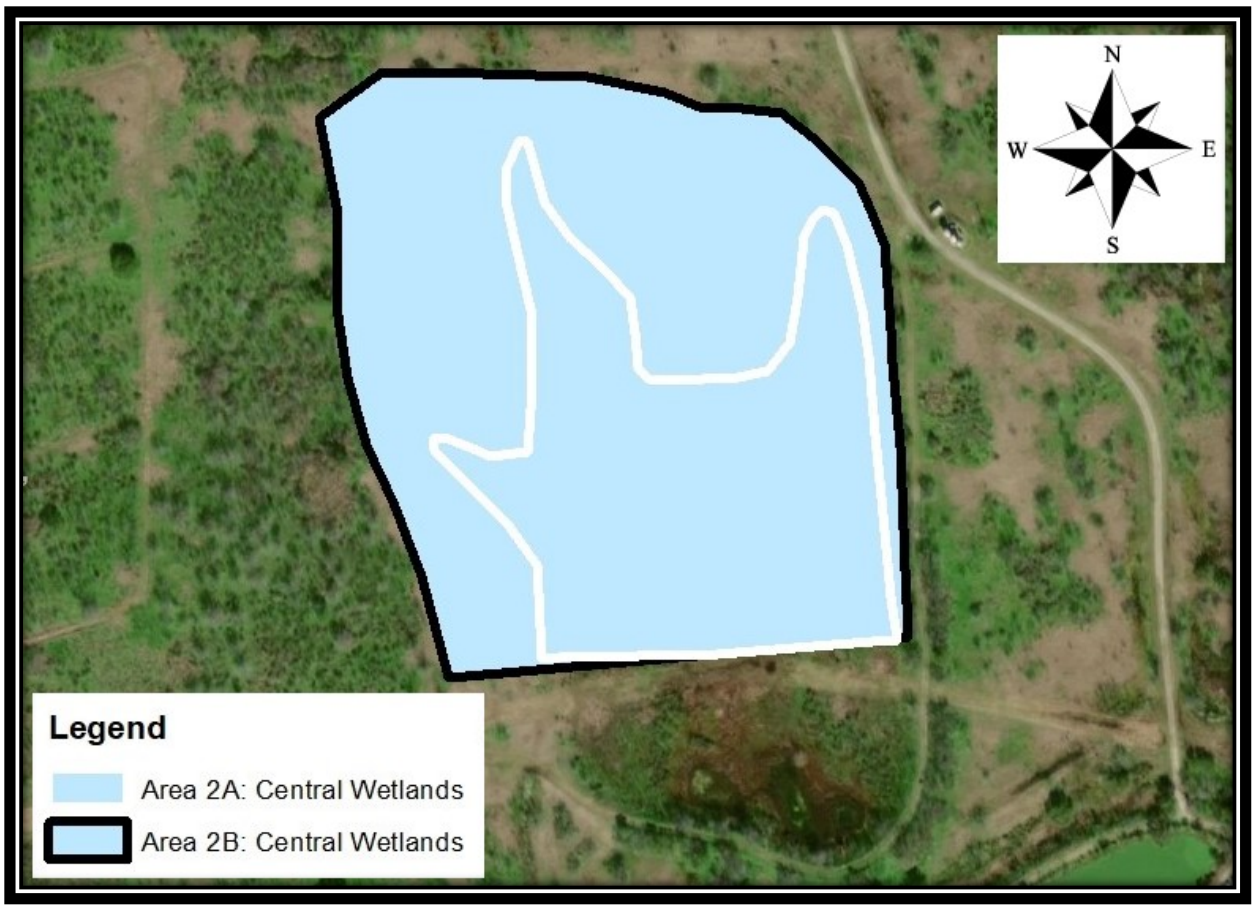

Figure 66 - Area 2: Central Wetlands Alternatives 2A and 2B

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: 4,826 cy

Construction of a water control structure

Stop log type water control structure 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.

Area 3: Skip's Pond Alternative

The Skip's Pond perimeter area to be part of the restored wetland feature is 2.18 acres. The water supply would be from the discharge ditch coming out of the Central Wetland cells (Figure 66 and Figure 67).

Figure 67 - Area 3: Skips Pond Single Alternative

Excavation at Skip's Wetland 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 if needed to maintain water levels as described above.

- Wetland Cell Excavation: 432 cy

Area 6: Polder Alternative

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 (Figure 68). 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 Mudflat cells.

Installation of new water control structures 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.

- Berms Fill Material: 3,309 cy

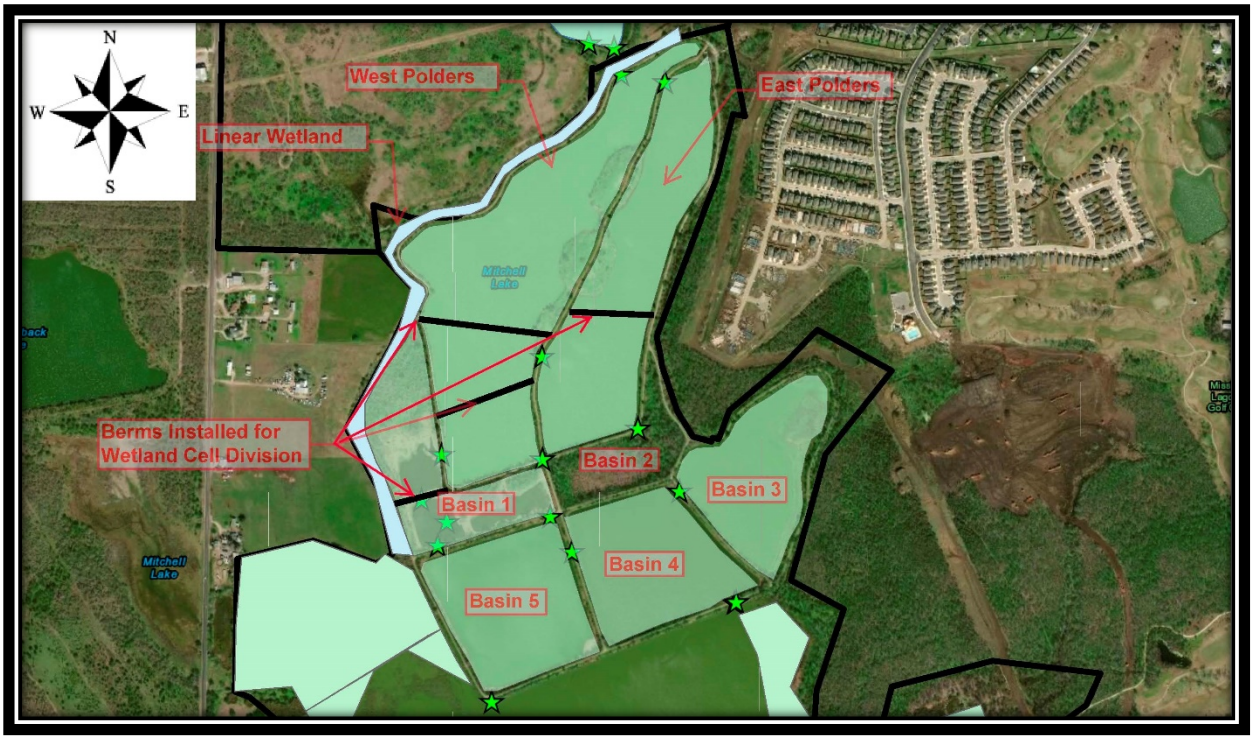

Figure 68 – Area 5: Linear Wetlands [blue] and Area 6: Polder Area [medium transparent green]

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

The perimeter area around the entirety of lake's edge is a total of 143.72 acres.

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 (Figure 69).

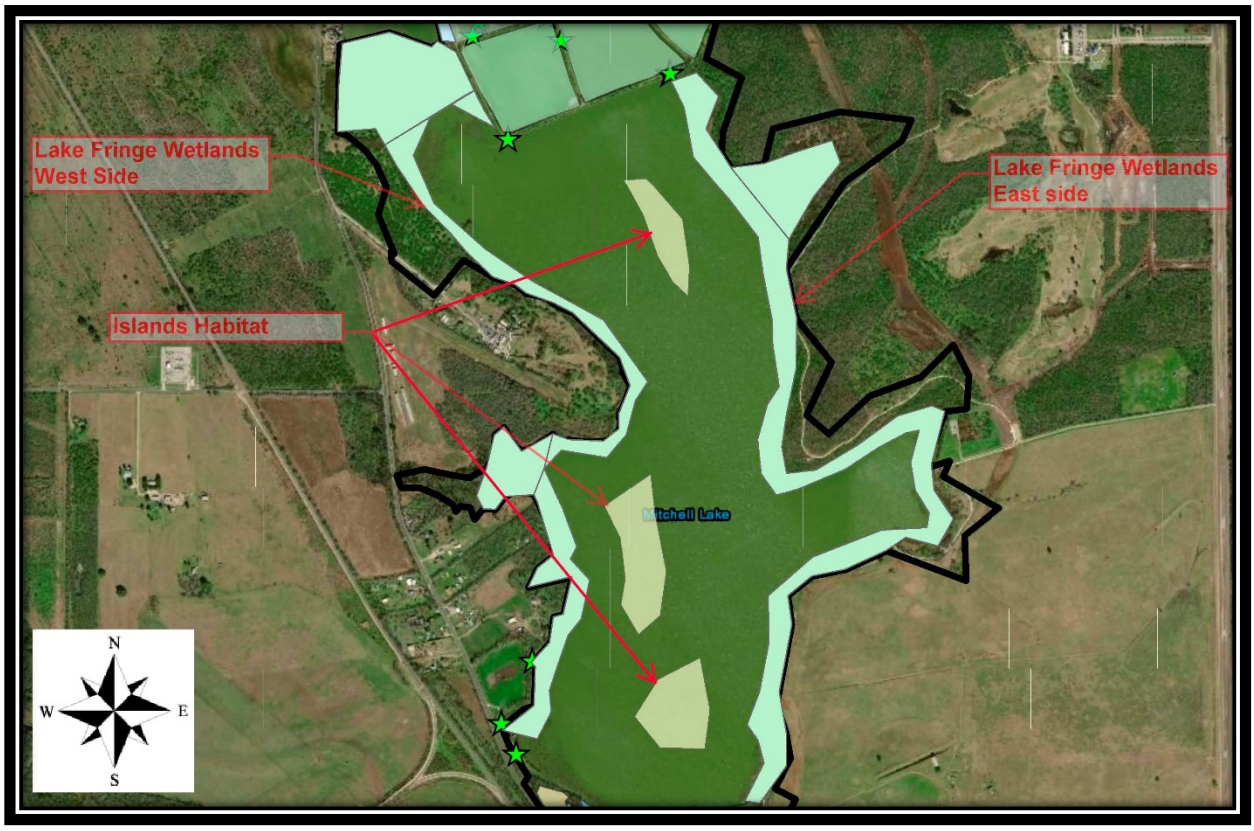

Figure 69 - Area 7: Fringe Wetlands / Coves 1 - 3 Wetlands [mint green] and Area 8: Islands [tan]

Area 10: Downstream Wetlands Alternative

Approximately 3000’ 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 with a water supply of treatment water from the lake. From water control structures at the wetland cells water can be supplied the new created wetlands with the excavation of drainage ditches (Figure 70).

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.

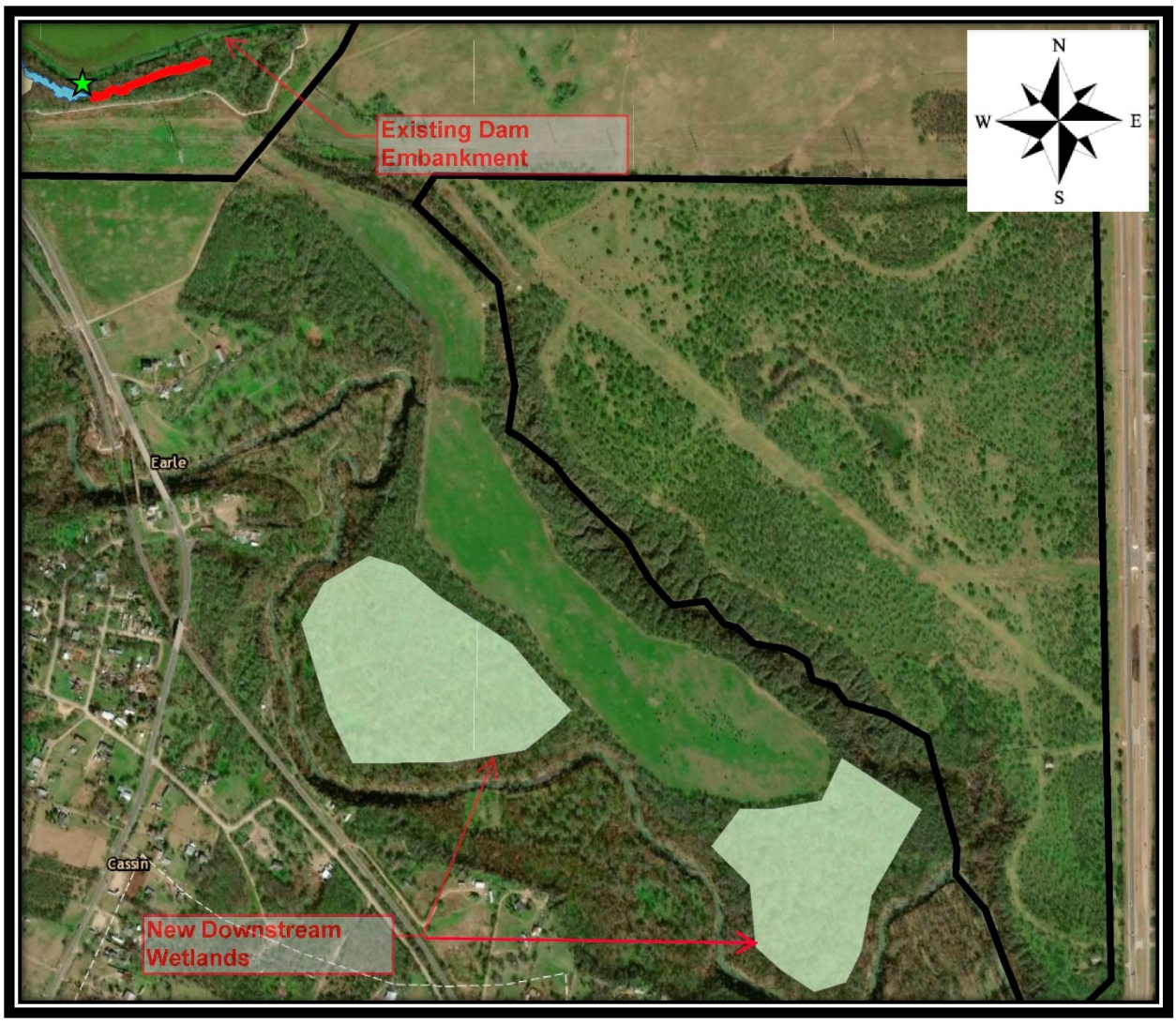

Figure 70 - Area 10: Downstream Wetlands [light green]

4.12.2 Adaptive Management and Monitoring

In an effort 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, Section 5.22, and Attachment K).

4.12.3 Relocations

Numerous oil and gas wells are located within 1.0 miles of Mitchell Lake and the restoration area. A RRC database also shows numerous operating oil, gas, and injection wells (Figures 1 & 2 of HTRW Appendix). Pipelines can be found crossing the lake and restoration areas. Most of the project plans 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 HTRW Appendix for maps of known pipelines and oil wells surrounding the lake (Appendix C – Environmental Resources, Section 3.12).

4.12.4 Hazardous and Toxic Materials

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 HTRW Appendix for maps of known pipelines and oil wells surrounding the Lake. The project alternatives involving excavations and displacement of sediment or soil materials may need to consider these oil and gas wells and pipelines (Appendix E – HTRW, Section 4).

4.12.5 Operation and Maintenance

The SAWS) is the owner of the dam and is responsible for its operation, inspection, maintenance and repair.

4.12.5.1 Inspections

A representative of San Antonio Water System (SAWS) shall perform routine inspections to ensure timely identification of potential problems. Inspections will be performed annually during the non-flood season, which allows needed work to be completed before summer thunderstorms. Three types of inspections are required to ensure that the flood control structure functions as designed.

1. Special inspections will be conducted immediately following severe storms, earthquakes, initial filling of the reservoir, vandalism, and other significant events.
2. Annual inspections will be accomplished during the non-flood season by trained personnel of the SAWS.
3. Formal inspections shall be conducted at least once every 5 years. These inspections are to be accomplished under the direction of a registered professional engineer licensed in the State of Texas and qualified in the design and construction of dams. The purpose of the inspection is to perform a detailed inspection and engineering evaluation of the dam and appurtenances.

The following is a recommended sequence for an annual inspection of the main earthen embankment structure.

- Crest - Walk along the crest from abutment to abutment.
- Downstream Toe - Walk the entire length of the downstream toe.
- Upstream/Downstream Slope - Walk across the slope from abutment to abutment in a pattern such that the entire slope is inspected.
- Principal Spillway and Outlet Conduit - Observe all accessible features of the principal spillway.

- Auxiliary (Emergency) Spillway - Walk along the entire length of the spillway in a back and forth manner.
- Embankment-Abutment Contacts - Walk the entire length of the embankment-abutment contacts (groins).
- Abutments - Traverse abutments in a practical manner to gain a general feel for the conditions that exist along the valley sidewalls.
- Downstream Channel - Travel the route of the stream below the dam to maintain familiarity with locations of residences and property that can be affected by dam failure.
- Reservoir Slopes - Scout the reservoir perimeter in an effort to develop an overall familiarity with its conditions.

SPECIAL INSPECTIONS

1. Record reservoir level in the Operating Log.
2. Check and record outlet flow in the Operating Log.
3. Visually examine condition of:
    a. Embankment crests
    b. Upstream and downstream slopes (faces)
    c. Principal spillway inlet and outlet
    d. Riser
    e. Auxiliary (emergency) spillway
    f. Fence and gates
4. Record observations of visual inspection in the Operating Log.
5. Check floodwater diversion, outlet channel, pool area, and inlet area for erosion, sediment, and debris.
6. Make note of any other pertinent observations in the Operating Log.

ANNUAL INSPECTIONS

1. Inspect earthen embankments for erosion, rills, cracks, and rodent burrows.
2. Inspect earthen embankments, outlet channels, and all concrete structures for woody vegetation, tree seedlings, trees, and large shrubs.
3. Inspect all concrete elements, including interior of riser for cracks, spalling, loss of joint filler or sealer, and other signs of deterioration.
4. Check fences, gates, and related appurtenances for signs of disrepair.
5. Check for corrosion on all exposed metalwork.
6. Inspect reservoir pool, outlet channels, inlet structures, and any other area that may result in debris blockage or debris being transported to or through the floodwater retarding structures or outlet channels.

4.12.5.2 Preventative Maintenance

Preventive maintenance will be performed on Mitchell Lake Dam and its appurtenances to ensure the safe function of the dam. Representatives of SAWS will execute routine maintenance tasks.

1. Dam Embankment – Inspect the dam crest for signs of ruts, minor depressions, or erosion. Fill any ruts or minor depressions with similar soil and compact it to surrounding grade. Inspect the slopes for signs of rill and gully erosion. Repair by installing appropriate erosion control measures such as wattles, net wire diversions, or gravel fill. Fill large rills and gullies with compacted soil.
2. Emergency Spillway – Keep concrete joints and surfaces free of vegetation. Make repairs to concrete surfaces and joints. Remove any obstructions or debris from the spillway channel, using NMOSE Vegetation Management on Dams. These guidelines are dated August 15, 2011 and are found in Appendix B-1.
3. Outlet Works – Remove debris from trash rack and spillway (port and weir) openings. Keep concrete joints and surfaces free of vegetation. Remove mineral deposits and paint or galvanize metal features as needed. Restore corroded metal to original condition by replacing or welding on new metal and painting to prevent corrosion. Visually inspect conduit from downstream end for corrosion, leakage, or other significant problems. Repair as needed. Inspect entire conduit interior either manually or via remote control camera, depending on accessibility. Repair as needed. Remove visible and accessible obstructions to flow (e.g. debris, vegetation, etc.) Repair concrete as necessary. Replace missing riprap with adequately sized riprap to prevent movement or removal by flow events. Reshape channel as necessary to maintain channel geometry shown on the as-built drawings. Repair erosion gullies by removing loose material and replacing it with compacted fill. Remove any obstructions, including small trees and bushes that could affect flow now or in the future.
4. Polders – Inspect pumping stations. Make repairs to pump as needed.
5. Reservoir Area – Keep reservoir area clear of debris and vegetation that could clog intake of principal spillway.

5 Cumulative Effects

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 (Appendix C – Environmental Resources, Section 5.18).

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.

5.1 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 (Appendix C – Environmental Resources, Section 5.18.2).

5.2 Recreation

Recreation is a vital component to the sustainability of any urban restoration project. Almost all of 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 the City 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 (Appendix C – Environmental Resources, Section 5.18.32.

5.3 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 the City, the SARA, the SAWS, Bexar County, the 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 emergent wetland and riverine habitat. Although future restoration and conservation initiatives will undoubtedly continue, the City 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 151.15 acres of enhanced or created wetland habitat and 49.52 acres of mudflat habitat with essential connectivity along a critical stopover corridor for the birds utilizing the Central Flyway (Table 53).

Table 53 - Increase of Mudflat and Wetland Habitat by Enhancement and Creation for Each Plan

Plan	Mudflat Habitat Increase (Acres)	Emergent / Submergent Wetland Habitat (Acres)	Emergent Wetland Habitat (Acres)	Forested Wetland Habitat (Acres)
1: No Action	0.00	0.00	0.00	0.00
2. Polders	49.52	0.00	0.00	0.00
3. Polders + Cove 3	49.52	6.84	0.00	0.00
4. Polders + Cove 3 +Downstream Wetlands	49.52	6.84	51.32	0.00
5. Polders + Coves 1-3 + Downstream Wetlands	49.52	72.36	51.32	0.00
6. Polders + Coves 1-3 + Downstream Wetlands + Skip's Pond	49.52	74.54	51.32	0.00
7. Polders + Coves 1-3 + Downstream Wetlands + Skip's Pond + Central Wetlands(2B)	49.52	74.54	69.69	0.00
8. Polders + Coves 1-3 + Downstream Wetlands + Skip's Pond + Central Wetlands(2B) + Bird Pond Wetlands (1B)	49.52	74.54	76.11	0.00
9. Polders + Coves 1-3 + Central Wetlands(2B) + Bird Pond Wetlands (1B) + Dam Forested Wetlands (9B)	49.52	74.54	76.11	4.48

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. 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 (Appendix C – Environmental Resources, Section 5.18.3).

5.4 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, indigo snakes, bobcat, and black bear migrated out of the area over time and tolerant species such as raccoons, opossums, and great-tailed grackles now thrive. The aquatic habitat that supported a diverse community of amphibians and aquatic invertebrates disappeared, further reducing wildlife diversity in this area of The City. Finally, the introduction of non-native wildlife species such as feral hogs and nutria rats, and vegetative species such as Johnson grass, Bermuda grass, and giant cane 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 TSP 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 TSP 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 City 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 (Appendix C – Environmental Resources, Section 5.18.4).

5.5 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, as a whole 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 (Appendix C – Environmental Resources, Section 5.19).

5.6 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 1. 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 TSP, 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 (Appendix C – Environmental Resources, Section 5.20).

6 Expected Future With-Project Condition for the Tentatively Selected 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.

6.1 Hydrology, Hydraulics and Sedimentation

Although the TSP 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

The implementation of the Downstream Wetlands would not affect the watershed hydrology or hydraulics of Cottonmouth Creek above the impacts that would occur with the water-quality treatment wetlands proposed by the SAWS. The SAWS' downstream wetlands may modify the hydrology and hydraulics of the system by diverting lake water to the wetlands and releasing the outflow back into Cottonmouth Creek or the Medina River. The construction of the USACE Downstream Wetlands will be integrated into the SAWS wetlands, with little to no additional changes to the hydrology and hydraulics.

The planting of emergent and submergent vegetation associated with Coves 1, 2, and 3 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 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 infiltrate into the ground, decreasing a portion of the runoff from the watershed. Plan 8 increases the wetlands size to 150.65 acres. The increase in wetland size also increases the hydrologic effect on the watershed.

The TSP 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 Wetlands and Bird Pond Wetland's 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. Therefore, 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.

The TSP would include the pumping of Mitchell lake water to the upstream side of the Bird Pond Wetlands. The pumped water would be part of a closed system and outside of that system, impacts to the hydrology and hydraulics would be negligible (Appendix C – Environmental Resources, Section 5.11.2.3).

6.1.1 Floodplains

Although the TSP is located partially within the 100-year floodplain, the primary design consideration 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 excavation of materials, an appropriate disposal site would be located in an upland area outside of both the 100- and 500-year floodplains. The TSP complies with EO 11988 (Appendix C – Environmental Resources, Section 5.11.2.4).

6.2 Environmental Resources – Affected Environment and Environmental Consequences

This section (and Appendix C – Environmental Resources, Section 5) describes the likely future conditions in the study area over the 50-year life of the FWP. 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 mud flat features, and invasive species management.

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 Chapter 4 and Appendix C – Environmental Resources. 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.

6.2.1 Climate

Although the small scale of the project area would limit any significant changes to the earth's climate, the restoration of 200.17 acres of habitat would contribute to the collective sequestration of carbon. In particular, wetland habitats sequester significantly more carbon than the associated upland habitats (Appendix C – Environmental Resources, Section 5.3.2).

6.2.2 Geology and Topology

See Main Report Section 6.5 Geology and the Structural Setting.

6.2.3 Soils, Including Prime Farmlands

The proposed project area is located within the city limits of The City, therefore prime farmland soils do not occur at the site. Therefore, Section 1541(b) of the FPPA of 1980 and 1995, 7 USC. 4202(b) is not applicable (Appendix C – Environmental Resources, Section 5.6).

The potential impacts to soils with the implementation of the Proposed Plans have been documented above in Section 5.5.2. The topsoil from the excavated areas would be stockpiled and used to line the excavated wetland areas to grade. Sedimentation and erosion Best Management Practices (BMPs) will be incorporated to avoid erosion and sedimentation to adjacent water bodies and wetlands Appendix C – Environmental Resources, Section 5.6.2).

6.2.4 Land Use

The Audubon Society manages the proposed project area for wildlife habitat, and the 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 FWP conditions (Appendix C – Environmental Resources, Section 5.4).

6.2.5 Air Quality

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, nitrogen oxides (NOx), CO, 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, windblown 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 (Appendix C – Environmental Resources, Section 5.7.2).

Air quality impacts from implementation of the NER 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. They 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; and
- 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; and
- Install wind fencing and phase grading operations where appropriate, and operate water trucks for stabilization of surfaces under windy conditions.

6.2.6 Noise

Implementation of the NER Plan 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 affect, substantially, adjacent noise sensitive receptors or wildlife areas. The nearest noise receptor to any of the restoration areas is the Mission del Lago neighborhood east of the polders. As all of the proposed alternatives include construction activities at the polders, each alternative would have a minimal temporary noise impact to the Mission del Lago community (Appendix C – Environmental Resources, Section 5.8.2).

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 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 TSP. Construction would be conducted in accordance with Chapter 21 of the City's Ordinances.

6.2.7 Transportation

For the TSP, short-term, insignificant impacts to traffic volumes would be expected during construction activities. Local roads are well designed and are capable of handling a large volume of vehicles. However, during construction, traffic congestion could occur as construction vehicles enter and exit the project area, or transport construction debris to the disposal site. 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 (Appendix C – Environmental Resources, Section 5.9.2).

Implementation of the NER Plan 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.

6.2.8 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. 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 (Appendix C – Environmental Resources, Section 5.10.2).

6.2.9 Water Resources

The TSP 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. The TSP beneficially affects study area water resources.

The TSP would restore the form and function of specific aquatic features with beneficial impacts. The TSP would have temporary localized water quality impacts during construction. However, these impacts would be temporary and would be minimized with the implementation of BMPs and a Stormwater Pollution Prevention Plan (Appendix C – Environmental Resources, Section 5.11.2).

6.2.9.1 Surface Water

The NER Plan increases the quality of the surface water habitat by increasing species diversity and habitat structure. As the plantings would be installed by hand, there would also be no adverse impacts to water resources from the implementation of the restoration. (Appendix C – Environmental Resources, Section 5.11.2.1).

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 ~3.0 acres of open water habitat. An additional berm would be constructed in Polder 1 to create two similar sized mudflat polders; however, Polder 1 is managed to capture overflows of the adjacent polders during storm events and remains dry most of the time. With the implementation of Plan 2, 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 Polder 1 mudflat polders) would be dry, 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 Polder 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 10 includes the conversion of 51.32 acres of uplands to emergent wetland habitat. The water supply for these wetlands would be provided by the future constructed treatment

wetlands proposed by the SAWS. Therefore, the construction of the Downstream Wetlands would have no measurable impacts on surface water resources.

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 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 TSP entails the excavation and re-contouring of portions of the pond's wetlands, the restoration would increase the habitat structure and diversity of the wetland resulting in a net increase in habitat quality by 110.8 AAHUs.

6.2.9.2 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 TSP (Appendix C – Environmental Resources, Section 5.11.2.2).

6.2.9.3 Wetlands

The TSP would effectively provide up to 151.15 acres of enhanced or created wetland habitat and 49.52 acres of mudflat habitat with essential connectivity along a critical stopover corridor for the birds utilizing the Central Flyway (Table 53).

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. 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 TSP would be moderately beneficial (Appendix C – Environmental Resources, Section 5.18.4).

6.2.9.4 Water Quality

Implementation of any of the NER Plan would directly affect 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 degrade water quality temporarily because 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 alternatives could have major beneficial impacts on water quality. The restoration and expansion of wetlands associated with the proposed alternatives 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 Wetland, Skip's Pond, the linear wetland adjacent to the polder berms, and Cover 1. Although the scale of these benefits may be relatively small, the proposed alternatives could be compatible with other water-quality treatment methods in an integrated water quality program (Appendix C – Environmental Resources, Section 5.11.2.5).

6.2.10 Visual Aesthetics

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 be beneficial to the aesthetic value of the area and pleasing to recreationists (Appendix C – Environmental Resources, Section 5.15.2).

6.2.11 Recreation

Although the proposed plans may have a temporary negative 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. The enhancement of 49.52 acres of mudflat habitat will attract shorebirds and other migratory birds. This will attract more birders to the area as well (Appendix C – Environmental Resources, Section 5.16.2).

6.2.12 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 wetland habitats, more closely mimicking historical conditions.

Approximately 150.65 acres of emergent and emergent/submergent wetlands will be planted within the project area. 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 will bring the environment closer to original conditions, in which case the vegetation structure and diversity is expected to increase in quality with the TSP. The TSP will have a long-term major beneficial impact on vegetation within the study area.

The overall increase of 110.8 AAHUs due to the restoration of riparian and emergent 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, Section 5.17.2.1).

6.2.13 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 significant long-term beneficial effects on fish and wildlife populations from the implementation of the TSP through geographic expansion and improved quality of their respective habitats. By restoring the Mitchell Lake project area to a more natural condition, native fish populations could repopulate areas that have not been favorable for their existence or survival. Water quality improvements (resulting from planting emergent wetland and riparian vegetation) would improve habitat conditions for intolerant native species, and would restore balance to the native tolerant/native intolerant species over time.

The restoration of riparian and emergent wetland vegetative structure would provide additional wildlife habitat (food, shelter, and reproductive resources) for small mammals, amphibians, reptiles, and bird (Appendix C – Environmental Resources, Section 5.17.2.2).

6.2.14 Federally Listed Threatened & Endangered Species

Some special status species listed in Appendix C – Environmental Resources, Section 3.16.3 are likely to occur in the Project Area after project implementation. Close coordination among the USACE, the USFWS, and the TPWD would continue as part of overall management of the Project Area and normal operations and maintenance activities for Mitchell Lake. Examples of T&E species that have been seen at Mitchell Lake are the Piping Plover, Red Knot, and the Interior Least Tern.

The NER Plan would not adversely impact threatened, endangered, or TXNDD species within the study area. Should federally listed species change in the future; associated requirements will be reflected in construction efforts in coordination with the USFWS (Appendix C – Environmental Resources, Section 5.17.2.3).

6.2.15 Migratory Birds

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 and riparian areas would result in an overall net increase in functional value, 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 the 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.

Implementation of the TSP would comply with the MBTA and EO 13186, Responsibility of Federal Agencies to Protect Migratory Birds (Appendix C – Environmental Resources, Section 5.17.2.5).

6.2.16 Invasive Species

As with any ground-disturbance 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, would be monitored for invasive species with action taken to prevent reestablishment 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 US). 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 alternatives would comply with EO 13112 (Appendix C – Environmental Resources, Section 5.17.2.6).

6.3 Cultural Resources

Activities associated with the TSP include all new construction, improvements, and maintenance activities. The preliminary Area of Potential Affection (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 71). No known terrestrial archaeological sites have the potential to be directly affected by the TSP.

The TSP does not overlap known eligible archaeological sites based on background research; however, with the majority of the TSP not being previously culturally surveyed to identify historic properties, pursuant to 36 CFR 800.4, the potential to encounter newly identified cultural resources is high.

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).

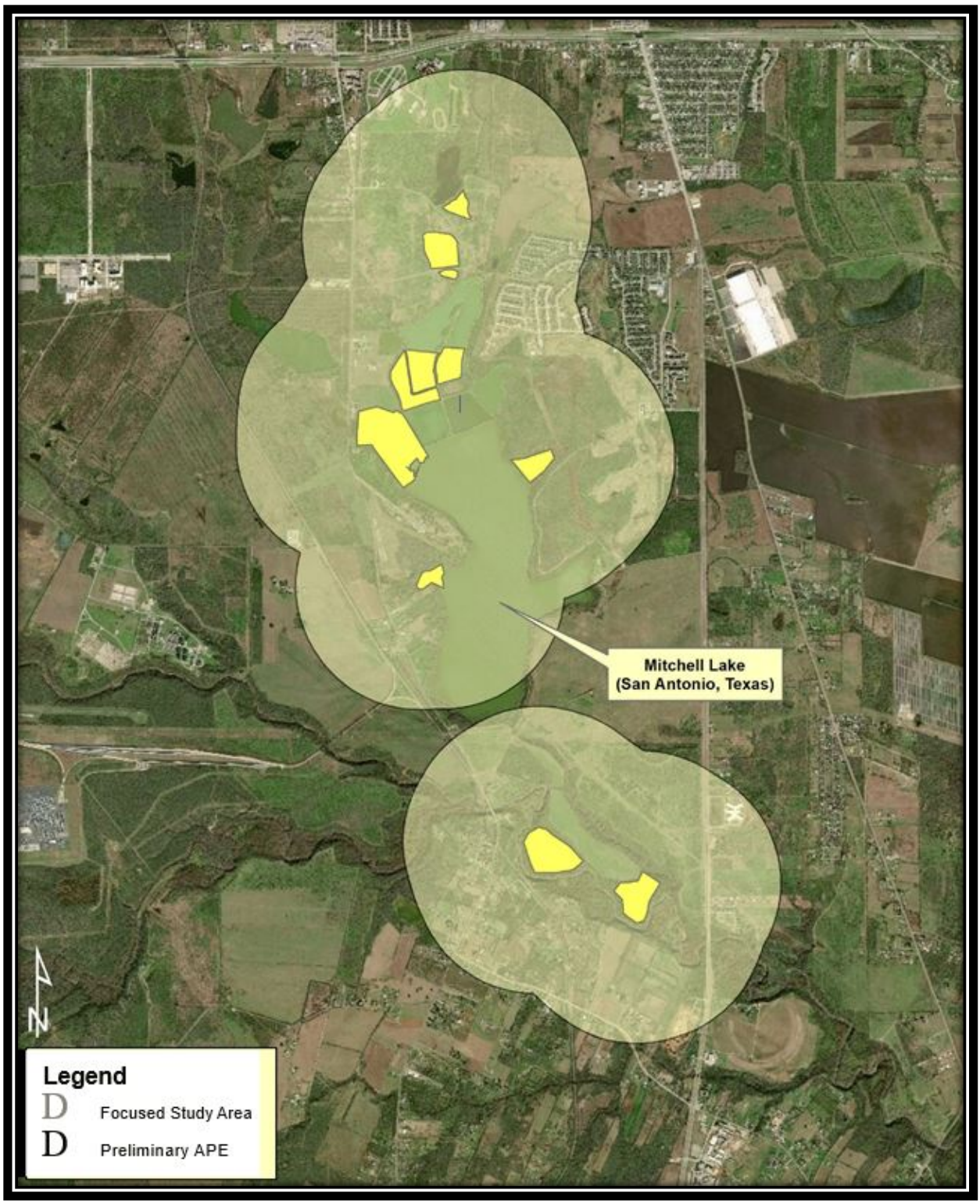

Figure 71 - Cultural Resources Study Area

6.4 Environmental Engineering

6.4.1 Hazardous Materials

No anticipated adverse impacts are expected by implementation of the TSP. 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.

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 the SAWS and the 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 (Appendix E – HTRW, Chapter 4).

6.5 Geology and the Structural Setting

Implementation of the NER Plan will have no effect upon geology (Appendix C – Environmental Resources, Section 5.5).

Plan 8 Areas 1, 2, 3, 9, and 10 require excavation to increase the extent and/or depth or create (Area 10) 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 Downstream Wetlands would require the excavation of upland material to create a series of wetland cells averaging approximately four feet in depth with small pools extending to six feet in depth. The Polders and Fringe Wetlands would not require changes to the topography in the proposed project area, with the exception of the installation of berms to segment off three of the existing polder 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 TSP (Appendix C – Environmental Resources, Section 5.5.2).

6.6 Socioeconomics & 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. The TSP would not result in the relocation of any residences or businesses. Therefore, there would be no adverse impacts to environmental justice populations and the TSP would be consistent with EO 12898 (Appendix C – Environmental Resources, Section 5.12.2).

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7 Plan Implementation

7.1 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 LERRD Considerations

Please see Appendix F – Real Estate.

7.3 Operations and Maintenance Considerations

Please see Main Report Section 4.12.6, and Appendix G – Civil Engineering.

7.4 Institutional Requirements

7.4.1 The USACE Campaign Plan[3]

The USACE has developed a campaign plan with a mission to "deliver vital engineering solutions, in collaboration with our partners, to secure our Nation, energize our economy, and reduce risk from disaster". This Campaign Plan shapes the USACE command priorities, focuses transformation initiatives, measures and guides progress, and helps the USACE adapt to the needs of the future.

The TSP does address Goals 2 and 4 of the Campaign Plan.

- Campaign Plan Goal 2: Deliver enduring and essential water resource solutions using effective transformation strategies
    - Objective 2c: Deliver quality solutions and services
    - Objective 2d: Deliver reliable, resilient, and sustainable infrastructure systems
- Campaign Plan Goal 4: Build resilient people, teams, systems, and processes to sustain a diverse culture of collaboration, innovation, and participation to shape and deliver strategic solutions
    - Objective 4b: Enhance trust and understanding with customers, stakeholders, teammates, and the public through strategic engagement and communication

[3] http://www.usace.army.mil/about/campaignplan.aspx.

7.4.2 Environmental Operating Principles[4]

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 TSP 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
- 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

[4] http://www.usace.army.mil/Missions/Environmental/Environmental-Operating-Principles/

8 Summary of Coordination, Public Views, and Comments

This section demonstrates how the TSP 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, Section 5.21.1).

8.2 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 404(b) (1) analysis is in progress for the Mitchell Lake project. A draft 404(b) (1) analysis can be located in Attachment I of this document, describing potential impacts to water quality within the study area (Appendix C – Environmental Resources, Section 5.21.2).

8.3 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 (Appendix C – Environmental Resources, Section 5.21.3).

8.4 Executive Order 11312, Invasive Species

The TSP would comply with EO 13112 by restoring native aquatic and riparian vegetation species to the degraded habit. Mitchell Lake is dominated by non-native invasive plant species (Appendix C – Environmental Resources, Section 5.21.4).

8.5 Executive Order 11990, Protection of Wetlands

EO 11990 requires Federal agencies to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in executing Federal projects. The TSP complies with EO 11990 by increasing the areal extent of wetlands within the study area (Appendix C – Environmental Resources, Section 5.21.5).

8.6 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 (Appendix C – Environmental Resources, Section 5.21.6).

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; and
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 TSP would remain in compliance with EO 11988 by protecting the values of the Mitchell Lake floodplains.

8.7 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 (Appendix C – Environmental Resources, Section 5.21.7).

8.8 Texas Senate Bill 2

In restoring the ecological and hydraulic functions of Mitchell Lake, the TSP is consistent with this State legislation (Appendix C – Environmental Resources, Section 5.21.8).

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 TSP would be consistent with EO 12898 (Appendix C – Environmental Resources, Section 5.21.9).

8.10 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 TSP. However, continued long-term beneficial impacts, such as habitat enhancement, could occur because of the TSP. 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” is currently assumed for the TSP (Appendix C – Environmental Resources, Section 5.21.10, and Attachments C and D).

8.11 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 TSP. Information provided by the USFWS and the TPWD on fish and wildlife resources has been utilized in the development of the TSP (Appendix C – Environmental Resources, Section 5.21.11).

A draft Fish and Wildlife Coordination Act Report describing existing and FWOP conditions and FWP conditions is currently being prepared.

8.12 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 (Appendix C – Environmental Resources, Section 5.21.12).

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 more effectively address existing and future environmental conditions contributing 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 The City with respect to the TSP. Appendix C – Environmental Resources, Attachment J includes the FAA’s decision of no impact.

8.13 Cooperating Agencies

Copies of agency coordination letters are presented in Attachment L. Formal and informal coordination has been and will continue to be conducted with the following resource agencies (Appendix C – Environmental Resources, Section 6.1);

- USACE,
- USFWS,
- EPA,
- TPWD,
- TCEQ,
- FAA,
- NRCS,
- 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 projections of Future With- and Future Without-Project benefits

8.14 Comments

8.14.1 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. The USACE, SWF placed advertisements on the USACE webpage and mailed official Public Notices, while the SAWS posted advertisements on social media prior to the public scoping meeting (Appendix C – Environmental Resources, Section 6.2).

Table 54 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 54 - Public Scoping Meeting Comment and Response

Public Comment	USACE Response
I am a member of a club a relatively short distance from Mitchell Lake. Out 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 IFR-EA.

8.14.2 Public Review of DRAFT Integrated Feasibility Report and EA

In accordance with NEPA, a 30-day review period of the DRAFT IFR-EA, with a Draft FONSI, will be provided via a Notice of Availability. This public review period is schedule to begin 9 December 2019. During the review period, agencies will have the ability to respond in favor of or against the project (Appendix C – Environmental Resources, Section 6.2).

8.15 List of Preparers

Name	Technical Specialty
Andrew Johnson	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
Cody Bowden	Real Estate
Tuan Nguyen	Civil Engineering
Ninfa Taggart	Cost Engineering

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9 District Engineer's Recommendation

This chapter contains the findings and recommendation of the SWG Commander and may serve as the basis for new additional authorization and costs.

9.1 About Recommendations

When a project is authorized by Congress, the recommendations contained in the feasibility report become the basis for proceeding with the project as a Federal undertaking. Authorizing legislation normally references the "recommendations" of the Chief of Engineers, which are derived from the recommendations of the District Commander. The provisions of the recommendations provide a legislative basis that would not change unless modified by Congress through applicable general legislation or by specific legislative action for the particular authorization in question. Accordingly, the wording of recommendations, incorporated by reference in the authorizing act, has the force of law for the project.

9.2 Disclaimer

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels with the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorizations and implementation funding. However, prior to transmittal to the Congress, the NON-FEDERAL SPONSOR, the State, interested Federal agencies, and other parties would be advised of any modifications and would be afforded an opportunity to comment further.

9.3 Recommendation

Recommendation For the Proposed Implementation of the Mitchell Lake, San Antonio, Texas, FINAL Integrated Feasibility Report and Environmental Assessment.

I have considered environmental, social, and economic effects, and the engineering feasibility of the recommended plan, which is also the National Ecosystem Restoration (NER) Plan. I recommend the transmission of this report to Congress for authorization of the NER Plan, as a Federal project, with such modifications thereof as in the discretion of the Commander, US Army Corps of Engineers, may be advisable. The estimated first cost of the recommended plan is $_____ and the estimated average annual OMRR&R cost is $_____ (Month Year price level). The Federal portion of the estimated first cost is $_____. Federal implementation of the recommended project would be subject to the non-Federal sponsor agreeing to comply with applicable Federal laws and policies, including but not limited to:

a. Provide 35 percent of total project costs as further specified below:
    1. Provide 35 percent of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;
    2. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all

improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the project;

3. Provide, during construction, any additional funds necessary to make its total contribution equal to 35 percent of total project costs;

b. Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal obligations for the project unless the Federal agency providing the funds verifies in writing that the funds are authorized to be used to carry out the project;

c. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;

d. Shall not use the project or lands, easements, and rights-of-way required for the project as a wetlands bank or mitigation credit for any other project;

e. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 USC. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

f. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, except as limited by Section 1161 of the WRDA of 2016, Public Law 114-322 (33 USC. 2330a(e)), at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

g. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

h. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

i. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of three years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as would properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 CFR Section 33.20;

j. Comply with all the requirements of applicable Federal laws and implementing regulations, including, but not limited to: Section 601of the Civil Rights Act of 1964, Public Law 88-352, as amended (42 USC. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto; the Age Discrimination Act of 1975 (42 USC. 6102); the Rehabilitation Act of 1973, as amended (29 USC. 794), and Army Regulation 600-7 issued pursuant thereto; and all applicable Federal labor standards requirements including, but not limited to, 40 USC. 3141- 3148 and 40 USC. 3701 – 3708 (labor standards originally enacted as the Davis-Bacon Act , the Contract Work Hours and Safety Standards Act, and the Copeland Anti-Kickback Act);

k. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 USC. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with written direction;

l. Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of project;

m. Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operation, maintain, repair, rehabilitate, and replace the project in a manner that would not cause liability to arise under CERCLA; and

n. Comply with Section 221 of Public Law 91-611 Flood Control Act of 1970, as amended (42 USC 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Las 99-622, as amended (33 USC 2213(j), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

_____ _____

DATE

KENNETH N. REED, PMP
Colonel, EN
Commanding

The recommendations contained herein reflect the information available at this time, and current Department of the Army, and US Army Corps of Engineer policies governing formulation of individual projects. The recommendations do not reflect the program and budget priorities inherent to the formulation of a national Civil Works construction program, nor the perspective of higher review levels within the Executive Branch of the US Government. Consequently, the recommendations may be modified before they are transmitted to Congress as proposals for implementation funding. However, prior to transmittal to Congress, the sponsor, the State, interested Federal agencies, and other interested parties would be advised of any modifications, and be afforded the opportunity to comment further.

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11 Quality Control

District Quality Control (DQC) Reviewers	
Name	**Title**
Natalie Garrett – RPEC	DQC Lead
Cheryl Jaynes – RPEC	Plan Formulation
Sarah Harris – DWT	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
TBD	Real Estate
TBD	Civil Engineering
TBD	Structural Engineering
TBD	Cost Engineering

Agency Technical Review (ATR) Team	
Name	**Title**
Michael Scuderi - NWS	ATR Lead
Scott Miner – SPK	Plan Formulation
Zac 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

12 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
amsl	Above Mean Sea level
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
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
EPA	Environmental Protection Agency
ER	Engineering Regulation
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FPPA	Farmland Protection Policy Act
FWOP	Future Without-Project
FWP	Future With-{roject
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
IFR-EA	Integrated Feasibility Report and Environmental Assessment
L	Liter
LRSI	Life Requisite Suitability Index
m	Meter
MBTA	Migratory Bird Treaty Act

Measures	Management Measures
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
O_3	Ozone
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
RRC	Railroad Commission
s	Second
SACIP	San Antonio Channel Improvement Project
SARA	San Antonio River Authority
SAWS	San Antonio Water System
SO_2	Sulfur Dioxide
SWF	Fort Worth 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