DRAFT

INTEGRATED
DETAILED PROJECT REPORT AND
ENVIRONMENTAL ASSESSMENT

Spring Lake Section 206 Restoration Project

DECEMBER 2005

DRAFT

INTEGRATED
DETAILED PROJECT REPORT AND
ENVIRONMENTAL ASSESSMENT

Spring Lake Section 206
Aquatic Ecosystem Restoration Project

U.S. Army Corps of Engineers
Fort Worth District
Fort Worth, Texas

December 2005

DRAFT FINDING OF NO SIGNIFICANT IMPACT

PROPOSED SPRING LAKE SECTION 206
AQUATIC ECOSYSTEM RESTORATION PROJECT
SAN MARCOS, TEXAS

A Detailed Project Report and integrated Environmental Assessment (DPR/EA) have been prepared to evaluate environmental restoration alternatives at the Aquarena Center and Spring Lake located on the Texas State University – San Marcos (TxSt) in San Marcos, Texas. The proposed project would restore valuable aquatic and terrestrial habitats throughout Spring Lake, which have been degraded by the construction, operation, and existence of the Aquarena Center, the surrounding golf course and other urban developments. Structures and facilities associated with the Aquarena Center would be removed, native grassland habitat would be restored on the peninsula between Spring Lake and Sink Creek, and a vegetated buffer zone would be created between the golf course and Spring Lake. This restoration project would help restore and protect sensitive habitat for five Federally listed species. Approximately 22 acres of lacustrine habitat, 10 acres of peninsula floodplain habitat, and 9 acres of riparian habitat would benefit from the project.

Four measures were considered for the restoration project, but excluded from further analysis due to unacceptable environmental impacts and high restoration costs. After elimination of restoration measures having unacceptable impacts, five possible measures, were carried forward for cost-benefit analysis. Each of these measures was independent of the others, meaning each could serve as a stand-alone plan. The five measures were A) removal of structures on hill, B) removal of structures on the peninsula and grassland restoration, C) removal of exotics, D) removal of all submerged structures, and E) establishment of a vegetated buffer zone. Alternatives evaluated included a No Action Plan, and all combinations of the five measures. All restoration plans were evaluated using an incremental cost analysis to ensure that the most cost effective plan was selected. The proposed National Environmental Restoration (NER or recommended plan) included the removal of structures on the peninsula and grassland restoration, the removal of exotics, the establishment of a vegetated buffer zone, and the removal of all submerged structures. Additionally, plans to enhance recreational opportunities around Spring Lake included construction of a rest room facility, new and rehabilitated trails, picnic tables and benches, traffic control gates, and signage.

Approximately 15 acres of soils would be temporarily exposed and susceptible to erosion during construction, however with the implementation of best management practices (BMPs), which would be defined by a Storm Water Pollution and Prevention Plan (SWPPP) to be prepared for the project, the potential for sediments to enter the lake through runoff and pollute surface waters would be minimized. The degrading terrestrial and submerged structures and 9.4 acres of hard surfaces associated with the Aquarena Center would be removed from the peninsula, and the runoff of polluted stormwater into Spring Lake would be reduced. The creation of a vegetated buffer zone between Spring Lake and the golf course would filter chemicals that may be found in runoff flowing into Spring Lake and downstream into the San Marcos River. The removal of Aquarena structures and the creation of a vegetated buffer zone would increase the storage of floodwaters within the 100-year floodplain resulting in negligible, beneficial effects as the potential for flooding downstream is reduced. While the removal of structures associated with the Aquarena Center would occur within the 100-year floodplain, negligible effects would be expected from the storage of floodwaters in newly created buffer zones. Removal of structures would occur within jurisdictional Waters of the U.S. The proposed project would likely be authorized by a general permit, such as Nationwide Permit (NWP) 27 for Stream and Wetland

Restoration Activities. The Texas Commission on Environmental Quality has issued a water quality certification for NWP 27; thus, no further coordination for Section 401 water quality certification is required.

The U.S. Army Corps of Engineers and U.S. Fish and Wildlife Service (USFWS) have completed Section 7 Endangered Species Act consultation for the proposed project. The USFWS issued a Biological Opinion (BO), which determined that with implementation of reasonable and prudent measures, construction related activities would not result in the incidental take of more than 732 San Marcos salamanders and 965 fountain darters. The BO also states that this level of anticipated take is not likely to result in the jeopardy to the species or result in destruction/adverse modification of critical habitat. Critical habitat for the San Marcos salamander, fountain darter, and Texas wild-rice could experience temporary degradation during construction, primarily due to increased turbidity and sedimentation. However, the NER plan would improve aquatic habitat in Spring Lake and the San Marcos River providing a long-term benefit to protected species. Further, removal of the submerged structures would create an additional 4,600 square feet of Critical Habitat and potentially uncover spring openings that could be colonized by Federally protected species.

The removal of the existing structures and hard surfaces and the replanting of the area with native vegetation would have the potential to adversely impact known and unknown cultural resources that may be located under the existing structure and pavement. Section 106 consultation with State Historic Preservation Office, additional archaeological testing, monitoring, and demarcation of areas to be avoided would mitigate potential adverse impacts to cultural resources from the restoration project. The restoration project would remove hazardous materials from the project area and they would be transported and disposed of in accordance with all applicable Federal and state regulations.

Based on a review of the information contained in this EA, it is concluded that the implementation of the Spring Lake Section 206 Aquatic Ecosystem Restoration Project is not a major Federal action that would significantly affect the quality of the human environment within the meaning of Section 102(2)(c) of the National Environmental Policy Act of 1969, as amended.

_____ _____

John R. Minahan
Colonel, Corps of Engineers
District Engineer

Date

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

EXECUTIVE SUMMARY

This Detailed Project Report/Environmental Assessment (DPR/EA) is submitted under the authority of Section 206 of the Water Resources Development Act of 1996, as amended (33 U.S.C. 2201). The purpose of this study was to identify potential ecosystem restoration alternatives for Texas State University (TxSt) owned properties within and adjacent to Spring Lake in San Marcos, Comal County, Texas. The goal of the DPR/EA was to evaluate each proposed alternative and, through coordination with the U.S. Army Corps of Engineers (USACE), the non-Federal, Local Sponsor, and participating agencies, develop a National Ecosystem Restoration (NER or recommended) plan for the proposed study site.

San Marcos is located in Hays County in south-central Texas, approximately 40 miles south of Austin, Texas. Spring Lake is located within the city limits of San Marcos on the TxSt campus. The proposed aquatic ecosystem restoration site is located within Spring Lake, the Aquarena Center, and TxSt 9-hole golf course. The site consists of approximately 10 acres of floodplain habitat on the Aquarena Center peninsula, 9 acres of riparian corridor habitat along the shoreline of Spring Lake, and 22 acres of lacustrine habitat within the headwaters of the San Marcos River. The proposed project is needed to restore the aquatic ecosystem components of the proposed study area to a condition closer to natural conditions within the constraints of existing land uses. The aquatic ecosystem components are composed of Spring Lake and riparian corridor/grassland habitat located directly adjacent to the lake, which provides functions (i.e., buffering of pollutants, cover, shoreline stability) essential for a healthy aquatic ecosystem.

Specific problems associated with the proposed study area include:

1. Expansion of non-native plant species such as Chinese tallow tree, chinaberry, elodea, hydrilla, watermilfoil, west Indian hygrophila, and elephant ear have negatively impacted the study site through displacement of native riparian corridor species, adverse impacts to recreational activities, increased sedimentation of suspended solids, and displacement of Texas wild-rice and other rooted macrophytes.
2. Construction of the Spring Lake Dam in 1854 converted the natural run-dominated system of the headwaters into a pool-dominated system, resulting in a shift of species adapted to a lotic environmental to those better suited for lentic conditions.
3. Construction of the Aquarena Center in the 1900s replaced valuable riparian corridor and floodplain habitat with numerous buildings, structures, and hardpan surfaces. The current dilapidated state of the facility has also resulted in public safety concerns, a reduced aesthetic value, and the potential of polluted runoff from the deteriorating structures.

4. Construction and maintenance of the TxSt 9-hole golf course has resulted in the removal of high quality riparian corridor habitat to the shoreline of Spring Lake. Sheet flow from the golf course has the potential to adversely impact water quality and aquatic habitat.
5. Polluted surface runoff from surrounding areas, expansion of exotic species, fragmentation of the riparian corridor, alterations to natural stream flows, and sedimentation of in-stream habitat have resulted in the loss of high quality wildlife habitat for resident, migratory, and Federally listed species that inhabit the study area.

The recommended plan as defined in this DPR/EA consists of the removal of Aquarena Center structures located on the peninsula, grassland restoration of the peninsula, removal of exotic vegetation within the study site, establishment of a vegetated buffer zone between Spring Lake and the golf course, and removal of all submerged structures in Spring Lake. Improvements to and creation of additional habitat under the recommended plan would result in a net gain of approximately 23.5 grassland average annual habitat units (AAHUs), 7.0 riparian AAHUs, and 2.5 lacustrine AAHUs. The recommended plan would also include minor recreational developments consisting of construction of a rest room facility, new and rehabilitated trails, picnic tables and benches, traffic control gates, and signage. The total restoration cost is estimated at $2,383,282 and includes the cost of all lands, easements, rights-of-way, and necessary relocations.

TxSt, as the non-Federal, Local Sponsor, would provide the lands required for the recommended plan. TxSt would also be responsible for all operation, maintenance, replacement, and repair costs. Both the Texas Parks and Wildlife Department and U.S. Fish and Wildlife Service are supportive of this Section 206 project. This report includes sections that contain information necessary to fulfill National Environmental Policy Act requirements, such as Study Purpose and Scope; Environmental Restoration Measures; Recommended Restoration Plan (NER plan); and Environmental Effects. A Finding of No Significant Impact (FONSI) will be issued after review of the EA, if appropriate.

SECTION 1.0
INTRODUCTION

1.0 INTRODUCTION

1.1 LOCATION

San Marcos is located in Hays County in south-central Texas, approximately 40 miles south of Austin, Texas. The Aquarena Center and Spring Lake are located within the city limits of San Marcos on the Texas State University (TxSt) campus (Figure 1-1). The proposed project study site would include the Aquarena Center, Spring Lake, and the TxSt golf course (Figure 1-2). Site photographs are included in Appendix A.

1.2 STUDY AUTHORITY

The proposed project would be constructed in accordance with and in partial fulfillment of U.S. Army Corps of Engineers (USACE) obligations under Section 206 of the Water Resources Development Act (WRDA) of 1996, USACE Planning Guidance Book (Engineering Regulation (ER) 1105-2-100), USACE Procedures for Implementing the National Environmental Policy Act (NEPA; ER 200-2-2), the Clean Water Act of 1977, as amended, the National Historic Preservation Act of 1966, as amended (PL-96-515), the Archaeological and Historical Preservation Act of 1974, as amended (PL-93-291), Section 404 of the Clean Water Act, the NEPA of 1969, as amended (PL-90-190), the Council on Environmental Quality (CEQ) Regulations for Implementation of NEPA (40 Code of Federal Regulations [CFR] parts 1500-1508), Noxious Weed Act, and Executive Orders #11593 (Protection and Enhancement of the Cultural Environment), #13112 (Invasive Species), #11988 (Floodplain Management), and #11990 (Protection of Wetlands).

The USACE is the lead agency for this study. The non-Federal, Local Sponsor, TxSt, has expressed their desire to act as a participatory agency in this restoration project. The USACE is also the lead Federal agency for NEPA compliance. The U.S. Fish and Wildlife Service (USFWS) and Texas Parks and Wildlife Department (TPWD) are participating agencies. As a participating agency, the USFWS completed a Fish and Wildlife Coordination Act Report for this project (Appendix B). This report includes an integrated Environmental Assessment (EA) to determine the potential impacts that would occur if this project were implemented. A Finding of No Significant Impact (FONSI) will be issued after public review of the EA, if appropriate.

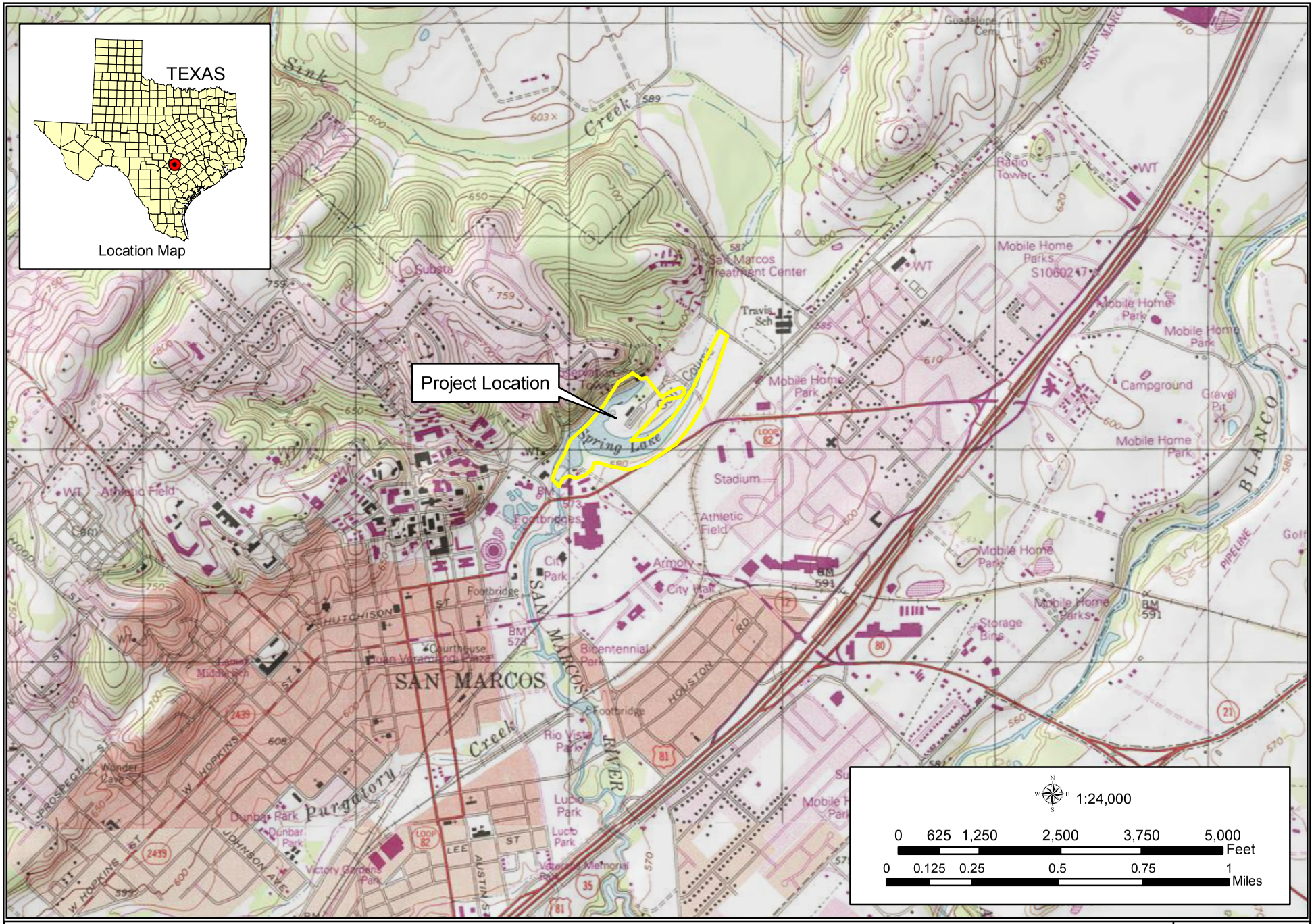


Figure 1-1: Spring Lake Location Map

GSRC

December 2005

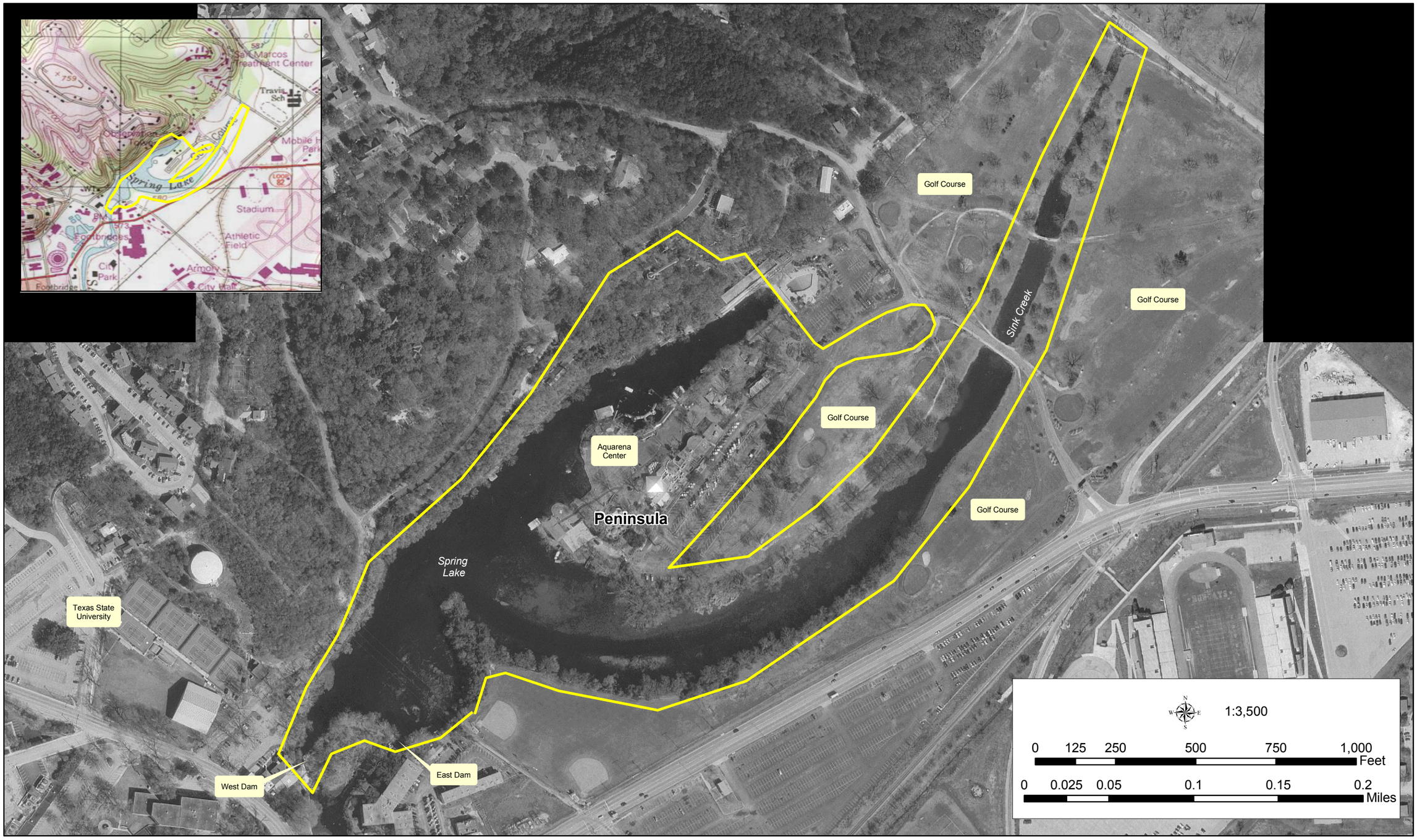


Figure 1-2: Spring Lake Project Area

GSRC

December 2005

THIS PAGE LEFT INTENTIONALLY BLANK

1.3 STUDY PURPOSE AND SCOPE

Spring Lake was created in 1854 by the construction of a dam that impounded the headwaters of the San Marcos River. Flows into Spring Lake originate from springs of the Edwards Aquifer. This unique environment is home to five Federally threatened or endangered species. The Aquarena Center was built in 1900, was a major tourist attraction and, in its prime, included several state-of-the-art rides and an underwater theater. However, due to competition from other regional attractions, the Aquarena Center closed in 1994 and in recent years the Aquarena Center has fallen into a state of disrepair. The Aquarena Center and other urban development around Spring Lake have caused the expansion of terrestrial and aquatic invasive species and increased water quality problems.

The Detailed Project Report and integrated Environmental Assessment (DPR/EA) address the need for and desirability of undertaking a plan to restore the ecosystems associated with Spring Lake in San Marcos, Texas. The project is needed to restore the aquatic ecosystem components of the proposed study area to a condition closer to natural conditions within the constraints of existing land uses. The aquatic ecosystem components are composed of Spring Lake and riparian corridor/grassland habitat located directly adjacent to the lake, which provides functions (i.e., buffering of pollutants, cover, shoreline stability) essential for a healthy aquatic ecosystem. Prior to construction of Aquarena Springs and Spring Lake Dam, the floodway along the San Marcos River was comprised of high quality riparian and in-stream habitat. However, the majority of the bottomland plant community within the watershed has become highly disturbed and fragmented due primarily to conversion of land to urban uses and invasion of exotic vegetation. Likewise, the quality of in-stream aquatic habitat has degraded along the San Marcos River due to increased nutrient and sediment loads from clearing of vegetated floodways and alterations to natural water flows. Ecosystem degradation has resulted in a loss of high quality in-stream and riparian habitat for terrestrial and aquatic wildlife that inhabit the study area.

The purpose of the proposed action is to implement mitigation measures that would remedy some of these habitat degradations by restoring habitats to a condition closer to natural conditions within the constraints of existing land uses. Specific habitat degradations within the proposed study areas that require restoration include:

- A narrow to nonexistent riparian corridor around Spring Lake and the San Marcos River, reduced plant and wildlife species diversity, and decreased wildlife cover and nesting habitat due primarily to urban development, encroachment of landscaped parklands, and expansion of invasive and exotic vegetation;

- Existing structures associated with the Aquarena Center are a safety threat to humans utilizing the area and are the primary reason for degradation of the surrounding habitat;

- Current environmental conditions threaten habitat utilized by five Federally listed species endemic to the area;

- In-stream habitat features are lacking diversity due to impoundment of the San Marcos River, subsequent sedimentation, and expansion of invasive aquatic vegetation; and

- Water quality is negatively impacted by the existing Aquarena Center, associated hardpan surfaces, and a surrounding 9-hole golf course through increased surface water runoff from the surrounding landscape.

The considerations of restoration alternatives that would improve ecological resources within this portion of the San Marcos River system are documented in this DPR/EA. This DPR/EA is provided to the general public, agencies, and interested parties to review and comment on the plan formulation process and recommended aquatic ecosystem restoration plan or National Environmental Restoration (NER) plan. The 30-day public review is in accordance with the NEPA and ER 200-2-2. After comments have been received, USACE will determine if all environmental concerns have been adequately addressed and, if appropriate, sign the FONSI, completing the NEPA process.

1.4 STUDY GOALS AND OBJECTIVES

The general goal of this report is to complete a feasibility-level study by evaluating alternatives that are technically feasible, supported by the non-Federal, Local Sponsor, and are consistent with the authorized project purposes of restoring the degraded habitat in the study area to a less degraded, more natural condition. Tasks undertaken and included as part of this DPR/EA are:

- Field investigations to obtain baseline information;

- A description of the existing conditions (affected environment) including documentation of environmental degradations;

- Descriptions of project alternatives and levels of restoration efforts including conceptual designs and construction cost estimates;

- Assessment of the potential impacts on cultural resources within the project area;

- Documentation of any potential Hazardous, Toxic, Radioactive Wastes (HTRW) concerns within the project area;

- Assessment of real estate value and boundaries;

- Completion of an incremental cost analysis of the various alternatives and associated restoration measures and scales;

- Identification of a recommended restoration plan, conceptual design of plan features, and development of supporting technical data;

- Conceptual design and justification of any associated recreation features included in the recommended plan; and

- Preparation of an integrated EA to comply with NEPA, which includes environmental consequences, cumulative impacts, and mitigation measures to minimize environmental impacts.

For this study, the process of evaluating the project alternatives has been streamlined such that the alternatives have been presented and evaluated, but a detailed analysis, including a construction cost estimate, was developed for only the NER or recommended alternative.

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 2.0
EXISTING CONDITIONS

2.0 EXISTING CONDITIONS

2.1 CLIMATE

The average annual temperature of Hays County is 68 degrees Fahrenheit (°F) with the average January temperature being around 40°F and the July average being 96°F (Cecil and Greene 2002). The average annual precipitation is 34.4 inches. The growing season is approximately 245 days.

2.2 SOILS AND GEOLOGY

2.2.1 Soil Associations

Three soil types are located in the proposed project area: Eckrant-rock outcrop complex; Tinn clay, frequently flooded; and Oakalla soils, frequently flooded (U.S. Department of Agriculture [USDA] 1984, Figure 2-1). The Eckrant soil type is found along the steep slopes on the northwestern side of the lake and consists of a stony clay surface layer with underlying limestone. The Tinn clay soil type is found in the central portion of the peninsula, where many of the buildings are located. This soil type is characterized by deep, poorly drained soils that provide good wildlife habitat in areas that are located along streams and creeks (USDA 1984). The Oakalla soil type is distinguished by deep, well-drained soils that are flooded at least once every 2 years. The Oakalla soils also provide good wildlife habitat due to their food and cover production (USDA 1984). Much of the area where the Tinn soil type is found is developed. Buildings, parking lots, and sidewalks cover much of the central portion of the peninsula.

2.2.2 Hydric Soils

None of the three soil types found in the project area are listed as hydric soils on the local or state hydric soils list (USDA 2002).

2.2.3 Geology and Physiography

The project area lies in the Balcones Fault Zone, a geologic feature that divides the Edwards Plateau and the lower Blacklands Prairie. The Balcones Fault Zone is a major geologic boundary separating coastal and inland regions and marks a transition from limestone soils to sands and clays. The Edwards Plateau region comprises an area of central Texas commonly known as the Texas Hill Country (Correll and Johnston 1996). It is a land of many springs,

THIS PAGE LEFT INTENTIONALLY BLANK

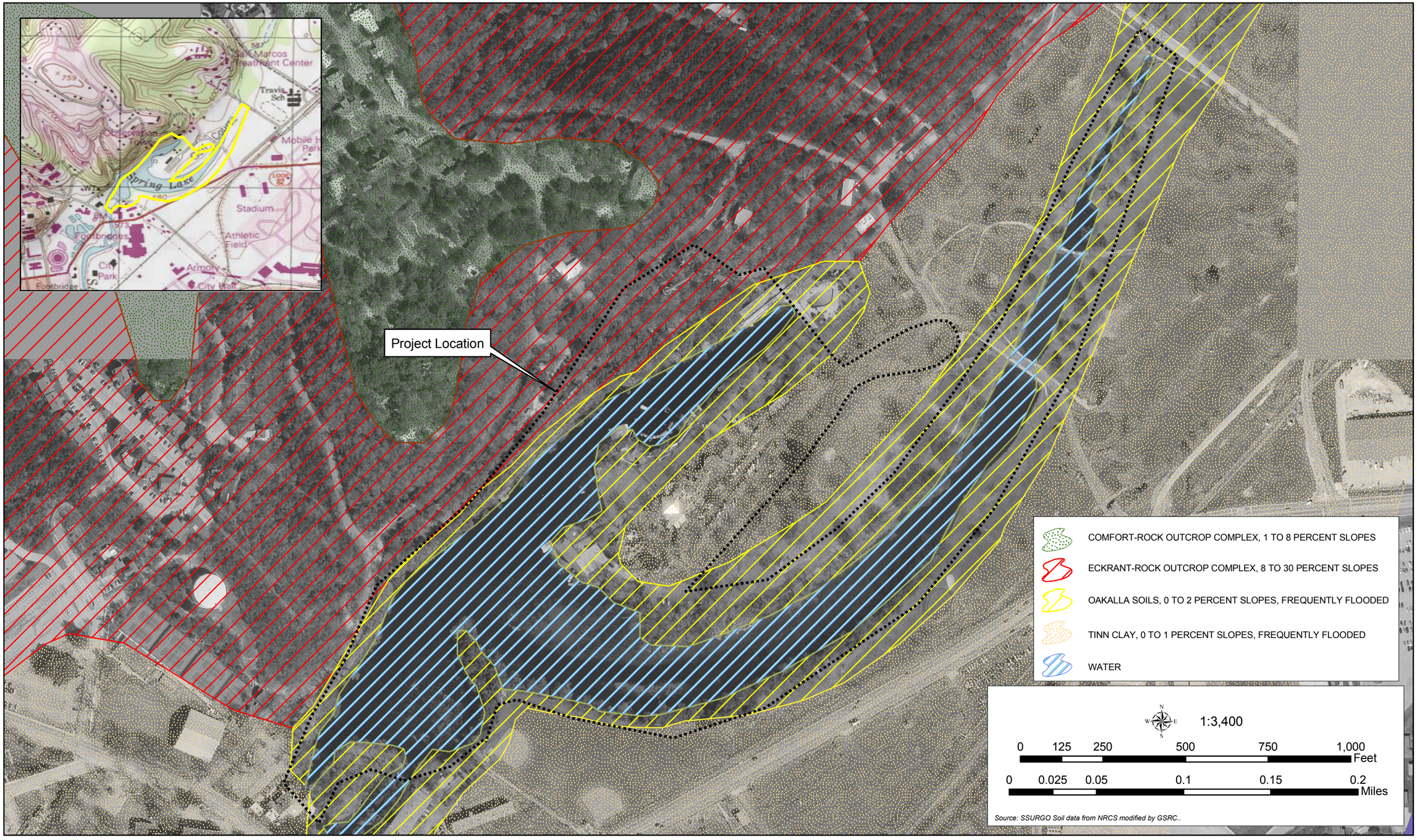


Figure 2-1: Soils Map

GSRC

December 2005

THIS PAGE LEFT INTENTIONALLY BLANK

stony hills, and steep canyons. Elevations range from slightly less than 1,000 feet to more than 3,000 feet. The Blacklands prairie has a gently rolling to nearly level topography with well-dissected, rapid surface drainages (Correll and Johnston 1996). Elevations above sea level are 300 to 800 feet for the Blacklands Prairie.

The Edwards Aquifer underlies the southeastern portion of the Edwards Plateau. There are three zones that make up the aquifer region: the aquifer contributing zone, the aquifer recharge zone, and the aquifer transition zone (Edwards Aquifer Authority [EAA] 2001, Figure 2-2). The aquifer-contributing zone is where the rainfall is collected to begin its journey through the limestone. This area is the largest portion of the aquifer and covers an area of approximately 1,800 square miles. The aquifer recharge zone is also called the Balcones Fault Zone, and this is where surface waters enter the ground water system. This area covers approximately 1,500 square miles and collects water that comes from streams, caves, and sinkholes. Here the water is percolated into the Edwards Aquifer and then through the limestone to the aquifer transition zone. The aquifer transition zone, also referred to as the discharge, or artesian zone, covers approximately 200 square miles. This is the zone where the filtered water is pushed out of the Edwards Aquifer through faults, which form springs (EAA 2001).

2.3 SURFACE WATER AND OTHER AQUATIC RESOURCES

2.3.1 Surface Water

The San Marcos Springs serve as headwaters for the San Marcos River (Figure 2-3) and are dammed just south of the springs to form Spring Lake. Sink Creek, which is located north of Spring Lake, discharges storm waters into the lake (USFWS 1996). Four miles downstream from the springs, the Blanco River joins the San Marcos River and they collectively empty into the Guadalupe River (Smyrl 2001).

Spring Lake and the headwaters of the San Marcos River are threatened by pollution and by increasing water demands that threaten the potential depletion of the aquifer (Brune 2001, Smyrl 2001). Physical and chemical parameters, as well as fish communities, quantified in multiple studies conducted from 1992 to 1994 have shown similar trends in water quality of the San Marcos River (Whiteside et al. 1995, Slattery 1997, Groeger et al. 1998). Waters of the Edwards Aquifer, the primary source for the headwaters of the San Marcos River, typically

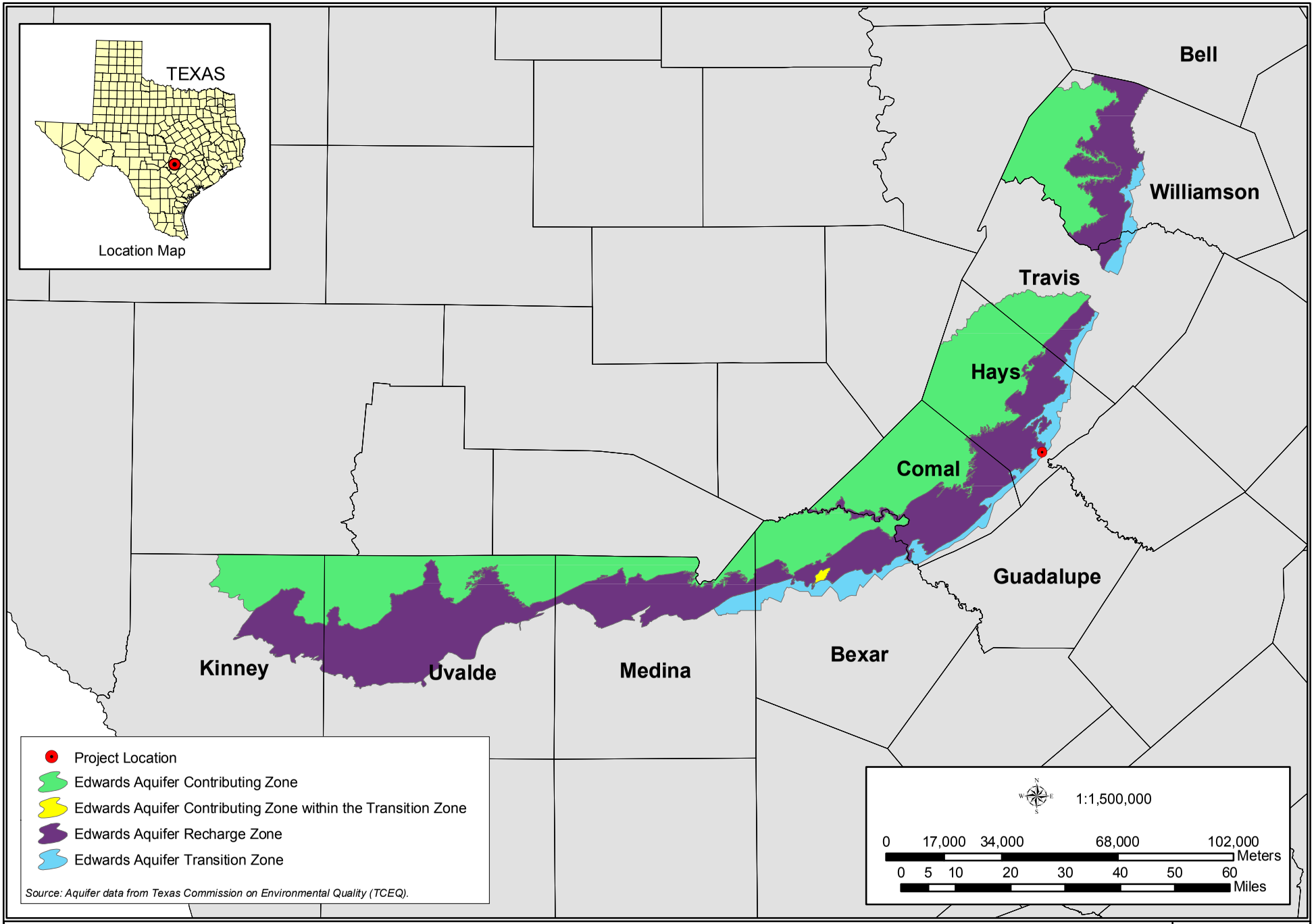


Figure 2-2: Edwards Aquifer Recharge Zone Regulatory Boundary

GSRC

December 2005

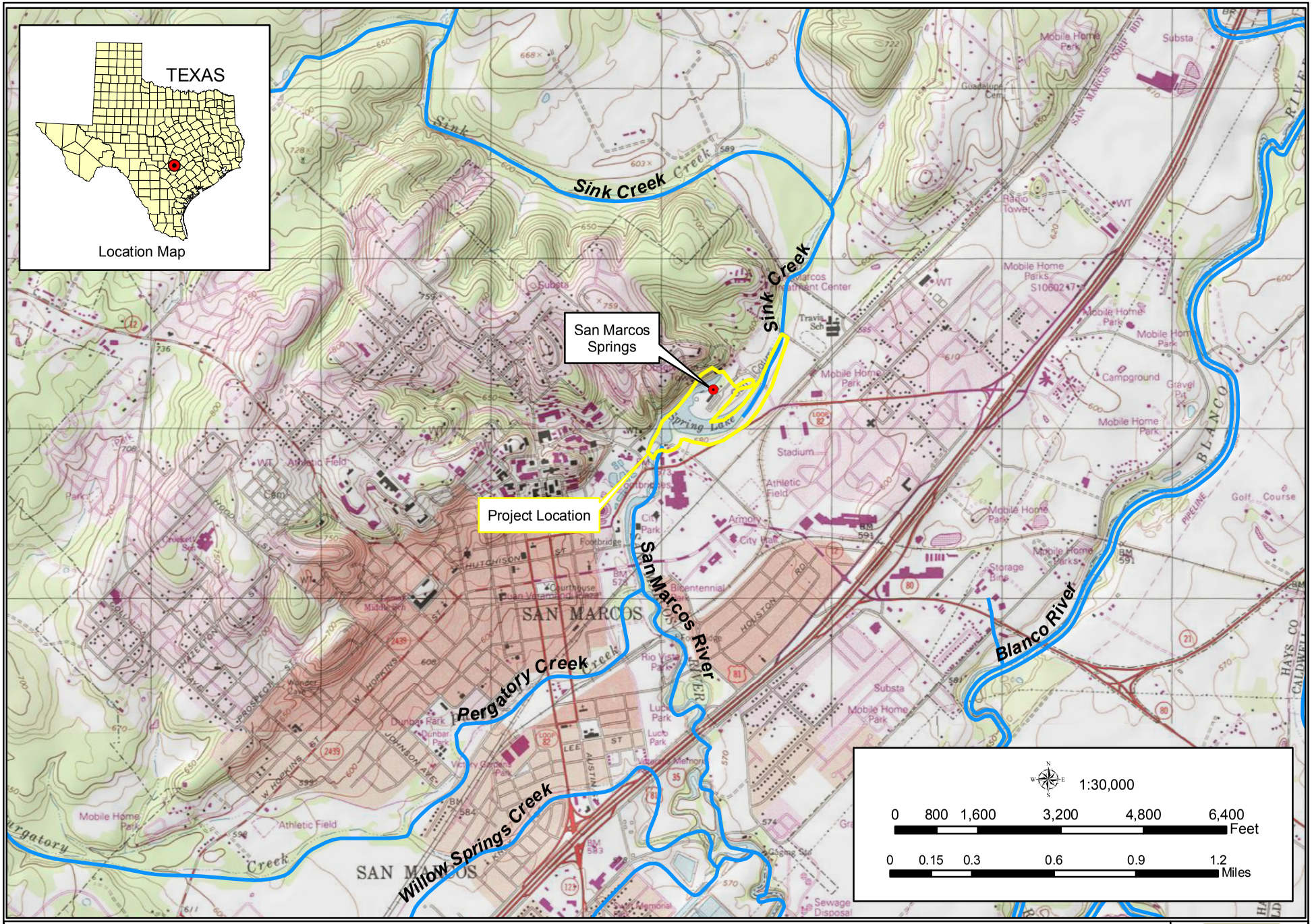


Figure 2-3: Surface Waters

GSRC

December 2005

exhibit high carbon dioxide levels, low pH, and large concentrations of calcium and alkalinity (Groeger et al. 1998). The headwaters of the San Marcos River also typically contain low turbidity, high flows, dense growth of aquatic plants and constant water temperatures (Whiteside et al. 1995). At four sites on the San Marcos River located below Spring Lake Dam, specific conductance, pH, temperature and dissolved oxygen were monitored from July 1 – August 30, 1994, with a total of 1,331 samples collected at each site. Site 1 was the most upstream site located immediately downstream of Spring Lake Dam. Site 2 was located on the downstream side of I-35. Site 3 was located just downstream of the fish hatchery, and Site 4 was the most downstream of the sites, located downstream of a municipal wastewater treatment plant (WWTP). Table 2-1 gives the median values for the water quality parameters sampled at the four sites (Slattery 1997). Water quality in the San Marcos River was excellent with only slight changes further downstream from the Spring Lake Dam.

Table 2-1. Water Quality Summary of San Marcos River, 1994

Water Quality Parameter	Site 1	Site 2	Site 3	Site 4
Median Specific Conductance (microSiemens/cm)	582	585	577	590
Median pH	7.4	7.6	7.7	7.8
Median Temperature (°F)	72.7	73.9	75.0	75.7
Median Dissolved Oxygen (milligrams/liter)	7.8	7.9	8.3	7.9

Source: Slattery 1997

Turbidity also shows a consistent increase downstream of Spring Lake (Whiteside et al. 1995). Soluble phosphorus and ammonia concentrations, as well as total nitrogen and phosphorus levels increased sharply near the San Marcos WWTP (Whiteside et al. 1995). Although the City of San Marcos implemented a $28 million upgrade to their WWTP, historically changes in water quality, such as increases in nitrate and phosphorous levels, affected by effluent from the WWTP were associated with an increase in algal growth (Groeger et al. 1998) and a decrease in fish diversity (Whiteside et al. 1995).

2.3.2 Groundwater

The project area lies on a fault line that divides the Edwards Plateau and the lower Blacklands Prairie. The San Marcos Springs are the second largest spring system in Texas and one of the greatest outflows from the limestone rock of the Edwards Aquifer (Eckhardt 2002a). The water found in Spring Lake and the San Marcos River comes from three large fissures along the Balcones Fault Zone (Brune 2001). These three fissures then split into approximately 200 small

openings, which pour out crystal clear water that remains a constant 71.6°F year-round (USFWS 1996, Brune 2001). This constant temperature and clear water create a unique environment found only in the San Marcos area.

The Edwards Aquifer was the first aquifer designated as a sole-source aquifer in 1975 and is the main source of water for the San Antonio and Austin areas (Eckhardt 2002b, Edwards Aquifer Research and Development Center 2002). A sole-source aquifer is an aquifer designated by the U.S. Environmental Protection Agency (USEPA) under the Sole Source Aquifer Program as the "sole or principal" source of drinking water for an area. The USEPA defines a sole-source aquifer as one that supplies at least 50 percent (%) of the drinking water consumed in the area overlying the aquifer (Safe Drinking Water Act, Section 1427). The Edwards Aquifer is approximately 180 miles long and varies in width between 5 and 40 miles, covering 10 counties in central Texas (EAA 2001).

2.3.3 Flood Plains

According to the Federal Emergency Management Agency (FEMA), the project area is within the 100-year floodplain of Sink Creek (FEMA 2000). Additional hydrologic and hydraulic assessment information can be found in Appendix C.

2.3.4 Waters of the United States including Wetlands

Section 404 of the Clean Water Act (CWA) of 1977 (P.L. 95-217) authorizes the Secretary of the Army, acting through the USACE, to issue permits for the discharge of dredged or fill material into Waters of the U.S., including wetlands. Waters of the U.S. (Section 328.3[2] of the CWA) are those waters used in interstate or foreign commerce, subject to ebb and flow of tide, and all interstate waters including interstate wetlands. Waters of the U.S. are further defined and may include waters such as intrastate lakes, rivers, streams, mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, natural ponds, or impoundments of waters, tributaries of waters, and territorial seas. Jurisdictional boundaries for Waters of the U.S. are defined in the field as the ordinary high water mark (OHWM) which is that line on the shore established by the fluctuations of water and indicated by physical characteristics such as clear, natural lines impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.

Wetlands are those areas inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (USACE 1987).

The USACE has established Nationwide Permits (NWPs) to efficiently authorize common activities that do not result in more than minimal adverse impacts to waters of the U.S. The NWPs were modified and reissued by the USACE in the *Federal Register* on 15 January 2002, with an effective date of 18 March 2002. All NWPs have an expiration date of 18 March 2007. The USACE has the responsibility to authorize permitting under a NWP, or to require an Individual Permit.

Spring Lake, San Marcos River, and Sink Creek are classified as Waters of the U.S., all of which are located within the project area. Potential jurisdictional wetlands in the project area occur primarily along the edges, or in extremely shallow regions, of the Spring Lake, Sink Creek and San Marcos River. Typical wetland vegetation that occurs in the project area includes bald cypress (*Taxodium distichum*), black willow (*Salix nigra*), elephant ear (*Colocasia esculenta*), hydrilla (*Hydrilla verticillata*), and eelgrass (*Vallisneria americana*).

2.4 WILDLIFE HABITATS

2.4.1 Vegetation

The vegetation surrounding the project area near Spring Lake and the upper San Marcos River is comprised of native and exotic species due to the mixture of residential, golf course, and landscaped surroundings. Native tree species in the area include black willow, American sycamore (*Platanus occidentalis*), bald cypress, boxelder (*Acer negundo*), black walnut (*Juglans nigra*), hackberry (*Celtis laevigata*), and sweet pecan (*Carya illinoensis*). Non-native tree species include Chinese tallow tree (*Sapium sebiferum*) and chinaberry (*Melia azedarach*).

Aquatic plant species observed in the area include elephant ear, fanwort (*Cabomba caroliniana*), water primrose (*Ludwigia repens*), duckweed (*Lemna* sp.), water lettuce (*Pistia stratiotes*), floating water fern (*Azolla caroliniana*), yellow pond lily (*Nuphar advena*), arrowhead (*Sagittaria platyphylla*), eelgrass, and Texas wild-rice (*Zizania texana*), a Federally protected species.

Several exotic species have been introduced since the early 1900s: elodea (*Egeria densa*), hydrilla, watermilfoil *(Myriophyllum* spp.), west Indian hygrophila (*Hygrophila polysperma*), Chinese tallow tree, chinaberry, and elephant ear. These introduced species have created a negative effect on the project area due to overabundance and the displacement of native species, such as Texas wild-rice (USFWS 1996). In particular, the hydrilla, elodea, and West Indian hygrophila have formed large stands in Spring Lake and the upper San Marcos River and are affecting water quality (USFWS 2001).

Non-native species observed during site visits were located in bottomland hardwood and riparian habitats located along the lake's edge and near the dam. Elephant ear seemed to be the most abundant non-native species found in the project area.

Much of the central region of the peninsula and surrounding areas are covered by turfgrass and other planted ornamentals. This area is developed with buildings and concrete lots, which has displaced much of the native vegetation.

2.4.2 Fauna

The San Marcos Springs and Spring Lake provide a very unique habitat for wildlife and aquatic species due to the constant water temperature and continuous flow. This area supports many native species along with several species that cannot be found elsewhere in the world (USFWS 1996).

Common native species known to occur in the project area or that were observed in the project area include largemouth bass (*Micropterus salmoides*), redear sunfish (*Lepomis microlophus*), snapping turtle (*Chelydra serpentina*), and giant river prawn (*Macrobranchium* sp.). Wading birds that commonly use this ecosystem include the green heron (*Butorides virescens*), great blue heron (*Ardea herodias*), American coot (*Fulica americana*), and great egret (*Casmerodius albus*). Waterfowl such as pied-billed grebe (*Podilymbus podiceps*), mallard (*Anas platyrhynchos*), northern shoveler (*Anas clypeata*), wood duck (*Aix sponsa*), and gadwall (*Anas strepera*) are also common visitors to the lake. Other resident birds in the area include the mourning dove (*Zenaida macroura*), barn swallow (*Hirundo rustica*), belted kingfisher (*Ceryle alcyon*), and the eastern kingbird (*Tyrannus tyrannus*).

Introduced, or exotic, species such as the giant ramshorn snail (*Marisa cornuarietis*), nutria (*Myocaster coypus*), blue tilapia (*Oreochromis aureus*), blue catfish (*Ictalurus furcatus*), and domestic ducks and geese, have posed a threat to native and Federally protected species in the project area. Several of these exotic species are known to feed on aquatic vegetation and subsequently destroy habitat for the protected fountain darter (*Etheostoma fonticola*) and San Marcos salamander (*Eurycea nana*), and graze on the Federally protected Texas wild-rice. One exotic species in particular, the thiarid snail (*Melanoides tuberculata*), is the host for a trematode that parasitizes on the gills of the fountain darter (USFWS 2001).

2.4.3 Existing Habitats

To evaluate potential habitat restoration opportunities, it was necessary to establish baseline habitat conditions within the study area. Existing habitats within the project area can be classified into one of four habitat types: riparian, lacustrine, grassland, or disturbed communities. Riparian areas occur along Sink Creek and the banks of Spring Lake. This community generally consists of hackberry, cottonwood (*Populus deltoides*), sweet pecan, live oak (*Quercus virginiana*), and Chinese tallow tree in the overstory. The sapling/shrub layer consists of ligustrum (*Ligustrum sinense*), deciduous holly (*Ilex decidua*), palmetto (*Sabal minor*), and small Chinese tallow trees. The understory layer contains such vines as ladies-eardrops (*Brunnichia cirrhosa*), greenbriers (*Smilax* sp.), and wild grape (*Vitis* sp.) The lacustrine habitat consists primarily of exotic species such as elephant ear, water hyacinth (*Eichhornia crassipes*) and hydrilla. Native aquatic species such as coontail (*Ceratophyllum demersum*), arrowweed (*Sagittaria* sp.), and cattail (*Typha latifolia*) were found sporadically in or along the lake. Grassland habitat consists of maintained turf grasses. The Aquarena Center and surrounding area comprise the disturbed habitat. This area contains several buildings, sidewalks and a large parking lot. Besides a few scattered pecan trees and maintained turf grasses, there is very little vegetation found in this area.

An overall evaluation of the quality of existing habitats within the project area was conducted using a Habitat Evaluation Procedure (HEP). HEP allows assessment of the current and potential value to wildlife species based on a Habitat Suitability Index (HSI), which assigns a comparative value based on a single species, multiple species, or on an ecosystem basis. An HSI value of 0.0 represents the lowest comparative value of habitat whereas 1.0 represents the optimum value of a particular habitat. Quantitative impacts of project plans can be determined by comparing the net change in Average Annualized Habitat Units (AAHUs) for with-project and without-project alternatives. The AAHUs are calculated by summing all HUs for successive years and dividing by

the economic life of the project, which for this project is 50 years. Additional information regarding the HEP can be found in Appendix D.

Existing HSI models were reviewed to determine 1) species applicable to this region of Texas, and 2) applicability of species to cover types created from habitat restoration. A list of applicable species were selected and ranked using criteria relevant to the project by HEP team members. Five indicator species were chosen to evaluate the existing habitat conditions, they were: eastern meadowlark (*Sturnella magna*), mink (*Mustella vison*), eastern cottontail (*Sylvilagus floridanus*), northern bobwhite (*Colinus virginianus*), and redear sunfish (*Lepomis microlophus*). The five species that were selected for the HEP analysis, serve as a guild for wildlife species that are found in the area. Computed baseline HSI and Habitat Unit (HU) values for each of the indicator species and representative habitat type were calculated and results are presented in Table 2-2.

Table 2-2. Baseline Values for Existing Conditions

Evaluation Species	Representative Habitat (Acres)				HSI	HU
	Woodland		Grassland	Lacustrine		
	Hill	Peninsula				
Eastern meadowlark	x	x	0.10	x	0.10	0.01
Mink	2.42		x	x	0.61	1.47
Eastern cottontail	4.92	0.80	5.07	x	0.5/0.0	2.46/0
Northern bobwhite	4.92	0.80	5.07	x	0.5/0.0	2.46/0
Redear sunfish	x	x	x	22.40	0.4	9.12

Eastern Meadowlark

Table 2-2 shows that the existing 0.10 acres of turf grass and other manicured vegetated areas on the peninsula provide poor habitat for the eastern meadowlark. The overall average HSI value for the eastern meadowlark is 0.10 with 0.01 HUs available. Restoration of the peninsula with native grassland and forbs species would benefit the eastern meadowlark and other grassland-dependent species.

Mink

The 2.42 acres of existing, riparian woodland habitat around the lake provides 1.47 HUs for the mink (see Table 2-2). The riparian corridor habitat is considered average habitat (HSI 0.61) for the mink. Current golf course maintenance practices have removed or disturbed riparian habitat by maintaining a manicured landscape to the waters edge. The creation of a riparian buffer

zone would help prevent this maintenance, and the amount of cover for the mink would increase and improve habitat suitability.

Eastern Cottontail

The woodland habitat on the hill provides 2.46 HUs for the cottontail, and existing habitat on the peninsula does not provide suitable habitat for the cottontail (see Table 2-2). The HSI value of 0.50 for woodland habitat is considered fair habitat for the cottontail. Establishment of native grassland species, removal of exotic vegetation, removal of hard surfaces, and establishment of vegetated buffer zones, would help increase cottontail habitat and suitability.

Northern Bobwhite

The bobwhite's requirements, although defined by a more complex model, are similar to the cottontail requirements, and as with the eastern cottontail, existing habitat on the hill provides 2.46 HUs while existing habitat on the peninsula is not suitable and provides 0.00 HUs (see Table 2-2). Similar habitat improvements to those outlined for the eastern cottontail would also improve bobwhite habitat area, suitability, and value.

Redear Sunfish

Existing lacustrine habitat provides 9.12 HUs for the redear sunfish (see Table 2-2). The HSI value of 0.40 for lacustrine habitat is considered fair habitat for the redear sunfish. Existing lacustrine habitat is degraded due to expansion of invasive and exotic aquatic plant species, the presence of deteriorating submerged structures, decreased water quality due to overland surface runoff, and loss of habitat due to sedimentation.

2.5 ENDANGERED AND THREATENED SPECIES

The Endangered Species Act (ESA) [16 U.S.C. 1532 et. seq.] of 1973, as amended, was enacted to provide a program for the preservation of endangered and threatened species and to provide protection for the ecosystems upon which these species depend for their survival. All Federal agencies are required to implement protection programs for designated species and to use their authorities to further the purposes of the act. Responsibility for the identification of a threatened or endangered species and development of any potential recovery plans lies with the Secretary of the Interior and the Secretary of Commerce.

The USFWS and the National Marine Fisheries Service (NOAA Fisheries) are the primary agencies responsible for implementing the ESA. The USFWS is primarily responsible for birds, terrestrial, and freshwater species, while the NOAA Fisheries is responsible for most non-bird marine species. The USFWS's responsibilities under the ESA include: (1) the identification of threatened and endangered species; (2) the identification of Critical Habitats for listed species; (3) implementation of research on, and recovery efforts for, these species; and (4) consultation with other Federal agencies concerning measures to avoid harm to listed species.

An endangered species is a species in danger of extinction throughout all or a significant portion of its range. A threatened species is a species likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Proposed species are those, which have been formally submitted to Congress for official listing as threatened or endangered. Species may be considered endangered or threatened when any of the five following criteria occurs: (1) the current/imminent destruction, modification, or curtailment of their habitat or range; (2) overuse of the species for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) the inadequacy of existing regulatory mechanisms; and (5) other natural or human-induced factors affect continued existence.

In addition, the USFWS has identified species that are candidates for listing as a result of identified threats to their continued existence. The candidate designation includes those species for which the USFWS has sufficient information on hand to support proposals to list as endangered or threatened under the ESA. However, proposed rules have not yet been issued because such actions are precluded at present by other listing activity.

2.5.1 Federal

A total of nine Federally protected species have the potential to occur in Hays County. This list includes two amphibians, two birds, two fish, two insects, and one plant. Eight of those species are listed as endangered and one as threatened. Information pertaining to species identified by the USFWS as well as all other Federally protected species, is included in Table 2-3.

Table 2-3. Federally Protected Species in Hays County, Texas

Common Name	Scientific Name	Federal Status
Golden-cheeked warbler	*Dendroica chrysoparia*	E
Fountain darter	*Etheostoma fonticola*	E
San Marcos salamander	*Eurycea nana*	T
San Marcos gambusia	*Gambusia georgei*	E
Comal Springs riffle beetle	*Heterelmis comalensis*	E
Comal Springs dryopid beetle	*Stygoparnus comalensis*	E
Texas blind salamander	*Typhlomolge rathbuni*	E
Black-capped vireo	*Vireo atricapillus*	E
Texas wild-rice	*Zizania texana*	E

Source: USFWS 2002

Of the nine Federally listed species, five are known to occur within the project area. These five species are the fountain darter, San Marcos salamander, Texas blind salamander, Comal Springs riffle beetle, and Texas wild-rice. A Biological Assessment (BA) addressing these five species and the potential effects, both adverse and beneficial, from the proposed restoration project was submitted to the USFWS and formal consultation under Section 7 of the ESA was initiated. The USFWS Final Biological Opinion (BO) outlining the project effects, incidental take, and conservation recommendations on four of the Federally listed species was completed and is included in Appendix B.

2.5.2 State

The TPWD maintains lists of threatened and endangered species in Texas. This list includes flora and fauna whose occurrence in Texas is or may be in jeopardy, or with known or perceived threats or population declines. These species are not necessarily the same as those protected by the Federal government under the ESA. None of the state listed species are known to occur within the project area. A list of those species can be found in Appendix E.

2.5.3 Critical Habitat

Along with protecting the individual species, the ESA also calls for the conservation of what is termed Critical Habitat - the areas of land, water, and air space that an endangered species needs for survival. Critical habitat also includes such things as food, breeding sites, cover or shelter, and sufficient habitat area to provide for normal population growth and behavior. One of the primary threats to many species is the destruction or modification of essential habitat by uncontrolled land and water development.

Three of the five Federally listed species known to occur within the project area have designated Critical Habitat: Texas wild-rice, San Marcos salamander, and fountain darter. All three of these designations fall within the project area. The BO prepared for this project discusses the designated Critical Habitat for the three species and can be found in Appendix B.

2.6 RECREATIONAL, SCENIC, AND AESTHETIC RESOURCES

2.6.1 Local Resources

Educational and recreational resources are still available at the former Aquarena Center. Existing structures on the peninsula are used as a snack bar and gift shop. An endangered species exhibit and glass bottom boat tours are currently available to the public. Glass bottom boat tours account for the majority of the park's revenues.

TxSt does not allow access to Spring Lake or the upper San Marcos River for aquatic recreation such as swimming. Generally, swimming (other than specifically permitted SCUBA diving) and wading are prohibited in Spring Lake and water recreation such as tubing, canoeing, and kayaking in the immediate headwaters of the San Marcos River, just below the dam, are discouraged.

Spring Lake adds to the scenic and aesthetic quality of the urban setting of San Marcos. The Aquarena Center facilities are largely unused and in a dilapidated state. Many of these structures can be seen from a great distance (observation tower and tram ride) and in general, the structures detract from the scenic and aesthetic quality of the area.

2.6.2 Regional Resources

Recreation is an important economic resource to the City of San Marcos and to the region. The clear, clean and constantly cool waters of the upper San Marcos River have been a frequent leisure destination since the 1900s. Recognizing the economic value of this resource, the City of San Marcos passed the San Marcos River Corridor Ordinance (SMRCO) in 1985. The SMRCO recognizes that "continued economic growth and quality of life of the City is dependent on a pleasing natural environment, quality recreational opportunities and unique natural resources within and in close proximity to the City..."

The Texas Department of Commerce estimated that tourism generated $30 million in the San Marcos area in 1991 (Wegner 1991). Arts, entertainment, recreation, accommodation, and food services provided 10% of employment in Hays County in 2000 and 17% within the City of San

Marcos (Texas State Data Center and Office of the State Demographer 2004). Recreation was the 2nd largest employer for the City of San Marcos and the 3rd largest employer for the county. In the state of Texas, however, recreation ranks 6th among other industries and accounts for only 7% of year 2000 employment state wide.

Common recreation activities on the upper San Marcos River include swimming, tubing, canoeing, kayaking, fishing, and nature watching (Saunders et al. 2001). These activities have been enhanced through access to the river provided by state- and city-owned parklands including the San Marcos River Walkway that unites three parks along the river. Canoe outfitters, tube renters, and shuttle services have seen significant growth over the last 2 decades. In 1985, an estimated 25,000 people rented equipment for use on the river, and by 1992, a single equipment provider recorded 26,874 rentals for the summer (Saunders et al. 2001).

2.7 CULTURAL RESOURCES

2.7.1 Cultural History

Prehistoric occupation in the project area is divided generally into five periods, the Paleo-Indian period, the Early Archaic period, the Middle Archaic period, the Late Archaic period and the Late Prehistoric period. These periods are commonly subdivided into smaller temporal phases based on particular characteristics of the artifact assemblages encountered. The prehistoric periods and corresponding phases are defined by the presence of particular diagnostic artifacts such as projectile points, certain types of pottery, and occasionally, particular site locations. For the Historic period, documentary information more often is used to distinguish certain phases; nevertheless, particular artifacts also can be used to recognize certain historic affiliations. For additional information on the cultural resource history in the project area, see Appendix F.

2.7.2 Previous Investigations

Six archaeological sites are recorded in the vicinity of the current Area of Potential Effect (APE). The sites are 41HY37, 41HY147, 41HY160, 41HY161, 41HY165, and 41HY306 (Appendix F). Four sites 41HY160, 41HY165, 41HY161, and 41HY147 lie within the APE of the project and would have the potential to be impacted by the proposed restoration project. As a result, the discussions of previous archaeological work done within the vicinity of the project area will be discussed in relation to these sites.

2.7.2.1 Site 41HY147

In 1979, Shiner (1983) began underwater excavations at site 41HY147 (the Terrace Locality), which is located in Spring Lake adjacent to a large springhead. Excavations at 41HY147 recovered shouldered and side notched Archaic projectile points, PaleoIndian lanceolate projectile points, and many large faunal remains including mammoth and mastodon teeth, and bison bone. Shiner's (1983) underwater excavations at 41HY147 along with his excavations at 41HY161 in 1978 produced abundant evidence of Archaic and PaleoIndian, including Clovis, occupation of the area, but the remains were not found in sedimentary contexts that could be used to reconstruct detailed views of the people's past lifeways. In 1990 and 1991, Paul Takac, a graduate student at Southern Methodist University in Dallas, Texas, continued Shiner's underwater work at 41HY147. His project was eventually abandoned due to the difficulty and high costs of doing careful underwater investigations. Combined, Takac's and Shiner's excavations recovered a total of 46 PaleoIndian projectile points, most dating to the Late PaleoIndian period (Appendix F).

2.7.2.2 Site 41HY160

In 1982, TxSt conducted field investigations at 41HY160 as part of an archaeological field school. The field school uncovered intact deposits dating from the Late Prehistoric to Early Archaic periods with the deepest excavation unit extending 7.9 feet below the surface. From the 1982 excavations conducted at 41HY160 over 35,600 lithic artifacts were recovered, including 504 lithic tools and 53 diagnostic projectile points. Faunal remains recovered from the site include bison, deer, and antelope. Thirteen documented features were also recorded including burned rock middens, stone hearths, stone alignments, a posthole, a trash pit, and a special activity area possibly associated with ceramic production. The TxSt field school returned to 41HY160 in 1983 but the results of those excavations have not been analyzed or reported. In 1991 the TxSt field school returned to 41HY160. Test excavation units were placed near the Aquarena Springs swimming pool and the Anthropology Field Laboratory. The test excavations revealed that most of the upper deposits in the vicinity of the swimming pool were disturbed, but some of the lower deposits seemed intact. The TxSt field school returned to 41HY160 again in 1998 and conducted six excavations in the vicinity of the Aquarena Springs offices. Intact deposits were found immediately below the surface in two of the six excavation units. Neither the 1991 nor 1998 excavations have been analyzed or reported. Finally, in 1997 a pedestrian survey and shovel-testing project was conducted on the east side of Sink Creek and north of the entrance road immediately east of the escarpment. All but one shovel test produced prehistoric artifacts (Appendix F).

2.7.2.3 Site 41HY161

In 1978, Shiner's underwater investigations began at site 41HY161 located below the dam at Spring Lake. The site appeared to be largely disturbed with a combination of historic and prehistoric artifacts most of which were Archaic. In 1997, Ford and Lyle conducted a limited shovel testing and backhoe testing operation at 41HY161 in the parking lot constructed for Joe's Crab Shack on the west bank of Spring Lake immediately upstream from the dam. The investigation uncovered extensive disturbed deposits. In 1998 another series of backhoe trenches, shovel tests, and excavation units were conducted along the route of a proposed waterpipe line. In addition, the entire length was monitored during construction, which extended from the banks of the San Marcos River immediately downstream of the western spillway and Joe's Crab Shack, and ran adjacent to the TxSt Aquatic Biology Building and continued west from this building. Test units excavated near the Aquatic Biology Building documented eight stratigraphic units with a Late Archaic component overlying a Later PaleoIndian component (Appendix F).

2.7.2.4 Site 41HY165

Site 41HY165 was recorded and briefly tested in 1984 by the TxSt field school. Excavations were renewed in 1996 and continued through 1998. Analysis of the faunal remains is currently underway and will be reported in the future (Appendix F).

Additional fieldwork to identify unknown cultural resources within the project area will be conducted by TxSt during the Plans and Specifications phase as part of the Cultural Resources investigation for the project.

2.8 AIR QUALITY

The Clean Air Act, which was last amended in 1990, required states to adopt ambient air quality standards that are at least as stringent as the Federal National Ambient Air Quality Standards (NAAQS) however; the state standards may be more stringent. The state of Texas has adopted the NAAQS (40 CFR Part 50) as the state's air quality criteria. The NAAQS consists of primary and secondary standards for selected criteria pollutants. Primary standards are established to protect public health while secondary standards provide protection for the public's welfare including wildlife, climate, recreation, transportation, and economic values. Criteria pollutants include lead, particulate matter, sulfur dioxide, carbon monoxide, ozone, and nitrogen dioxide.

The Texas Commission on Environmental Quality (TCEQ) is responsible for reporting air quality in the state.

As required by the Clean Air Act, an independent scientific advisory body, Clean Air Scientific Advisory Committee (CASAC), evaluated the existing standards to determine if they were adequately protective of public health. CASAC determined that USEPA's current ozone and particulate standards should be strengthened. As of July 18, 1997, USEPA revised two standards, ozone, and particulate matter, to ensure a more effective and efficient protection of public health and the environment. These revised and strengthened standards are an 8-hour ozone standard of 0.08 parts per million (ppm), a 24-hour $PM_{2.5}$ (particulate matter with a diameter of 2.5 microns or smaller) standard of 65 micrograms per cubic meter ($\mu g/m^3$) and an annual $PM_{2.5}$ standard of 15 $\mu g/m^3$. USEPA has maintained the existing standard for the annual and 24-hour PM_{10} standard, but replaced the 1-expected-exceedance form with the 99^{th} percentile form, aged over 3 years.

The project area is in attainment, or it meets the national primary or secondary ambient air quality standard for all pollutants (USEPA 2005).

2.9 NOISE

Noise is generally described as unwanted sound, which can be based either on objective effects (hearing loss, damage to structures, etc.) or subjective judgments (community annoyance). Measurement and perception of sound involves two basic physical characteristics: amplitude and frequency. Amplitude is a measure of the strength of the sound and is directly measured in terms of the pressure of a sound wave. Because sound pressure varies in time, various types of pressure averages are usually used. Frequency, commonly perceived as pitch, is the number of times per second the sound causes air molecules to oscillate. Frequency is measured in units of cycles per second, or Hertz (Hz).

Sound is usually represented on a logarithmic scale with a unit called the decibel (dB). Sound on the decibel scale is referred to as a sound level. The threshold of human hearing is approximately 0 dB, and the threshold of discomfort or pain is around 120 dB. Noise levels are computed over a 24-hour period and adjusted for nighttime annoyances to produce the day-night average sound level (DNL). DNL is the community noise metric recommended by the

USEPA (USEPA 1973, USEPA 1974) and has been adopted by most Federal agencies (Federal Interagency Committee on Noise 1992).

A DNL of 65 dB is the level most commonly used for noise planning purposes and represents a compromise between community impact and the need for activities like construction, which do cause noise. Areas exposed to DNL above 65 dB are generally not considered suitable for residential use. A DNL of 55 dB was identified by the USEPA as a level below which there is effectively no adverse impact (USEPA 1973, USEPA 1974). This is the lowest level at which adverse health effects would be credible in a DNL of 75 dB (USEPA 1973, USEPA 1974). The very high annoyance levels make such areas unsuitable for residential land use. Noise levels at the project level are relatively low for an urban environment. Although no measures of noise levels were conducted for this study, Spring Lake is surrounded by a golf course and urban development. The many large trees and the distance of the facilities from development create a park-like atmosphere in which the noise levels are probably less than 55 dB.

2.10 HAZARDOUS MATERIAL

In 1993, the Aquarena Center retained Geraghty & Miller, Inc. (now Arcadis) to conduct a Phase I environmental site assessment of approximately 10 acres of land and improvements at the existing park (Appendix G). The environmental site assessment does not detail any testing or inspection for lead based paints. The following information characterizing the facilities and previous surveys was obtained from the report dated November 1993.

As a part of the site assessment, an asbestos inspection of site buildings was performed. A state-licensed asbestos inspector performed a visual inspection taking bulk samples of those materials suspected of containing friable asbestos. Those materials that may have been hidden, such as behind walls and floor coverings, were not evaluated. Subsequent to the inspection, some of the asbestos containing materials (ACMs) were removed from the Inn Annex mechanical room and disposed of off-site. Table 2-4 shows the locations of the ACMs known to remain at the site.

Table 2-4. Known Asbestos Materials in the Project Area*

Material Sampled	Sample Location	% Asbestos	Estimated Amount of Material
Transite siding	residence (Pepper's)	25	600 square feet
Pipe wrap	between Inn and Annex	15	mastic (no estimate)
Transite siding	locker room (show area)	25	250 square feet

* see Appendix G

Within the Spring Lake Restaurant building, corrugated transite panels were also observed on an interior wall (approximately 70 square feet) in a mechanical room located between the kitchen and dining areas.

In Texas, the Texas Department of Health (TDH) and the TCEQ are authorized by the USEPA to regulate the renovation and demolition of ACMs. The TDH, the TCEQ, and the Railroad Commission of Texas regulate the transportation and disposal of ACMs. ACMs must be disposed of in accordance with TCEQ requirements. The Occupational Safety and Health Administration (OSHA) regulates occupational exposure to asbestos resulting from the handling of ACMs.

Geraghty & Miller also performed a subsurface investigation, consisting of soil sampling and a soil vapor survey. The purpose of the investigation was to determine whether soils have been impacted by past operational practices at the maintenance building or the boat repair shop. A remedial action at two spill areas in the vicinity of the Maintenance building was performed to excavate soils contaminated by releases of gasoline spilled from two aboveground storage tanks and vehicle maintenance fluids.

A 500-gallon underground storage tank previously located at the golf course pro shop was removed in July 1993. Because the tank leaked, three monitoring wells were installed. Monitoring of the wells began on January 12, 2000.

A review of standard environmental record sources in accordance with American Society of Testing Materials (ASTM) Practice E 1527 was conducted by the Environmental Design Branch, Fort Worth District USACE as part of the HTRW investigation for the project. The records review identified three Resource Conservation and Recovery Information System, Small Quantity Generator (RCRIS-SQG) sites, twenty-three Leaking Petroleum Storage Tank (LTANK) sites, eleven Underground Storage Tank (UST) sites, and two Texas Voluntary

Cleanup Program (TX-VCP) sites within a 1.0-mile search radius of Spring Lake. The majority of sites identified by the records review was greater than 1/4 mile from Spring Lake and should not pose a risk to the proposed project. One LTANK site was identified within 1/8 mile of Spring Lake. The status of the LTANK is "Final Concurrence Issued, Case Closed". Therefore, it is unlikely that any recognized environmental conditions exist that would pose an HTRW threat to the proposed project. The HTRW database search report is contained in Appendix G.

Health and human safety issues have been addressed in the form of mitigation measures found in Section 8.0 of this DPR/EA.

2.11 SOCIOECONOMIC AND ENVIRONMENTAL JUSTICE

The Region of Influence (ROI) for the proposed Spring Lake restoration project is Hays County. Hays County is part of the Austin-San Marcos Metropolitan Statistical Area (MSA). Hays County had a year 2000 population of 97,589 which ranked 35th in the state (U.S. Census Bureau [USCB] 2005). This is a 48.7% increase over the 1990 Hays County population of 65,614. The population density of Hays County was 144 persons per square mile. The 2000 population of San Marcos, the community containing the project area, was 34,733. The racial mix of Hays County is predominantly Caucasian (79%), followed by people claiming to be some race other than African-American, Native American or Alaskan Native, Asian, native Hawaiian or other Pacific Islander, or two or more races (13%), and African American (4%). The remaining 4% is split between Native American and Alaskan Natives, Asians, Native Hawaiians or other pacific islanders, and people claiming to be two or more races. Of the total population, 30% claims to be of Hispanic or Latino origin.

In 2000 the total number of jobs in Hays County was 49,602 (BEA 2002). This is a 92% increase over the 1990 total number of jobs (25,812). The services industry provided the most jobs followed closely by the retail trade industry and state and local government employment, respectively. The average annual unemployment rate for Hays County was 2.3%. This is 2.9 points lower than the 1990 unemployment rate of 5.2%.

Hays County had a 2000 Per Capita Personal Income (PCPI) of $22,970 (BEA 2002). This PCPI ranked 79th in the state and, and was 83% of the state average, $27,752, and 78% of the national average, $29,469. In 1990 the PCPI was $13,879 and ranked 147th in the state. The

average annual growth rate of PCPI over the past 10 years was 5.2%, which is higher than both the growth rate for the state (4.8%) and the nation (4.2%).

Hays County has a Total Personal Income (TPI) of $2.3 billion (BEA 2002). This TPI ranked 37th in the state and accounted for 0.4% of the state total. The 1990 TPI for Hays County was $913 million and ranked 43rd in the state. The average annual growth rate for TPI over the past 10 years was 9.6%, which was higher than both the growth rate for the state (6.9%) and the nation (5.5%). According to the 1997 model based estimate, 13.1% of all persons within Hays County are living below poverty. This is lower than the 16.7% that are estimated to be below poverty in the state of Texas. The median household income for Hays County is $37,341 and for the state of Texas is $34,478.

In 2000, a total of 35,643 housing units were located within Hays County, Texas (Real Estate Center 2002). This represents less than 1% of the total housing units for the state of Texas. The housing density of Hays County equals 52.6 housing units per square mile. Of the 35,643 housing units 94% (33,410) are occupied and 6% (2,233) are unoccupied. The 2000 homeownership rate for Hays County is 64.8%; this is slightly higher than the homeownership for the state at 63.8%. In 2001, building permits authorized 724 housing units.

2.11.1 EO 12898 Environmental Justice

Executive Order (EO) 12898 of February 11, 1994, “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations” requires each Federal agency to identify and address, as appropriate, disproportionate adverse effects of its proposed actions on minority populations and low-income communities. Hays County is predominantly Caucasian (78%) with 30% of the population claiming Hispanic or Latino origin.

2.11.2 EO 13045 Protection of Children

EO 13045, "Protection of Children from Environmental Health Risks", requires consideration of the potential for a project to generate disproportionately high environmental health and safety risks to children. This EO was prompted by the recognition that children, still undergoing physiological growth and development, are more sensitive to adverse environmental health and safety risks than adults. Children less than 18 years of age comprised 24.5% of the Hays County population in 2000, and were estimated to account for 23.6% of the Hays County population by 2004 (USCB 2005).

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 3.0
PLAN FORMULATION

3.0 PLAN FORMULATION

3.1 ENVIRONMENTAL PROBLEMS AND DEGRADATION

Existing conditions in the study area and region were described in Section 2.0 and set the baseline condition for each resource to identify ecosystem problems and opportunities for restoration. This baseline condition also represents a point of comparison for prediction of environmental consequences for NEPA compliance as described in Section 7.0.

The primary problems associated with Spring Lake and the surrounding area include: (1) potential reductions in aquifer discharge, (2) expansion of invasive and exotic species, (3) alterations in natural stream hydrology, hydraulics, and morphology, (4) urban development and encroachment, (5) degradation of Spring Lake and San Marcos River water quality, and (5) potential impacts to Federally listed species and their Critical Habitat.

Reductions in discharge from the aquifer remain the main, long-term threat to the regional environment. The Edwards Aquifer and the springs and rivers flowing from it have a long history of occupation and use by humans. Archeological evidence suggests that man has continuously inhabited the San Marcos Springs area for over 12,000 years, perhaps the oldest such site in North America. Early Europeans were also drawn to the aquifers resources and by the 1800s substantial well discharge had begun. Recently, however, this use has compromised or stressed the wildlife inhabitants and ecological integrity of the system. Projections by water resource planners suggest that demands for water from the aquifer will exceed recharge rates by 163,000 acre-feet per year by 2020. (EAA 2001).

Expansion of exotic and invasive species also poses serious threats to both the regional environment of the Edwards Aquifer and to the local environment of San Marcos Springs and headwaters of the San Marcos River. Introduction of non-native aquatic macrophytes as well as fish and mammal species have significantly altered habitat and changed both the diversity and dominance of the macrophyte and fish communities (USFWS 1996, Saunders et al. 2001). Non-native plant species include Chinese tallow tree, chinaberry, elodea, hydrilla, watermilfoil, west Indian hygrophila, elephant ear, turfgrass, and planted ornamentals. These introduced species have created a negative effect on the project area due to overabundance and the displacement of native species. Large stands of hydrilla, elodea, elephant ear, and West Indian

hygrophila have negatively impacted recreational opportunities in the San Marcos River and Spring Lake such as boating, rafting, swimming, and operation of glass-bottomed boat rides. The stands have also increased sedimentation of suspended solids and subsequent loss of in-stream substrate and habitat. Floating mats of aquatic plant fragments have also smothered and negatively impacted the health and survival of Texas wild-rice and other rooted macrophytes located downstream. Introduced, exotic species such as the giant ramshorn snail, thiarid snail, nutria, blue tilapia, blue catfish, and domestic ducks and geese, have also posed a threat to native and Federally protected species in the project area.

The headwaters of the San Marcos River were historically described as a run-dominated system with rapid flow, a dense assemblage of aquatic macrophytes, and a diverse faunal community (Brune 2001, Vaughn 1986, Eckhardt 2002a). Habitat in the area has been most significantly altered by the construction of a dam in 1854 and the construction of the Aquarena Center in the 1900s (Eckhardt 2002a). The Spring Lake Dam has converted the natural run-dominated system of the headwaters into a pool-dominated system. The conversion of the system into a pool-dominated environment has resulted in the shift of species adapted to a lotic environment to those better suited for lentic conditions. During the floods of October 1998, the dam suffered major damage. At that time, it was suggested that removing the dam and restoring the habitat would provide an educational and plausible option for returning the system to the natural run-dominated system (see Section 4.1.2, below).

Until the early 1990s, the Aquarena Center was one of the premiere tourist attractions in central Texas. The facility contained state-of-the-art amusement rides, outdoor entertainment shows and other unique recreational amenities such as a submarine theater. Competition for the tourist dollar dramatically increased and other major attractions in the immediate area of San Marcos caused a significant decrease in attendance at the Aquarena Center. Over the years the facility has flooded several times and severely deteriorated in condition. Many of the buildings and structures are dilapidated, recreational rides are unsafe and not in working condition and the overall aesthetic appearance is no longer appealing. The Aquarena Center occupies land that could be restored to valuable wildlife habitat.

Surrounding the Aquarena Center is a 9-hole golf course. The golf course was constructed in a manner that resulted in the removal of high quality wildlife habitat surrounding Spring Lake. Wildlife habitat in many locations has been removed down to the shoreline of Spring Lake. Golf

course maintenance activities, particularly; mowing, prevents the development and reestablishment of native wildlife habitat. Amateur golfers also disturb existing wildlife habitat while searching for errant golf balls. Although the golf course is managed using minimal application of chemicals, sheet flow from the golf course and the surrounding hard surfaces during storm events adversely impact the water quality and aquatic habitat of Spring Lake and the San Marcos River.

Sheet flow from hardpan surfaces of the Aquarena Center and the surrounding 9-hole golf course provide inputs of sediment, nutrients, and chemicals into Spring Lake and the San Marcos River. These inputs have degraded water quality and have also likely increased eutrophication rates within Spring Lake. Seepage flow carrying sewage occurs along some portions of Spring Lake, Sink Creek and contributing watersheds. Upstream from the junction of the Blanco River with the San Marcos, three creeks, various storm sewers, and one wastewater treatment plant discharge into the river. Sink Creek, largest of the three creeks, discharges large quantities of storm runoff from the north into Spring Lake. Spring Lake Dam backs water approximately 1 mile up Sink Creek. The other two creeks, Willow Springs and Purgatory Creeks, are normally dry except during periods of high rainfall. The removal of exotic, submerged macrophytes as part of the long-term eradication program in Spring Lake also contribute to degradation of water quality within Spring Lake by increasing suspended sediments.

Along the Balcones Fault Zone, waters from the Edwards Aquifer reach the surface and contribute to unique habitat conditions supporting over 40 highly adapted, aquatic and subterranean species (Eckhardt 2002a). Many of these species are endemic to the riverine system and are identified for protection under the ESA. Spring Lake and upper parts of the San Marcos River have been designated as Critical Habitat for many of these species (USFWS 1996). Much of the system's uniqueness, to which many of its inhabitants have become highly adapted, depends upon its thermal stability (71°F year around) and constant volume of pure water. In fact, there is no historic or geological record of the San Marcos Springs ever drying up. San Marcos Springs is one of the greatest outflows from the Edwards Aquifer (Eckhardt 2002a), and the waters from these springs are some of the most pristine in Texas (Slattery and Fahlquist 1997). The five Federally listed species, known to occur within the project area (fountain darter, San Marcos salamander, Texas blind salamander, Comal Springs riffle beetle, Texas wild-rice) and associated Critical Habitat would benefit from restoration activities that improve native riparian

and floodplain habitat, reduce pollutants entering Spring Lake, replace hardpan surfaces with native vegetation, and decrease invasive and exotic vegetation.

3.2 OBJECTIVES AND CONSTRAINTS

3.2.1 Objectives

Ample opportunities exist for environmental restoration throughout Spring Lake and the San Marcos River. General goals and objectives of the study were enumerated in Section 1.4; the specific objectives for the proposed restoration include:

- Restoration of wildlife habitat through reforestation of the riparian corridor and adjacent floodplain of Spring Lake with native vegetation.
- Management and control of invasive and exotic flora and fauna followed by replacement with native plant species.
- Removal of in-stream debris within Spring Lake and hardpan surfaces along the floodplain to improve aquatic habitat and reduce overland surface runoff.
- Reduction of point and non-point nutrient loadings via creation of on-channel wetlands, off-channel wetlands, hydraulic meadows, and riparian corridor buffer systems.
- Removal or modification of on-channel structures that impact natural stream hydrology, hydraulics, and morphology.
- Reduction in withdrawals from the Edwards Aquifer through water conservation and identification of alternative water supply sources.
- Restoration of the Aquarena Center, TxSt golf course and other urban developments along the San Marcos River that negatively impact wildlife habitat and water quality.
- Incorporate restoration measures that improve environmental conditions for Federally listed species endemic to the area.

Multiple field studies and inspections were conducted by the USACE, USFWS, and Gulf South Research Corporation (GSRC) to identify site conditions, define resources in the vicinity of the study area, identify relevant ecological restoration opportunities and review any existing constraints which may limit the practicality and future success of implementation. The field studies document that existing aquatic ecosystem components are degraded due to population growth, urban development, and land use practices within Spring Lake and along the San Marcos River.

Baseline habitat conditions of the study area were quantified using HEP, as described in Section 2.4.3 and detailed in Appendix D. After the HEP analysis was performed, suggestions were compiled from participating resource agencies and personnel involved in the site visits. Restoration scenarios were established to restore ecological function of the study area. The primary objective of the Spring Lake restoration project is to restore valuable aquatic and terrestrial habitat throughout the Spring Lake and San Marcos River ecosystems. These habitats have been removed or compromised by construction of the Aquarena Center, the proliferation of invasive, terrestrial and aquatic plant species, and the construction of the TxSt golf course. Key opportunities for several major features within the study area were identified. These opportunities included:

- Demolition and removal of buildings and structures associated with the Aquarena Center and restoration of the peninsula with native tree, shrub, and grassland species.
- Removal of exotic plant species located on the peninsula and within the riparian corridor surrounding Spring Lake.
- Removal or modification of the Spring Lake Dam to restore stream dynamics and aquatic habitat conditions to a more natural setting.
- Reforestation of the riparian corridor in areas lacking or devoid of native vegetation.

3.2.2 Constraints

Planning constraints for the proposed project included the following:

- The authority under Section 206 requires that the aquatic ecosystem restoration project improve the quality of the environment, is in the public interest, and is cost-effective. Projects carried out under Section 206 involve cost sharing; 35% of the project is funded by a non-Federal entity and the Federal funds are limited to $5 million.
- All applicable Federal laws, laws of the state of Texas, Executive Orders of the President, and regulations of the USACE.
- Minimization of disturbance to sensitive habitats, cultural resources and Federally-listed species at Spring Lake and the San Marcos River.
- The project footprint is limited to TxSt property, which prevents optimum restoration impact by defining boundaries by land ownership rather than habitat types or need for restoration. Therefore, only restoration measures and features that would be utilized on University-owned property were considered for evaluation and optimization.
- Reforestation design was restricted to certain locations within the study area based on existing habitat and existing land use needs. Only environmentally friendly biological engineering techniques were considered for proposed restoration measures.

- Dam removal/restoration design would need to consider the existing hydrology and hydraulic parameters of Spring Lake, impacts on the 100-year floodplain, impacts on existing aquatic habitats, and potential adverse impacts on river stability.

- Exotic vegetation removal would require on-going operation and maintenance requirements by the Local Sponsor throughout the project life.

3.3 MOST PROBABLE FUTURE WITHOUT THE PROPOSED PROJECT

Without the proposed project, the buildings and structures at Aquarena Center would continue to be flooded and deteriorate. The terrestrial structures would continue to degrade and polluted runoff from the hard surfaces at the facility would impact water quality causing adverse impacts to the highly sensitive terrestrial and aquatic habitat of the study area. The purchase of Aquarena Center by TxSt in 1994 was undertaken as a measure on the part of the University to prevent the expansion of other commercial ventures and to preserve the natural resources in the area. The University has made the commitment to restore the natural resources of the area rather than repair or replace any of the park facilities. The removal of structures associated with the Aquarena Center provides an opportunity to restore degraded riparian corridor and floodplain habitat, reduce the amount of pollution entering Spring Lake, and improve the safety of visitors and downstream recreational activities.

It is anticipated that without the proposed project, adverse impacts to water quality from fertilizers and other chemicals discharged in storm waters from the golf course grounds would continue. Submerged debris and structures would continue to contribute to the degradation of water quality and to occupy habitat available for lacustrine species. Without the proposed project, existing exotic plant species would not be removed or managed, resulting in their propagation and continued invasion of the Spring Lake area. The Spring Lake Dam would not be removed or modified, resulting in continued impoundment of the headwaters of the San Marcos River. As long as the dam remains functional, species that are more tolerant of pooled habitat conditions would continue to dominate Spring Lake.

As shown in Section 2.4.3, Table 2-2 there is very little wildlife value present with the site in its current condition (15.52 HUs). Without the proposed project, wildlife habitat would likely decrease in value resulting in lower HSI and HU values as compared to the baseline numbers. Under the no action conditions, the expansion of invasive and exotic species would be the primary reason for the decline in habitat value over the 50-year project life.

SECTION 4.0
ENVIRONMENTAL RESTORATION MEASURES

4.0 ENVIRONMENTAL RESTORATION MEASURES

Numerous environmental restoration measures were identified and considered during the planning stages of the restoration project, including the implementation of no measures, or the No Action Alternative. Each measure considered was then evaluated to determine if it met the planning objectives discussed in Section 3. Additional criteria considered included Local Sponsor input and support, reasonableness of project cost, professional judgments, and environmental benefits.

4.1 EXCLUDED MEASURES

Four measures were considered for the restoration project, but excluded from further analysis. The four measures considered were: 1) the reinforcement of Spring Lake Dam, 2) the removal of Spring Lake Dam, 3) the replacement of Spring Lake Dam, and 4) an alternative that would place an emphasis on reforestation efforts around Spring Lake and on the peninsula. Background information regarding the status and current condition of the Spring Lake Dam was collected and compiled by USACE geotechnical personnel. This initial information was used during the plan formulation phase to identify project constraints and determine the feasibility of including proposed Spring Lake Dam measures for eventual project implementation. Due to identified project constraints associated with the Spring Lake Dam, these measures were excluded from further consideration in the planning process, and the Spring Lake Dam was removed from the proposed project. This information has been provided to the non-Federal cost share partner and the TCEQ for consideration of potential compliance/corrective actions and dam safety issues regarding the Spring Lake Dam

4.1.1 Reinforce Spring Lake Dam

The dam reinforcement measure would have strengthened and capped the top and downstream slope of the dam between the east and west spillways as well as the area between the east spillway and the shoreline. Strengthening measures would consist of removing all trees and vegetation from the downstream slope of the dam and removing exotic trees along the crest of the dam. An inverted filter with riprap protection would be constructed on the downstream slope of the dam (with the exception of the area strengthened during the 2001 FEMA repairs). The downstream slope of the existing embankment would be covered with filter material and a 6-inch perforated drainage pipe would be embedded near the bottom of the embankment. The

filter would be covered with coarse gravel and riprap would be used to protect the natural area immediately downstream from the embankment. Geotechnical and engineering concerns that were identified regarding the dam's stability prevented further consideration of the reinforcement of Spring Lake Dam. Primarily, the measures proposed in the reinforcement of the dam would not meet USACE or State of Texas dam safety standards to ensure the long-term stability of the structure for safety to the public. Thus, this would expose the USACE to a potential liability throughout the project life.

4.1.2 Remove Spring Lake Dam

The idea to remove the impoundment structure at Spring Lake and the San Marcos River headwaters was considered as a possible restoration measure for this project. The intent of removing this structure was to eliminate the obstruction from the San Marcos River and return the system to an open, unimpeded riverine environment. However, the opinion of the TPWD, the USFWS, and TxSt is that removal of this structure would result in major short- and long-term adverse impacts to the local ecosystems of the lake and river. In addition, dam removal would expose many cultural resource sites in the lake bottom and behind the existing dam. Implementation of this measure would result in major controversy within the San Marcos community and environmental organizations across the state and would require the preparation of an Environmental Impact Statement to address potentially significant, adverse impacts. Cost estimates for dam removal indicate this action would exceed budget allowances for a Section 206 project. Due to the potential adverse impacts to the natural environment, costs, and the potential for controversy, this measure has been eliminated from any further consideration.

4.1.3 Replace Spring Lake Dam

A third measure considered was the replacement of the existing dam with a new zoned earth and rock filled structure that would have the ability to control water releases for Spring Lake. The spillways would be replaced with manually operated sluice gates. It is thought that any substantial work on the spillways and impoundment structure would adversely impact both cultural resource sites near the dam and threatened and endangered species and their habitats. Although detailed plan formulation has not been conducted, it is thought that the high cost associated with this option would prevent funding opportunities through the Section 206 process.

4.1.4 Bottomland Hardwood Restoration

The other measures considered for this project include removing all man-made facilities associated with the Aquarena Center and restore the area with native grass, shrubs, and trees (reforestation efforts would include bottomland hardwood species and fruiting shrubs); and construction of a 2-acre emergent wetland. The restoration of a bottomland hardwood community on the peninsula would have a negative effect on threatened and endangered species, particularly the fountain darter. The trees would provide roosting habitat for wading birds, which serve as intermediate hosts to a trematode that is a parasite of one of the Federally listed endangered species of the San Marcos ecosystem. In addition, cultural resources located close to the ground surface would be disturbed during planting. The construction of a 2-acre wetland area would increase the area of the 100-year floodplain and impound water off TxSt's property. Due to the potential adverse impacts to the natural environment, protected species, and cultural resources, this restoration measure has also been eliminated from any further consideration.

4.2 SELECTION OF RESTORATION MEASURES

After elimination of measures having unacceptable impacts, five possible measures, were carried forward for cost-benefit analysis. Each of these measures is independent of the others, meaning each can serve as a stand-alone plan.

- Measure A - Removal of Structures on Hill
- Measure B - Removal of Structures on Peninsula and Grassland Restoration
- Measure C - Removal of Exotics
- Measure D - Removal of All Submerged Structures
- Measure E - Establishment of Vegetated Buffer Zone

Measure B includes both removal of peninsular structures and grassland restoration. These two actions were not evaluated separately because they were not considered independent. Without the establishment of vegetation, soils exposed after the removal of structures and hard surfaces on the peninsula would be subject to severe erosion. Erosion of these soils would both contaminate aquatic habitats and potentially expose valuable cultural resources. Each measure requires a relatively high initial cost associated with the mobilization of special equipment. Thus, each measure is evaluated at only two scales, the no action scale and the action scale.

4.3 REMOVAL OF STRUCTURES ON HILL (MEASURE A)

Select structures to be demolished and removed from the hill are two skyline towers and appurtenant structures, a vendor building, a ticket booth, and the observation tower (Figure 4-1). All terrestrial demolition would remove the structures and their foundations: no excavation or removal of pipes or buried utilities would occur as part of the project. Utilities that are no longer needed would be capped and services would be shut-off.

The steps required to remove and demolish the terrestrial structures are:

1. Demolish the buildings and parking areas located on land
2. Load pieces of buildings and parking areas onto trucks for disposal
3. Disassemble tower structures and dispose
    a. Using a very large crane (boom exceeding 200 feet in length), disassemble the tower starting at the top
    b. Load tower pieces onto trucks and haul tower pieces away

The following is a best estimate of the type of equipment to be utilized as part of the demolition and removal activities; however, the type of equipment to be used is at the discretion of the selected contractor:

- 35-ton Truck Mounted Crane
- Front End Loader, Wheel Type, 1.5 cubic yards (CY), 85 horsepower (HP)
- Tractor, Dozer (D8), 335 HP
- Dump Trucks, 3-axle, 240 HP, 12 CY
- Air Compressor, 175 cubic feet/minute (CFM), 54 HP
- Jackhammers, Paving Breakers, 50 CFM
- Broom, 7 Ft Towed, Mechanical Drive, Sprinkler

4.4 REMOVAL OF STRUCTURES ON PENINSULA AND GRASSLAND RESTORATION (MEASURE B)

Removal of Structures on the Peninsula

Demolition activities proposed for the Aquarena Center area would include removing most structures and associated hard surfaces (Figure 4-2). Select structures and hard surfaces to be removed includes the gift shop, administration office, restaurant, turtle building, tent pavilion, the

Figure 4-1: Measure A: Removal of Structures on the Hill

GSRC

December 2005

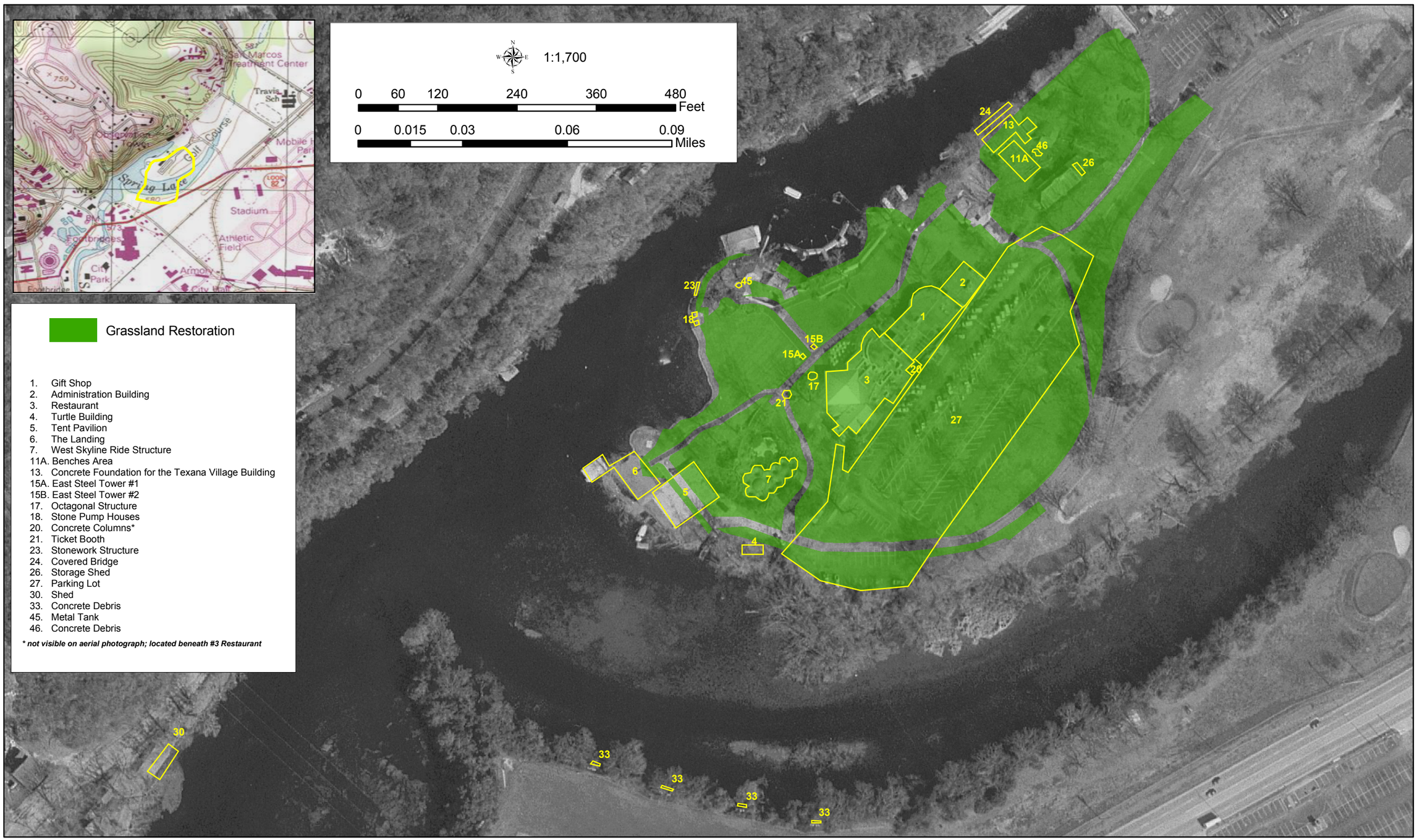


Figure 4-2: Measure B: Removal of Structures on Peninsula and Grassland Restoration

GSRC

December 2005

landing, shed, covered bridge, storage shed, Texana Village building foundation, two skyline towers and an associated structure, bench area, fences, parking lots, sidewalks, stone pump houses, concrete debris, steel tank, saloon/barbershop/general store, and blacksmith shop (Appendix H). The equipment used and steps taken to demolish and remove structures on the hill would be the same as those for structures on the hill.

Grassland Restoration

Upon the removal of the proposed buildings, pavement, and exotic Bermuda grass and existing turf, the remaining soil would be prepared to a maximum depth of 6 inches for native seeding. Areas limited by cultural resources considerations would be excluded from soil preparation. Because of the likelihood of encountering cultural resources during demolition operations, an archeologist would be present for monitoring during all excavation and soil preparation activities.

Once the ground is prepared, a mixture of compost and topsoil would be applied over the surface. Native grass/cover crop seed mixtures would be drilled into the rolled soil as indicated in the planting plan (Appendix I). Recommended seeding rates would be based upon suggested Natural Resources Conservation Service (NRCS) rates. All treated areas would be temporarily fenced to restrict access until vegetation is established. Mowing would be used to control annual forbs and to prevent cover crop seed production; mowing height would be restricted to a minimum of 6 inches. Grasses would be drilled during the early spring season. Wildflowers would be drilled onto the site during the early fall period of the first year. Tall-grass riparian areas would be clipped as needed to reduce wildfire hazards. Irrigation and chemical fertilizers would not be used to reclaim the site. These management features tend to promote undesirable weed competition and shift ecological processes toward exotic plant species such as Bermuda grass. Appropriate best management practices (BMPs) and mitigation measures would be implemented to prevent erosion and subsequent pollution of aquatic habitats.

4.5 REMOVAL OF EXOTICS (MEASURE C)

The Aquarena Center has numerous, complex problems with exotic plant species ranging from aquatic to ornamental shrubs and trees. Recommendations by the NRCS would be used to control exotic tree species. Exotic shrubs and trees on the site include Chinese tallow tree, chinaberry, ligustrum, and several species of palms. Individual removal and chemical stump treatment would be used to remove all exotic trees and shrubs within the project area (Figure

4-3). Exotic debris would be shredded and removed from the site for proper disposal. The removal of exotic and invasive aquatic plants, such as elephant ear, will not be addressed with this project. The City of San Marcos is in the process of addressing exotic aquatic species through a City Master Plan. Chemical herbicides would not be used because of endangered plant and animal species concerns. Undesirable vegetation would be controlled by hand removal or mowing.

4.6 VEGETATED BUFFER ZONE (MEASURE D)

This measure includes the establishment of a vegetated buffer zone between the restoration area, Spring Lake, and the existing golf course, with the goal of improving water quality by filtering stormwater runoff and creating riparian habitat (Figure 4-4). This measure would create a vegetative buffer zone protected by post and cable fencing around the restoration area and Spring Lake. The buffer zone would have an average width of 75 feet. In areas where fairways cross the lake, the vegetative buffer zone would be approximately 20 feet wide and be marked as off-limits to golfers. Fenced buffer zone areas would be allowed to re-vegetate naturally with native woody, grass, and forbs species. Invasive and exotic woody vegetation would not be allowed within fenced fairway areas.

4.7 REMOVAL OF SUBMERGED STRUCTURES (MEASURE E)

Submerged structures to be removed include a submarine theater, miscellaneous debris (volcano wall, concrete lily pads, and other diver training structures), and an unidentified, concrete and metal structure (Figure 4-5). The submarine theater was used to lower dozens of people seated in the structure to a point 6 to 8 feet below the water surface so that the people could observe the underwater shows. The theater structure was filled with concrete 2 to 4 feet thick beneath the seats to provide the weight (ballast) necessary to sink the theater.

A plan to remove these structures has been devised to limit impacts to the lakebed and shoreline and to reduce turbidity resulting from these disturbances. The plan includes a system of barges used as platforms for support of a crane and disassembly operations. When the structures are brought to the surface, they would be placed on this group of barges for disassembly and the barges would then be pulled to shore. The submarine theater is filled with water and may need to be drained as it is brought to the surface. The crane would transport the pieces to trucks and the debris would be hauled to an offsite disposal area. A large, industrial

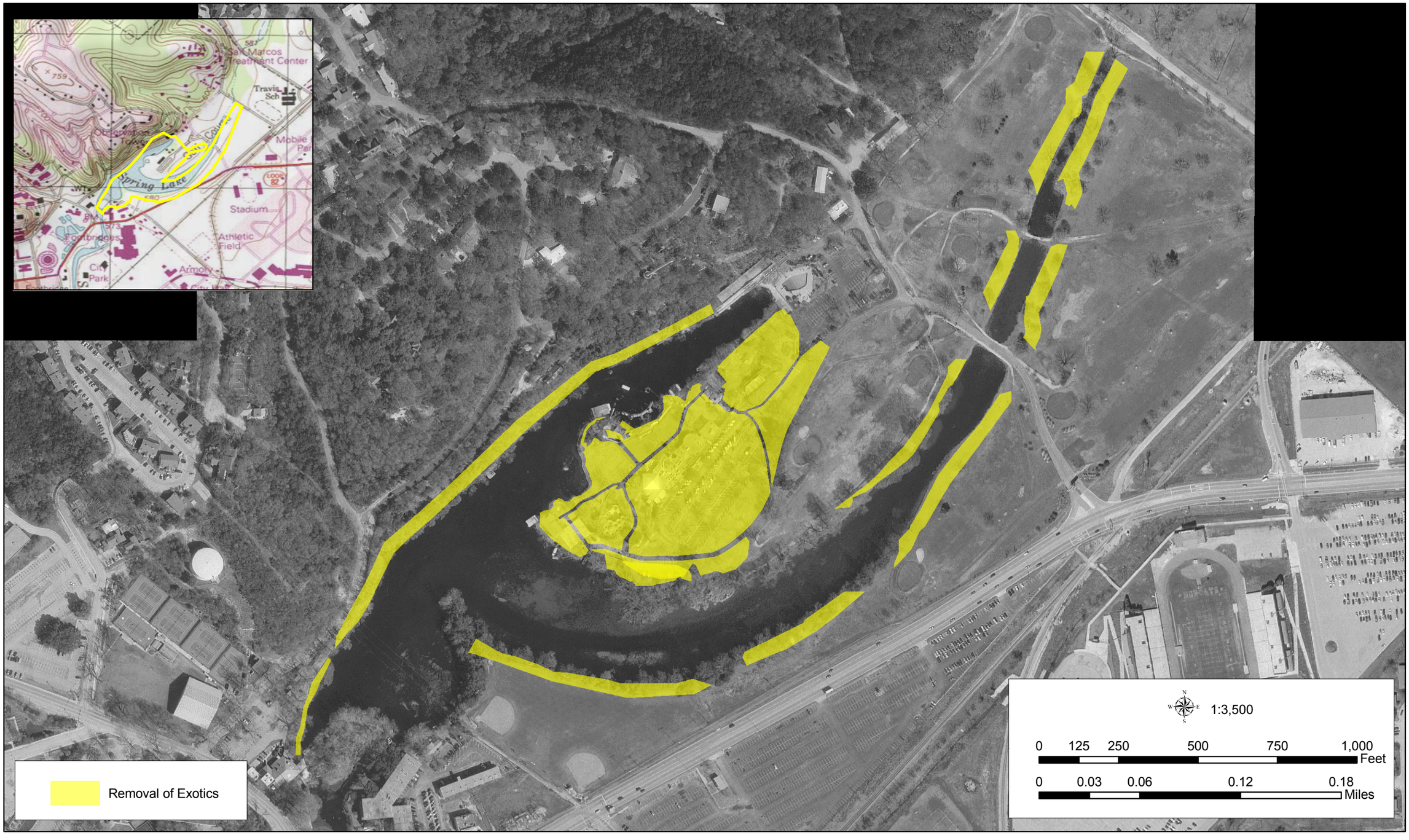


Figure 4-3: Measure C: Removal of Exotics

GSRC

December 2005

Figure 4-4: Measure D: Establishment of Vegetation Buffer Zone

GSRC

December 2005

Figure 4-5: Measure E: Removal of All Submerged Structures

GSRC

December 2005

THIS PAGE LEFT INTENTIONALLY BLANK

outboard motor would probably be adequate to maneuver the barges, since very little maneuvering should be required. The best location for loading and offloading the barges, crane, and debris would be at the “Landing Site” area. This site has good bank slope and adequate water depth to load and unload equipment and debris. Following loading and unloading at the “Landing Site” area, the shoreline may need to be strengthened with a temporary barge ramp to protect the shoreline. Removal of the submarine theater and underwater structure would be completed with silt curtains to restrict sediment to the immediate vicinity of the theater. A floating boom, or similar device, located upstream of the dam would be used to collect and remove any vegetative fragments created during demolition activities.

The steps necessary to remove the submerged structures are:

1) Remove the underwater structure
    a) Assemble an equipment barge
    b) Mount a 45 to 60 ton crane on the equipment barge
    c) Assemble another deep deck barge
    d) Launch barges at the “Landing Site” area
    e) Using a crane, lift the sunken structure pieces and place on second barge
    f) Maneuver barges (using large industrial outboard motors) to the “Landing Site” area and offload pieces onto trucks
    g) Remove any other miscellaneous sunken material using cranes and barges - where necessary divers would assist by cutting and disassembling pieces underwater

2) Remove the submarine theater structure from the water using the same floating barge and crane
    a) Place structure on three or more floating barges for draining, ballast removal and disassembly
    b) Transport submarine theater pieces to shoreline and unload onto trucks for disposal

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 5.0
INCREMENTAL COST ANALYSIS

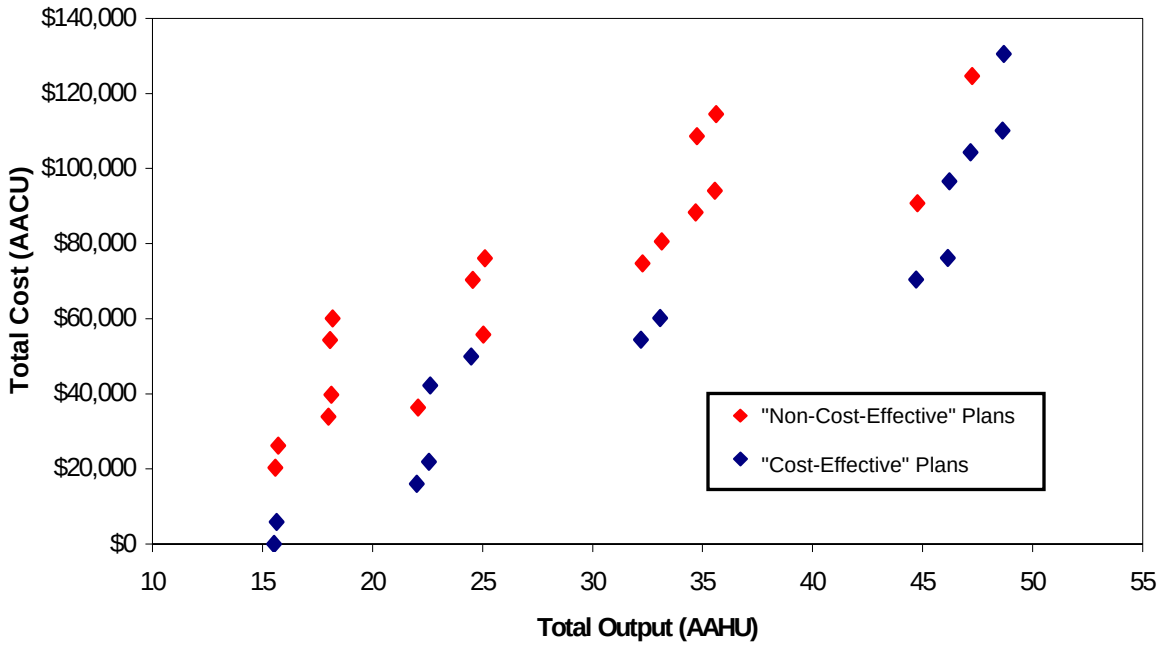
5.0 INCREMENTAL COST ANALYSIS

5.1 INCREMENTAL ANALYSIS

The guidelines in the Evaluation of Environmental Investments Procedures Manual (Robinson et al. 1995) and Incremental Cost Analysis (ICA) procedure techniques were used to determine the most cost effective restoration alternatives or plans. Proposed restoration alternatives were evaluated in terms of incremental cost per habitat unit based on Total AAHUs and Total Average Annual Cost Units (AACUs). The ICA procedure evaluated the multiple combinations of restoration measures to develop alternatives or plans that are cost effective and incrementally justified (i.e., best-buy plans). Best-buy alternatives or plans were then evaluated using tabular and graphical summaries for consideration of costs and benefits not accounted for in the HEP and ICA analyses to determine the NER or Recommended Plan for the study. Tabular and graphical summaries of this analysis are provided in Appendix J.

Alternative formulation was performed using the "assemble all possible combinations of management measures" approach. Cost and output were evaluated for each of the 32 possible combinations of the five proposed management measures including the No Action Plan, or implementation of no measures. Cost was measured in AACUs, which included costs related to lands, easements, right-of-ways, relocation and disposal areas (LERRDS); general construction; post project monitoring; support and administration (S&A); contingency; and operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) (Appendix K). Output was measured in AAHUs as assessed using the HEP analysis (see section 4.3.3). All plans were sorted by Total AAHU production to identify the cost-effective and non-cost-effective plans. Cost-effective plans are defined as those where greater output can be produced at a lesser or equal cost than previous plans. The ICA procedure identified 14 cost-effective plans from the 32 possible combinations of restoration measures (Figure 5-1).

Figure 5-1. Cost Effective versus Non-Cost-Effective Plans



The 14 cost-effective plans where then evaluated based on incremental cost per unit output (i.e., incremental AACU divided by incremental AAHU) to identify the best-buy plans. Best-buy plans are those, which have the lowest incremental cost per output at a given level of cost. Because the No Action Plan does not have an associated cost, it is identified as the first best-buy plan. Each successive plan is then compared to the No Action Plan until the next best-buy plan producing greater output per cost than previous plans is selected. Plans producing less output than the best-buy plan are removed from the analysis and the last identified best-buy plan becomes the baseline for comparison of successive plans. Selected best-buy plans can then be evaluated using tabular and graphical summaries for consideration of costs and benefits not accounted for in the HEP and ICA analyses.

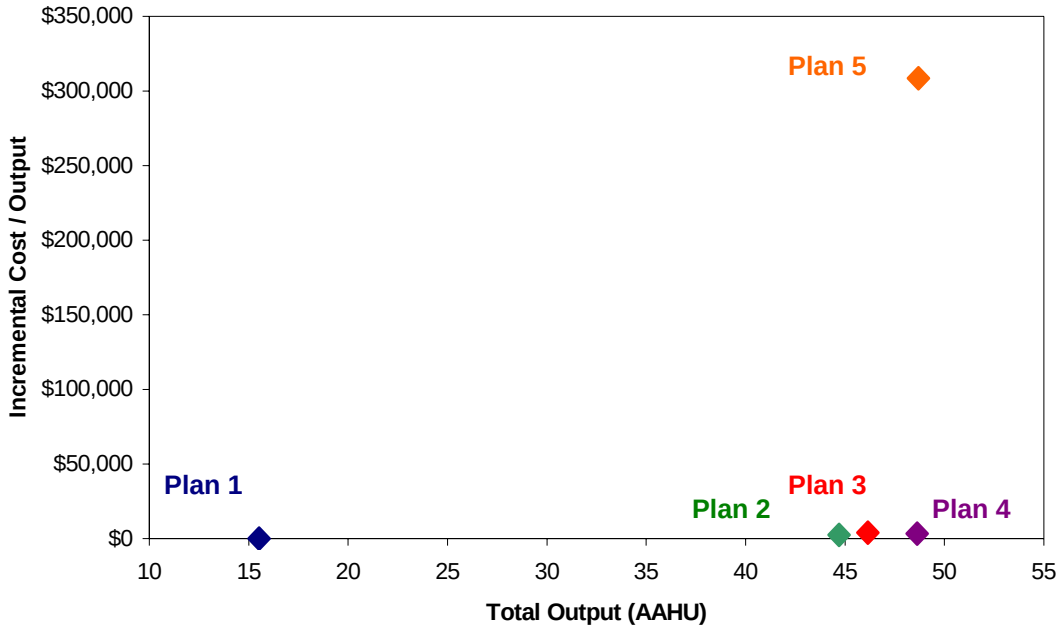
The ICA procedure identified five combinations of restoration measures that would be cost-effective and incrementally justified (i.e., best-buy plans). A summary of the restoration components in each of the best-buy plans is outlined below. Table 5-1 identifies the Total Cost, Total Output, Average Cost, Incremental Cost, Incremental Output, and Incremental Cost per Incremental Output for each best-buy plan. Figure 5-2 shows a graphical representation of Total Output and Incremental Cost per Incremental Output for all of the best-buy plans.

Table 5-1. Cost and Output Summary of Final Best-Buy Plans

Plan	Measure					Cost (AACU)	Output (AAHU)	Average Cost (AACU / AAHU)	Incremental Cost (AACU)	Incremental Output (AAHU)	Incremental Cost per Incremental Output
	A	B	C	D	E						
1	0	0	0	0	0	$0	15.52	$0	$0	15.52	$0
2	0	1	0	1	0	$70,397	44.70	$1,575	$70,397	29.18	$2,413
3	0	1	1	1	0	$76,223	46.15	$1,652	$5,826	1.45	$4,018
4	0	1	1	1	1	$110,149	48.63	$2,265	$33,926	2.48	$13,680
5	1	1	1	1	1	$130,517	48.69	$2,681	$20,368	0.06	$339,467

A = Removal of Structures on the Hill
B = Removal of Structures on the Peninsula and Grassland Restoration
C = Removal of Exotics
D = Golf Course Vegetation Buffer
E = Removal of Submerged Structures

Figure 5-2. Final Best-Buy Plans



Plan 1 – The No Action Plan or future, without project alternative. Under this alternative, none of the proposed restoration measures would be implemented. Study area conditions would likely remain in their degraded status and existing habitats would provide approximately 15.52 AAHUs over the project life.

Plan 2 – This plan would consist of implementation of the two most cost effective restoration measures: restoration on the peninsula and creation of the golf course vegetation buffer zone. Peninsula restoration would consist of demolishing the majority of existing structures located on the peninsula, followed by short and tall grass plantings. The golf course vegetation buffer zone would consist of post and cable fencing to establish a 75-foot wide vegetation buffer zone between existing golf course fairways and Spring Lake. Implementation of this restoration plan would increase AAHUs from 15.52 to 44.70.

Plan 3 – Would include implementation of Plan 2 above with the addition of the removal of exotic vegetation, restoration measure. This plan would include all of the habitat restoration measures in Plan 2 with the added benefit of individual removal of all exotic trees and shrubs within the study area. Implementation of restoration Plan 3 would provide an additional 30.63 AAHUs above the No Action Plan.

Plan 4 – This plan would include all of the restoration measures in Plans 2 and 3 above with the addition of the removal of submerged structures within Spring Lake. Removal of existing submerged structures would provide additional aquatic habitat to fish, salamander, and plant species within Spring Lake and potentially uncover aquifer vents located beneath the sunken structures. Plan 4 would provide an additional 33.11 AAHUs above the No Action Plan.

Plan 5 – This plan would include implementation of Plan 4 with the addition of the removal of structures on the hill restoration measure. This plan would involve demolition of the observation tower and skyline ride structures on the hill. Plan 5 would provide an additional 0.06 AAHUs as compared to Plan 4.

5.2 RECOMENDED PLAN SELECTION

Beginning with Plan 1, the No Action Plan, each successive plan requires additional cost over the previous plan. One means of identifying the most cost effective plan is to ask "Is it worth it?" of each plan in relation to the previous plan. When compared to Plan 1, Plan 2 provides an additional 29.18 AAHUs at an incremental cost per incremental output of $2,413 (see Table 5-1). These additional AAHUs would come from gains in meadowlark, cottontail, and mink habitat provided by the restoration of the peninsula and vegetated buffer zone. This plan provides further benefits not accounted for by the ICA process by reducing the amount of polluted storm water

affecting water quality in Spring Lake. Thus, we determine that, "Yes, 29.18 AAHUs and improved water quality is worth an incremental cost/output of $2,413."

When comparing Plans 2 and 3, we can see that Plan 3 provides only 1.45 AAHUs above Plan 2 at an incremental cost/output of $4,018 (see Table 5-1). These additional AAHUs would come from gains in habitat for the cottontail, bobwhite, and mink due to removal of exotic terrestrial vegetation within the study area. Removal of exotic trees and shrubs also improves the stability of terrestrial habitats while eliminating a source of exotic propagules that could affect adjacent and downstream habitats. Due to the benefits to threatened and endangered species within the study area, the Local Sponsor, USFWS, and TPWD are extremely supportive of this restoration measure. The additional 1.45 AAHUs and improved habitat stability provided by Plan 3 is worth the $1,605 increase in incremental cost/output over Plan 2.

When comparing Plans 3 and 4, we can see that Plan 4 provides only 2.48 AAHUs above Plan 3 at an incremental cost /output of $13,680 (see Table 5-1). These additional AAHUs would come from gains in habitat for aquatic fish, salamanders, and plants due to removal of submerged structures and debris within Spring Lake. Removal of the degrading structures would also improve local water quality by removing a contaminant source from the lake; increase local aesthetics; and increase navigational safety of boats in Spring Lake. There is also the opportunity to uncover aquifer spring vents that lie under the submerged structures, which would provide additional habitat for four of the five threatened and endangered species occurring in Spring Lake. Based on the additional benefits, the true “worth” of Plan 4 is not adequately captured or accounted for through the ICA. Therefore, the additional 2.48 AAHUs and additional benefits provided by Plan 3 are worth the $9,662 increase in incremental cost/output over Plan 3.

While there is no rule for selecting the most cost effective plan, decisions are generally based on output targets, output thresholds, cost limits, or curve anomalies. The first three criteria for decision making are not applicable to this project because there is no maximum or minimum required output and the most expensive plan is within budget constraints. Using curve anomalies to guide the decision process focuses the question "Is it worth it?" on plans that incur abrupt changes in the incremental cost curve represented in Figure 5-2.

One such curve anomaly can be seen in the incremental cost curve at the transition from Plan 4 to Plan 5 (see Figure 5-2). Plans 4 and 5 both include the removal of structures on the

peninsula/grassland restoration, the vegetated buffer zone, removal of exotics, and removal of submerged structures. However, Plan 5 also includes the removal of structures on the hill. The removal of structures on the hill provides a minor improvement in habitat suitability and/or habitat acreage for the cottontail, quail, and bobwhite. This plan also provides additional aesthetic benefits by removing large structures that are no longer functional. The removal of structures on the hill would increase available habitat by less than 1% and the average incremental cost per output was approximately 1500% greater than the average incremental cost per output of remaining plans. The additional 0.06 AAHUs and improved aesthetic benefits provided by Plan 5 are not worth the additional incremental cost/output of $325,787.

Although the incremental cost per AAHU associated with Plan 4 is higher relative to Plans 2 and 3, this plan has the greatest potential to improve habitat conditions not accounted for by the ICA process. The potential to improve water quality and create new Critical Habitat for Federally endangered species makes Plan 4 worth the added cost. Furthermore, the incremental cost/output of Plan 4 is substantially less than Plan 5, which is still within the budget constraints. Plan 4 is a cost effective plan, is incrementally justified, meets the restoration objectives of the study, and is within the limits established by the USACE under Section 206. Therefore, Plan 4 is identified as the NER or Recommended Plan in this study.

SECTION 6.0
RECOMMENDED RESTORATION PLAN

6.0 RECOMMENDED RESTORATION PLAN

The NER or Recommended Restoration Plan is Plan 4, which includes all proposed measures except the removal of structures on the hill. Measures included in the selected plan are: (1) removal of structures on the peninsula and grassland restoration, (2) removal of exotics, (3) establishment of a vegetated buffer zone, and (4) removal of all submerged structures. Plan 4 meets the study objectives and goals and is within the constraints specified in Section 3. Specifically, Plan 4 would achieve a reduction of stormwater runoff associated with structures, hard surfaces, and the golf course into Spring Lake, the creation of grassland, riparian, and lacustrine habitat, and the protection and restoration of riparian habitat.

6.1 COMPONENTS AND CONCEPTUAL DESIGN

The components and conceptual design for the Recommended Restoration Plan (Figure 6-1) would involve the removal of manmade facilities, both submerged and on the peninsula, associated with the Aquarena Center. Upon the removal of structures on the peninsula, the soils would be prepared, exotic shrubs and trees would be removed and the area planted with native grasses. An existing buffer strip of vegetation between the lake and golf course would be widened to 75 feet on average, and new riparian habitat would be created adjacent to Sink Creek and immediately below Spring Lake. The Recommended Restoration Plan would restore valuable aquatic and terrestrial habitat in the Spring Lake area, which has been degraded by the construction and operation of the Aquarena Center.

6.2 RECREATION COMPONENTS

Plans to enhance recreational opportunities around Spring Lake include construction of a rest room facility, new and rehabilitated trails, picnic tables and benches, traffic control gates, and signage. The proposed trail system would connect existing trails with the existing boardwalk and enhance the accessibility of the area. The recreational trail would be 8-foot wide consisting of cement-stabilized substrate or base material. Figure 6-2 identifies the location of proposed recreational features within the study area.

THIS PAGE LEFT INTENTIONALLY BLANK

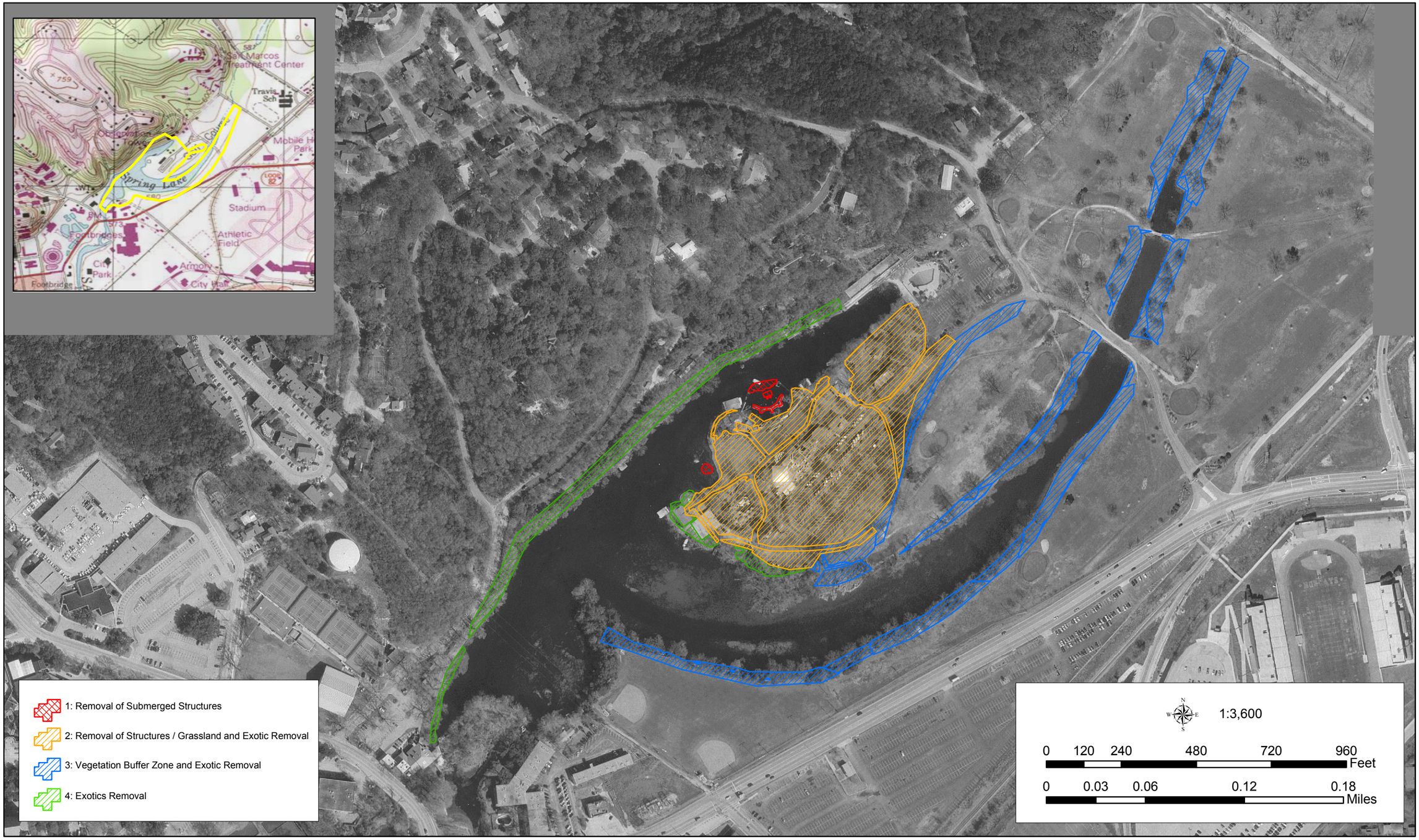


Figure 6-1: Recommended Restoration Plan

GSRC

December 2005

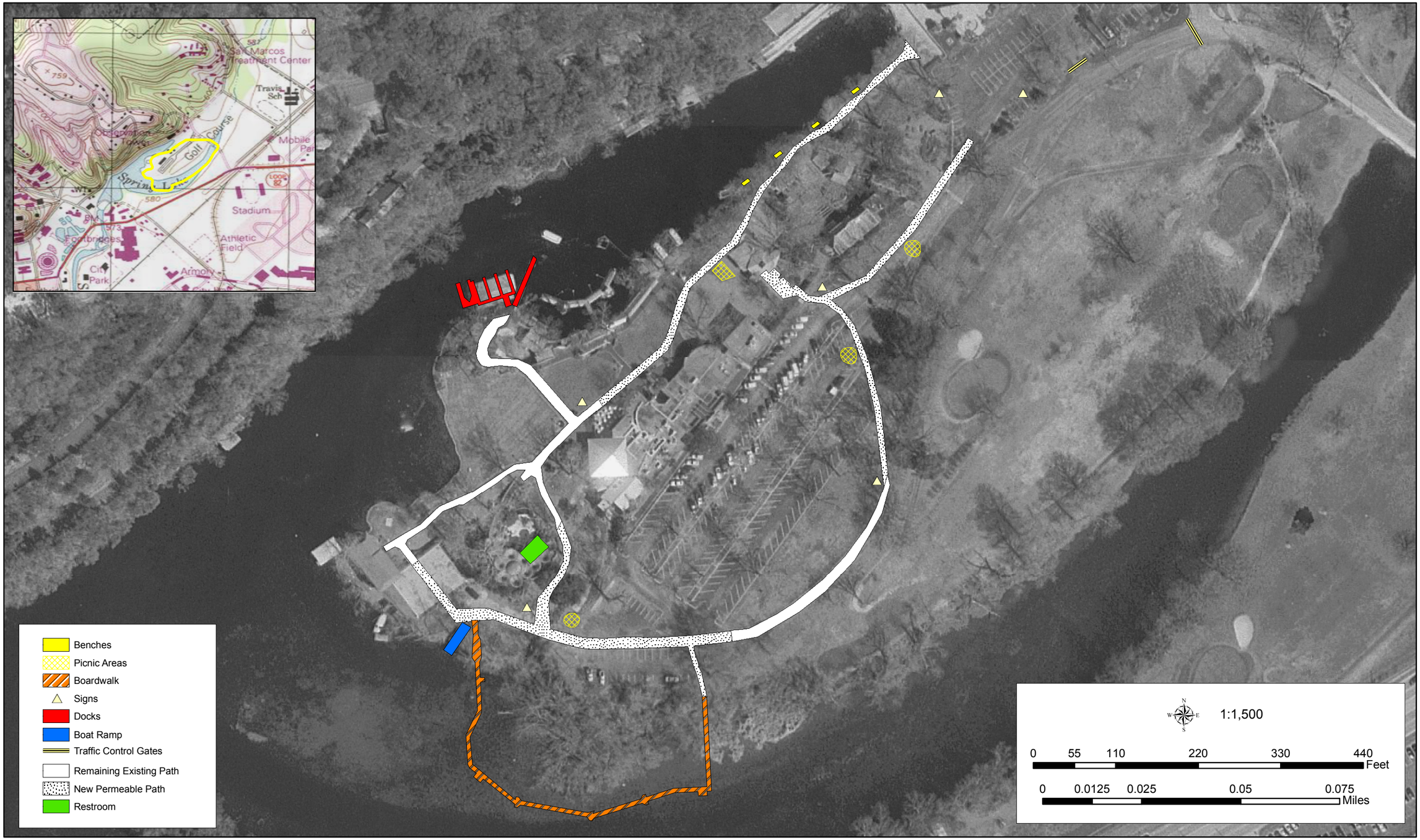


Figure 6-2: Recreational Features

GSRC

December 2005

The Local Sponsor supports the incorporation of the described recreational features into the recommended restoration plan. The proposed recreational features are compatible with the recommended restoration project and would serve the surrounding neighborhoods and region by providing non-consumptive recreational opportunities. The recreational features would not detract from the goals of the restoration plan and where possible, would utilize areas designated for operation and maintenance access. These features would function primarily for recreation purposes and would be cost shared at 50/50 percent (up to 10% of the total Federal restoration costs) between the government and the non-Federal, Local Sponsor per USACE guidance.

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

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

- are totally ancillary; i.e., project was not formulated solely for recreation;
- take advantage of the project's recreation potential;
- are not vendible;
- would not exist without the project.

Economic justification is based on an evaluation of competing facilities, existing and expected future use with and without the recommended plan, and unfulfilled demand. According to the TPWD, Texas Outdoor Recreation Plan (TORP) (TPWD 1990), which identifies population, usage, and demand trends within the region, including the study area, the demand for local recreation facilities, such as trails, is steadily increasing (TPWD 1990). Applying the appropriate participation rates to the population of potential users, the access would be used to capacity from the time it becomes available to the public through the period of analysis.

Based on 2000 USCB (USCB 2005) and TORP information, this type of trail would have approximately 3.4 user occasions and 118,092 visitors per year. Point values are then assigned based on selective criteria applicable to the proposed trail. The criteria and assigned points are:

- Several general activities; more than one high quality activity: 18 points
- None within 2 hour travel time: 16 points
- Adequate facilities to conduct without deterioration of resource: 7 points

- Fair access to site; good roads within site: 10 points
- Above average aesthetic quality: 9 points

60 points

The current unit day value for Fiscal Year 2005 is $7.15 for 60 points. Applying this value to 118,092 visitor-days per year results in a benefit of approximately $844,358 per year. Table 6-1 displays the costs associated with the recreational features and a summary of their expected annual costs and benefits.

Table 6-1. Economic Justification of Recreational Feature Costs

Feature	First Cost	Annual Cost	Annual Benefit	Benefit-Cost Ratio
0.76 Mile Trail	$84,160	$25,288	$844,358	33.4:1

Any construction, operations, or maintenance costs associated with project features that serve a purely recreational purpose would be assigned solely to recreation. Approximately 81% of the recreation costs (i.e., restrooms, picnic tables, benches, access control gates, and signage) would be assigned solely to recreational purposes and would provide a total recreation cost of $84,160 (Table 6-2). Project features required for ecosystem restoration (i.e., buffers, revegetation) would have their costs apportioned to ecosystem restoration. Installation and rehabilitation of the trail system would provide an ancillary ecosystem restoration benefit to the Local Sponsor by providing a project operation and maintenance route for vegetation management activities. Therefore, the remaining 19% of the recreation costs (i.e., pedestrian trail system) would be assigned as O&M access costs to ecosystem restoration and would increase the total ecosystem restoration costs $19,380 (Table 6-2).

Table 6-2. Summary of Overall Costs

Item	Cost ($)
Detailed Project Report	323,100
Plans and Specifications	
Design	230,000
HTRW	10,000
Cultural	50,000
Construction	
Ecosystem Restoration	880,114
Recreation	84,160
LERRDs	283,000
O&M Access	19,380
Post Project Monitoring	90,000
S&A and Contingency	413,528
Total	**2,383,282**

6.3 RESTORATION BENEFITS AND ACCOMPLISHMENTS

The Recommended Restoration Plan would provide benefits to 10 acres of terrestrial habitat, 9 acres of riparian habitat, and 22 acres of lacustrine habitat through improvements in water quality, removal of invasive species, and grassland restoration. It was estimated by using HEP, that the habitat conditions would improve by approximately 250% in 50 years under the "with project" conditions. The Recommended Restoration Plan would also provide additional benefits such as improved water quality, erosion reduction, expansion and connectivity of the riparian corridor, and improved wildlife viewing and education opportunities. The restoration project would protect and greatly improve habitat conditions for Federally listed species. Furthermore, there would be an overall improvement in the general aesthetics and safety of the natural areas surrounding the river. The recommended plan would accomplish the objectives and goals established in Section 3.

Improvements to and creation of additional habitat under the recommended plan has the potential to result in a net gain of approximately 23.5 grassland AAHUs, 7.0 riparian AAHUs, and 2.5 lacustrine AAHUs (Table 6-3). From an ecological standpoint, the recommended plan would provide much needed improvements to habitat quality and quantity, which can be used by a wide variety of species that depend on habitat created by the unique environmental conditions of Spring Lake.

Table 6-3. Estimated AAHUs with Implementation of the Recommended Plan

Evaluation Species	Output (AAHU)		
	Without Project	With Project	Net Change
Eastern meadowlark	0.01	5.85	5.84
Mink	1.47	8.52	7.05
Eastern cottontail	2.46	10.83	8.37
Northern bobwhite	2.46	11.83	9.37
Redear sunfish	9.12	11.60	2.48
TOTAL	**15.52**	**48.63**	**33.11**

6.4 DESIGN AND IMPLEMENTATION COSTS

The economic cost of the Recommended Plan includes estimates for construction, engineering and design, supervision and administration, and lands and damages, with allowances for contingencies. Using current material, equipment, and labor costs typical for work of this nature in the San Marcos vicinity, the USACE developed cost data. A summary of the cost associated

with completing the Recommended Restoration Plan is presented in Table 6-4 below. These costs include land acquisition, general construction, post project monitoring, S&A and contingency, and OMRR&R costs. The S&A and contingency is equal to 33% of the total construction cost. Annual OMRR&R is based on a 50-year project life and was also included in the ICA. A 19-month construction period for this project was assumed for the purpose of determining the total investment. A detailed presentation of the project costs is included in Appendix K, Cost/Specifications, of this report. The estimate of first costs is based on 2003 prices.

Table 6-4. Summary of Implementation and OMRR&R Costs by Measure

Cost Item	Measure B Demolition/ Grassland	Measure C Remove Exotics	Measure D Riparian Buffer	Measure E Remove Submerged
LERRDs	$140,731	$31,368	$109,094	$1,807
General Construction	$416,967	$16,900	$46,745	$399,502
Post Project Monitoring	$50,000	$10,000	$30,000	--
S&A and Contingency	$200,540	$19,229	$61,327	$132,432
Total Construction	**$808,239**	**$77,497**	**$247,165**	**$533,741**
Total OMRR&R	**$150,000**	**$45,000**	**$25,000**	**$0**
Annual OMRR&R	**$3000**	**$900**	**$500**	**$0**

6.5 REAL ESTATE CONSIDERATIONS

The subject property is located within the City of San Marcos, which was formally part of the Aquarena Center Amusement Park. TxSt owns the project land, which totals 16.6 acres. This area is no longer in use, and would be restored to its natural habitat. The restoration measures would provide significant benefits to the aquatic and terrestrial habitat, including the habitat of five Federally listed species.

Property values included in the cost estimate are based on a Gross Appraisal prepared by Randy Roberts and approved by Rocky Lee, MAI, SRA, Real Estate Division, Fort Worth District. A real estate value of $283,000 was estimated for the project area with contingencies. The total real estate value was based on the TxSt fee ownership of 16.6 acres at a value of approximately $16,627 per acre. The cost-share for this restoration project is 65% Federal and 35% Local Sponsor. The Real Estate Plan is located in Appendix L.

6.6 MONITORING CONSIDERATIONS

Following the completion of construction, a monitoring and adaptive management plan would be initiated. Monitoring and adaptive management activities would occur over a period of up to 5 years. The monitoring plan would allow for modifications and adjustments to the restoration plantings as necessary until restored areas become self-sustaining. The construction contractor would guarantee the success of the restoration measures during this monitoring period. The monitoring plan would allow for adaptive management due to unforeseen obstacles, provide a basis for evaluation of management practices, and provide a reference for future restoration plans.

Minimal site maintenance is anticipated for the Spring Lake Restoration project. No manipulation of Spring Lake's water level would be necessary as part of the site maintenance or management. The construction contractor would conduct an initial 2-year program for the removal of invasive, non-native vegetation. Following the initial removal of invasive vegetation, the Local Sponsor would be responsible for removal of any new exotic vegetation that appears during the project life. The presence of undesirable non-native plant species would be assessed annually and identified plant species would be removed by hand. Care would be taken not to disrupt or remove native plants; therefore, maintenance personnel would be trained to differentiate between native and non-native species. No herbicides would be used for the control of invasive plants during the construction or maintenance and management period. All invasive plant control would occur before seeds set, to the extent possible.

During the plant establishment period, a temporary chain-link fence would be installed to protect newly planted vegetation on the peninsula from pedestrian damage. Therefore, the temporary fence would be removed after plants are established. During this establishment phase, the fence would be checked periodically for damage and repaired when appropriate. Following construction and establishment of vegetation, the Local Sponsor would be responsible for periodic replacement, mowing, watering, and general care of vegetation plantings.

Following the construction and establishment periods, the USACE would utilize long-term habitat assessment techniques to determine the post project success of the restoration effort. Throughout the project life, the USACE and Local Sponsor would evaluate the success of the golf course buffer zone, peninsula vegetation plantings, and exotic vegetation removal. The

USFWS would assist in post-project habitat assessments through the use of HEP analysis. It is anticipated that the HEP analysis would occur approximately 5 to 10 years following completion of construction. Additional HEP assessments could be used throughout the project life to further evaluate project success and recommend adaptive management techniques to maintain optimal habitat conditions.

6.7 OPERATION AND MAINTENANCE CONSIDERATIONS

The Local Sponsor would assume all long-term project operations, maintenance, repairs, replacements, and rehabilitations following completion of construction and establishment of monitoring activities. Estimated annual operations and maintenance costs totaling $4,400 would include $3,000 per year for maintenance of grassland vegetation, $900 per year for management of exotic species, and $500 per year for operation and maintenance of the golf course buffer zone.

The operation and maintenance schedule would vary by season and necessity and should include, but not be limited to the following activities: 1) removal of debris from access paths in flood prone areas; 2) periodic mowing of the grassland area to promote stand health; 3) annual assessment and removal of invasive and exotic species within the project area; and 4) maintenance of the recreational features and the post and cable fencing within the golf course buffer zone. The shrub and grass species were specifically selected because they are native to the region and are expected to grow with minimal maintenance.

SECTION 7.0
ENVIRONMENTAL EFFECTS

7.0 ENVIRONMENTAL EFFECTS

This section of the DPR/EA describes the potential impacts of the various alternatives on the human and natural environment. An impact (consequence or effect) is defined as a modification to the human or natural environment that would result from the implementation of an action. The impacts can be either beneficial or adverse, and can be either directly related to the action or indirectly caused by the action (secondary, indirect, or synergistic effects). The effects can be temporary (short-term), long lasting (long-term), or permanent. For purposes of this DPR/EA, temporary effects are defined as those that would last less than 3 years after completion of the action. Long-term impacts are defined as those that would last 3 to 20 years. Permanent impacts would require an irretrievable commitment of resources.

Impacts can vary in degree or magnitude from a slightly noticeable change to a total change in the environment. The significance of the impacts presented in this DPR/EA is based upon existing regulatory standards, scientific and environmental knowledge, and/or best professional opinions of the authors of the DPR/EA. The significance of the impacts on each resource will be described as either significant, moderate, insignificant (or negligible), or no impact. Significant impacts are those effects that would result in substantial changes to the environment (as defined by 40 CFR 1500-1508) and should receive the greatest attention in the decision-making process. All impacts described in the following sections are considered to be adverse, unless stated otherwise.

The following discussions describe and, where possible, quantify the potential effects of each viable alternative on the resources within or near the project area. These discussions are presented in the same sequential order as they appeared in Section 2 for each alternative carried forward for analysis. Climate and geology would not be affected by, or affect the recommended plan and are not discussed.

7.1 SOILS

7.1.1 Recommended Restoration Plan

Some temporary disturbances would occur to soils while the Aquarena Center and associated paved areas were demolished and removed from the project area. These impacts are expected to be temporary in nature due to the restoration activities, such as re-seeding the area, once the

buildings and pavement are removed. This alternative would restore approximately 9.4 acres of soils to their natural condition by removing structures and pavement overlying them providing long-term beneficial impacts to soils.

7.1.2 No Action Plan

During site visits, there were no signs of erosion or soil loss attributable to the existing conditions of the project area. Under the No Action Plan, the parking lot, buildings and other structures, and exotic species would not be removed from the project area and there would be no disturbance to soils.

7.2 SURFACE WATERS AND OTHER AQUATIC RESOURCES

7.2.1 Recommended Restoration Plan

There is a potential for surface waters to be temporarily impacted during demolition and removal activities on the peninsula and during the removal of exotic shrubs and trees around Spring Lake. During the implementation of these measures, approximately 15 acres of soils would be temporarily exposed and susceptible to erosion, especially during large rainfall events. With the implementation of BMPs, which would be defined by a Storm Water Pollution and Prevention Plan (SWPPP) to be prepared for the project, the potential for sediments to enter the lake through runoff and pollute surface waters would be minimized. There is also potential for the removal of the submerged structures to increase turbidity in the immediate vicinity. This temporary effect would be kept to a minimum through the use of a silt curtain and other mitigation measures discussed in Section 8.

The Recommended Restoration Plan would have beneficial effects to Spring Lake and the San Marcos River. The degrading terrestrial and submerged structures and 9.4 acres of hard surfaces associated with the Aquarena Center would be removed from the peninsula, and the runoff of polluted stormwater into Spring Lake would be alleviated. The creation of a vegetated buffer zone between Spring Lake and the golf course would filter out chemicals that may be found in runoff flowing into Spring Lake and downstream into the San Marcos River.

Ground water in the project area would also benefit from the Recommended Restoration Plan. Contaminants from the degrading Aquarena Center would no longer leach into the soil and potentially pollute ground water resources.

The removal of Aquarena structures and the creation of a vegetated buffer zone would increase the storage of floodwaters within the 100-year floodplain resulting in negligible, beneficial effects as the potential for flooding downstream is reduced. Removal of the submerged structures would occur within jurisdictional Waters of the U.S, but would not require and material to be dredged or involve any filling. Therefore a Section 404 permit would not be required.

7.2.2 No Action Plan

Under the No Action Plan, surface and ground water would continue to be affected by stormwater runoff. The potential for the degrading Aquarena Center to contaminate Spring Lake, downstream reaches of the San Marcos River, and ground water would remain. Runoff from the surrounding golf course would continue to flow into surface waters.

7.3 WILDLIFE HABITATS

7.3.1 Recommended Restoration Plan

Temporary impacts to aquatic wildlife habitats, such as increased turbidity, are expected from the Recommended Restoration Plan. During the removal of submerged structures, turbidity is expected to increase in aquatic habitat occupied by Federally protected species. Silt screens would be used during the removal to limit the affected area to about 5,000 square feet. Increased turbidity in the vicinity of the submerged structures is considered to be insignificant due to the limited extent of proposed activities.

During the removal of terrestrial structures, 9.4 acres of the peninsula would be highly susceptible to erosion, and uncontrolled runoff from these areas could result in increased turbidity in aquatic habitats throughout Spring Lake. However, BMPs would prevent runoff from polluting Spring Lake during rain events; thus, any impacts resulting from demolition activities on the peninsula are considered to be insignificant.

The Recommended Restoration Plan would also include the removal of exotic shrubs and trees in approximately 15 acres of terrestrial and riparian habitats. These habitats would be temporarily disturbed, and the impacts would be insignificant because all areas would be immediately revegetated with native plants.

The Recommended Restoration Plan would have beneficial effects to both aquatic and terrestrial wildlife habitats. The removal of the submerged structures would restore 4,600 square feet of aquatic habitats supporting Federally protected species and potentially restore spring openings used by these species. The peninsula would be planted with native grassland species that would reduce the amount of polluted runoff entering aquatic habitats, benefiting aquatic species, and would create 9.4 acres of terrestrial habitat that would be beneficial for many faunal species. The proposed vegetated buffer zone between the golf course and Spring Lake would serve as a filter for any chemicals that may flow into Spring Lake from the golf course, protect existing riparian habitats, and create additional 5.3 acres of wildlife habitat. As demonstrated by the HEP analysis, the Recommended Restoration Plan would provide an additional 33.11 AAHUs benefiting all species used in the model and their representative guilds.

Removing exotic shrubs and trees from areas adjacent to Spring Lake would eliminate the seed source for these invasive species and allow native species to inhabit the area, and enhance riparian areas around the lake. The removal of non-native species seed source would potentially benefit the entire San Marcos River.

7.3.2 No Action Plan

Under the No Action Plan, aquatic wildlife habitats would continue to be polluted by stormwater runoff, existing terrestrial riparian habitats would remain unprotected, and exotic shrubs and trees would continue to compete with native species. The continued degradation of terrestrial and submerged structures would reduce the long-term water quality for aquatic species in Spring Lake.

7.4 ENDANGERED AND THREATENED SPECIES

7.4.1 Recommended Restoration Plan

The Recommended Restoration Plan would potentially disturb approximately 10,000 square feet of aquatic habitat near spring openings in the lakebed around the submerged structures. Texas-wild rice is found below the dam and would not be directly affected by the project, and a temporary boom would be placed along the spillway to preventing the accumulation of vegetative debris in Texas-wild rice habitat. The restoration project would adversely affect the San Marcos salamander and fountain darter and would result in the take of up to 732 San Marcos salamanders and 965 fountain darters during the removal of submerged Aquarena

Structures. However, proposed construction measures would limit the potential for adverse impacts to these species. Comal Springs riffle beetles and Texas blind salamanders would likely be present in the immediate vicinity of spring openings near the removal activity. These spring openings would be marked and avoided in order to prevent any direct impacts to these species. Therefore, the USACE has determined that the proposed actions would not likely adversely affect the Comal Springs riffle beetle and Texas blind salamander. Furthermore, the USFWS Final BO outlining the project effects, incidental take, and conservation recommendations on these four of the Federally listed species was completed and is included in Appendix B

Critical Habitat for the San Marcos salamander, fountain darter, and Texas wild-rice would experience short-term effects from increased turbidity. Additionally, physical habitat for the San Marcos salamander and fountain darter would be affected by construction. While these Critical Habitats would experience temporary degradation during the period of construction, each of the measures included in the Recommended Restoration Plan is designed to improve aquatic habitat in Spring Lake and the San Marcos River providing a long-term beneficial impact to protected species. Further, removal of the submerged structures would create additional Critical Habitat and potentially uncover spring openings that could be colonized by Federally protected species. Therefore, the USACE has determined that the proposed restoration activities would not adversely modify the Critical Habitat of these species.

7.4.2 No Action Plan

Although no direct impacts would result from the implementation of the No Action Plan, aquatic habitats supporting Federally protected species would continue to be impacted by polluted runoff and the submerged structures would continue to occupy and degrade Critical Habitat.

7.5 RECREATIONAL, SCENIC, AND AESTHETIC RESOURCES

7.5.1 Recommended Restoration Plan

The Recommended Restoration Plan would have beneficial effects to recreational, scenic, and aesthetic resources. Upon the removal of hazardous materials and the rapidly deteriorating buildings of the Aquarena Center, the safety of visitors would be greatly improved. Also, the replacement of these buildings, structures, and hard surfaces with native grassland would greatly enhance the scenic and aesthetic value of the area. The Recommended Restoration

Plan would allow for the connection of existing trails with new recreational trails and the existing boardwalk. The Recommended Restoration Plan is not expected to affect the recreational value of the surrounding golf course.

7.5.2 No Action Plan

Under the No Action Plan, the degrading structures of the Aquarena Center would continue to detract from the recreational, scenic, and aesthetic resources of the area. The proximity of Spring Lake to the Austin metropolitan area, its unique natural setting and endemic species, and the efforts of TxSt to educate the public about the importance of the Edwards Aquifer all contribute to the value of this natural resource. Under the No Action Plan, the Aquarena Center would remain a hazard to visitors and detract from the aesthetic value of the natural setting.

7.6 CULTURAL RESOURCES

7.6.1 Recommended Restoration Plan

The removal of the existing structures and hard surfaces and the replanting of the area with native vegetation would have the potential to adversely impact site 41HY160 and other potentially unknown cultural resources that may be located under the existing structures and pavement. Excavations at site 41HY160 showed that intact deposits are located adjacent to the Aquarena Office buildings, which would be removed as part of the restoration plan. In addition, excavations at site 41HY160 also show intact deposits to depths of 7.9 feet and cores taken show the potential of archaeological deposits to a depth of 27.9 feet below the ground surface. As a result, the potential of intact cultural deposits underlying the structures and hard surfaces is very high across the peninsula. Additional impacts can be anticipated from the construction of the post and cable fencing around the proposed buffer zone between the golf course and Spring Lake. Due to cultural sites being located close to the ground surface, revegetation efforts on the peninsula and in the proposed buffer zone between the golf course and Spring Lake would occur with minimal discing or other ground disturbance.

Section 106 consultation with SHPO, additional archaeological testing, monitoring, and demarcation of areas to be avoided would mitigate potential adverse impacts to cultural resources from the restoration project. These mitigation measures are outlined in Section 8.0.

7.6.2 No Action Plan

Without the removal of Aquarena Center and associated hard surfaces, the cultural resources located on the peninsula would not be further disturbed and no impacts to cultural resources would occur.

7.7 AIR QUALITY

7.7.1 Recommended Restoration Plan

The only impacts to air quality expected from the Recommended Restoration Plan alternative would be emissions generated by heavy equipment during construction activities. Increased emissions that would impact ambient air quality during construction activities are expected to be short-term and can be reduced further through proper equipment maintenance. Because the use of heavy equipment during demolition and ecosystem restoration will be limited in number and duration, emissions are expected to be minimal and below the *de minimus* thresholds and thus would not violate National or state standards. As a result, the Recommended Restoration Plan alternative would have no long-term impacts on local or regional air quality.

7.7.2 No Action Plan

Existing TxSt facilities and operations associated with the project area do not significantly affect air quality in the area and would not be altered as part of the No Action Plan.

7.8 NOISE

7.8.1 Recommended Restoration Plan

Temporary construction noise impacts would occur with the Recommended Restoration Plan. Short-term noise impacts would be expected from the necessary equipment needed to complete the demolition and removal of the Aquarena Center structures. No noise impacts are expected during the operation phase of the project.

7.8.2 No Action Plan

Existing TxSt facilities and operations in the project area do not significantly contribute to noise levels in the area and would not be altered as part of the No Action Plan.

7.9 HAZARDOUS MATERIALS

7.9.1 Recommended Restoration Plan

The Recommended Restoration Plan would remove hazardous materials from the project area. All hazardous materials would be transported and disposed of in accordance with all applicable Federal and state regulations. The Aquarena Center is known to have ACMs and is suspected to have lead-based paint products on-site. Due to the degraded condition of the structures associated with the Center, removing these buildings would remove the on-site toxic materials that continue to runoff into Spring Lake and the San Marcos River. This would alleviate the threat of hazardous materials affecting Federally protected species and recreational users of Spring Lake and the San Marcos River. This Recommended Restoration Plan would safely remove and dispose of hazardous materials found in the Aquarena Center buildings.

7.9.2 No Action Plan

Under the No Action Plan, asbestos and lead-based paints found in the deteriorating buildings of the Aquarena Center would continue to pollute Spring Lake and the San Marcos River. These hazardous materials could impact the Federally protected species found in the lake and river as well as visitors on the peninsula and recreationists in the river.

7.10 SOCIOECONOMICS AND ENVIRONMENTAL JUSTICE

7.10.1 Recommended Restoration Plan

The implementation of the Recommended Restoration Plan would have temporary, beneficial impacts to the income of the area while work is being conducted on site. This would result from the purchasing of materials, meals, lodging, and other items from the local commercial areas during construction. With improvements to the general aesthetics, safety, and educational opportunities provided by the recommended restoration plan, it is possible that visits to Spring Lake by both locals and tourists would increase. This increase of visitors would provide minimal, long-term benefits to local businesses and the general economy of San Marcos.

No impacts are anticipated to the population or racial mix of the area. No impacts are anticipated to the number of jobs, unemployment, or poverty levels within the ROI. Beneficial health impacts are anticipated for all populations, including potential minority and low-income populations, as well as children. Removal of the Aquarena Center buildings would eliminate a source of hazardous materials and prevent them from contaminating Spring Lake and the San

Marcos River. As a result, health and safety risks for people downstream from the site would be reduced. This would have a beneficial impact in regards to EO 12898, Environmental Justice, and EO 13045, Protection of Children.

7.10.2 No Action Plan

Under the No Action Plan, socioeconomic indicators would remain unchanged, but hazardous materials would continue to be a source of contamination to Spring Lake and the San Marcos River.

7.11 CUMULATIVE EFFECTS

There are several ongoing activities and proposed projects near Spring Lake. These projects and activities include:

1. Edwards Aquifer Withdrawal
   Past, unlimited groundwater withdrawals from the Edwards Aquifer threatened to reduce or stop flows from natural springs, especially during periods of drought. Because of both the environmental threat and the potential loss of water supply for residential, municipal, industrial and agricultural uses, the Edwards Aquifer Authority (EAA) was established through the Edwards Aquifer Authority Act to permit and limit groundwater withdrawals in the Edwards Aquifer.

2. Transportation infrastructure of San Marcos and Hays County
   The City of San Marcos, in coordination with the other area governmental agencies and community stakeholders, has developed a Transportation Master Plan to guide the development of transportation in the area through the Year 2025 (City of San Marcos 2004). This plan includes improvements to roads adjacent to Spring Lake and construction of new crossings along Sink Creek.

3. Texas Parks and Wildlife Department's Rivers Center project
   The project's mission is to educate the public about aquatic ecology, serve as a research center and to protect and restore the ecology, archaeology and history of the Aquarena property. As part of the Rivers Center project, the Aquarena Springs Inn would be converted to office space for all TxSt functions and programs now housed at the Aquarena Center, including the Office of Continuing Education.

4. Replacement of current Texas blind salamander collection structure
   The USFWS is working with TxSt and the San Antonio Water System to replace the structure above Diversion Springs to enable collection of Texas blind salamanders.

5. Invasive aquatic plant species removal programs
   The City of San Marcos and TxSt are working jointly on the removal of invasive and exotic aquatic plant species from the San Marcos River and Spring Lake. Much of this work is

focused on removing hydrilla, a highly invasive submersed aquatic plant species, and elephant ear, an invasive emergent aquatic plant species.

6. Ongoing recreational use
   With the exception of glass bottom boat tours, ongoing recreational use such as boating, swimming, and fishing is restricted to the San Marcos River.

7. Golf course use and maintenance
   The golf course adjacent to Spring Lake is managed using minimal applications of fertilizers and herbicides. However, runoff from the golf course has the potential to negatively affect water quality in Spring Lake.

8. Spring Lake Dam emergency repairs project
   On October 17, 1998, the Aquarena Center experienced a major flood that required the FEMA to propose funding for an emergency dam stabilization project. These repairs were addressed in the Environmental Assessment for the Spring Lake Dam Emergency Repairs Project, San Marcos, Texas, and a Biological Assessment completed in 2000.

9. Section 206 Restoration Plan
   The City of San Marcos and the USACE are proposing the restoration of aquatic habitats in the San Marcos River downstream of Spring Lake.

7.11.1 Recommended Restoration Plan

The combined impacts of the restoration project and other proposed projects would result in cumulative effects, beneficial or potentially adverse, to some resources and would have no cumulative effect on other resources.

Hazardous materials would be removed as part of the proposed restoration project and other projects in the area are not likely to increase hazardous materials in the area; thus, cumulative impacts would be slightly beneficial. The improvement of infrastructure, the addition of educational resources, and improvements to the natural setting and recreational opportunities would result in cumulative, beneficial effects to the local economy as jobs are created and revenues in the local service industry are increased.

If all proposed projects were scheduled simultaneously, air quality, noise, and surface waters and other aquatic resources could each be adversely affected. Projects that include substantial construction activities have the potential to reduce air quality and increase noise levels and should be scheduled to reduce these cumulative effects. The Spring Lake watershed is currently affected by the low quality of the current storm water system and has been affected by inadequate BMPs and SWPPs during peak rainfall events (personal communication with Pat Conner, USFWS 2004). Activities associated with the proposed restoration plan and

transportation infrastructure would both result in large areas of soil being temporarily subject to erosion. A large storm event would stress or compromise efforts to prevent pollution of surface waters from storm water runoff, and thus the area of exposed soils within the Spring Lake watershed should be kept to a minimum through coordination and scheduling of activities.

Transportation infrastructure projects would increase the area of hard surfaces, increase water pollution, reduce available wildlife habitat, and detract from the scenic and aesthetic value of the area resulting in adverse impacts to soils, endangered species, wildlife, and aesthetics in the Spring Lake watershed. However, the proposed restoration project would result in long-term beneficial effects to these resources as well as reduce the adverse affects of other proposed projects through the creation of a vegetated buffer zone around Spring Lake. Furthermore, the Texas Rivers Center and improvements to the salamander collection structure would serve to educate the public about endangered species and benefit this resource. Also, the control of exotic species by the City of San Marcos and TxSt would benefit wildlife habitats in the area. Therefore, although the there would be some adverse impacts to soils, endangered species, wildlife, and aesthetics, the proposed restoration project and other projects would benefit these resources and reduce the impacts of the transportation project resulting in minimal adverse cumulative effects. Cultural resources would be protected by the proposed restoration plan and other projects in the area are not likely to affect these resources; thus, there are no cumulative effects.

7.11.2 No Action Plan

Under the No Action Plan, improvements to habitats on the peninsula and around the lake would not be made and the Aquarena structures would continue to pollute aquatic habitats in Spring Lake. Without the proposed restoration project, pollution from within and outside the project area would continue to degrade aquatic habitats and adversely affect protected species in Spring Lake. Therefore, the No Action Plan would directly contribute to the degradation of aquatic habitats in Spring Lake on its own and to the cumulative affects of existing conditions and proposed projects in the area.

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 8.0
MITIGATION MEASURES

8.0 MITIGATION MEASURES

This section describes the mitigation measures that would be implemented as part of the proposed restoration project for Spring Lake and the surrounding area. Due to the limited nature of disturbance, the proposed restoration activities are not expected to cause any long-term adverse effects. The mitigation measures discussed below would decrease the severity of any short-term or temporary project-related activities on resources such as protected species.

8.1 GENERAL MITIGATION MEASURES

All construction equipment would be maintained and fueled outside of the project area to prevent any spills from affecting water resources. Construction activities would be performed with careful staging of heavy equipment near the shoreline of Spring Lake. Inspections would be made for leaking fluids and any other maintenance work that may be needed on construction vehicles.

Increases in suspended sediments would be controlled by the use of silt fences in the construction area. In addition, work that would potentially cause excess siltation would be completed in shifts to limit the total amount of silt suspended in Spring Lake. Turbidity monitoring would be required during the construction activities. The SWPPP would detail the BMPs, including silt fences, necessary to reduce or eliminate water pollution from storm water discharges both during and after construction. Permanent solutions, such as sedimentation ponds, would be preferred over temporary measures and would be considered during the development of the SWPP.

A temporary boom, or other appropriate device, would be used to collect any floating, vegetative debris resulting from removal of submerged structures, barge ingress/egress, or dam construction. This device should be located downstream of any activities resulting in the disturbance of submerged aquatic or shoreline vegetation, and should be large enough to collect all resulting debris. Collected debris would be removed from the lake or river and destroyed using appropriate methods. A permanent, self-cleaning screen on Spring Lake Dam would be a benefit for downstream habitats and Texas wild rice populations; however, it could not be supported by this project. This measure may be included in the existing city-sponsored Section 206 project located just downstream of the Spring Lake project. The City of San

Marcos and TxSt would evaluate this restoration measure in the future. All applicable restoration scales or alternatives associated with this measure could be explored during the Feasibility Study of the city-sponsored project.

All work would be actively monitored by a representative from the USACE or TxSt to ensure that actions at the site are consistent with all approved plans. Monitoring of water quality and implementation of BMPs would be used during construction for all proposed action items of the Recommended Restoration Plan to mitigate the amount of negative effects that would occur in the project area. The USACE has the capability of conducting short-term monitoring after the project has been completed for a period of 2 to 3 years. No defined monitoring plan has been established.

Written notification would be made to the USFWS, Austin Field Office of the beginning of work, the end of work, and any notable or unforeseen event that may affect the aquatic community in a manner not considered in the Biological Opinion.

8.2 TEXAS WILD-RICE

Areas vegetated with Texas wild-rice would not be directly disturbed during restoration activities. The flow of water over the spillways would be uninterrupted, eliminating any threat of drying out inhabited areas below the dam. Although mats of vegetation regularly flow over the dam and into the San Marcos River, a temporary boom designed to collect these mats would prevent any project-related vegetation mats from affecting downstream Texas wild-rice populations. Stands of Texas wild-rice immediately downstream of spillways would be monitored for siltation during structure removal. If suspended sediments that are attributable to the restoration project implementation are of a volume great enough to impede photosynthesis by Texas wild-rice, a reassessment of BMPs used would occur and more effective measures would be implemented.

8.3 FOUNTAIN DARTERS

Before any submerged structure removal or demolition activities, fountain darters would be removed from the immediate area of impact, to the extent possible, by using seines and/or long-handled dip nets. Fountain darters would be relocated to USFWS approved areas away from construction zones. Prior to the removal of the submerged theater structures, floating algal mats in the area would be pushed away and vegetation on the submerged structures would be

removed. While removing vegetation by hand, divers would work slowly to allow any remaining darters to leave vegetation. Cut submerged aquatic vegetation would be brought to the surface and checked again for the presence of fauna before appropriate disposal. Qualified and permitted biologists would conduct removal of darters and vegetation from the impact areas.

8.4 SAN MARCOS SALAMANDERS

Two surveys for San Marcos salamanders would be conducted in the vicinity of the Submarine Theater following methods described in Nelson (1993). The first survey would occur approximately 1 month prior to structure removal begins. The second survey would take place within 1 month of the completion of the removal of submerged structures. The results of the surveys would be reported to the USFWS. The report would include the area surveyed, the dates and times of the surveys, findings, and an estimate of the local population size based on the number of salamanders observed beneath overturned rocks and an estimate of the number of rocks available in aquatic habitats. Persons involved in the San Marcos salamander surveys would have the proper equipment and permits from the USFWS.

Efforts to remove San Marcos salamanders from the area of potential impact during submerged structure removal would be identical to those used to remove and relocate fountain darters. Attempts would be made to collect protected specimens inadvertently killed during construction activities or relocation efforts; any dead specimens would be deposited with the USFWS National Fish Hatchery and Fish Technology Center in San Marcos, Texas. All construction activities would be conducted in a manner that would avoid existing habitat and create additional habitat for the salamanders to the maximum extent possible.

8.5 TEXAS BLIND SALAMANDERS

Removal of the submarine theater and underwater structure would be completed using silt curtains to restrict sediment to the immediate vicinity of the theater. This would prevent silt and turbidity from potentially affecting Texas blind salamanders present at spring openings. Silt curtains would remain in place until sediment has resettled to the lake bottom and turbidity returns to original levels near the submarine theater. This would also prevent temporary increases in turbidity from affecting other portions of the lake. Spring openings near the potential impact area would be located and marked for avoidance.

8.6 COMAL SPRINGS RIFFLE BEETLE

Before removal of submerged structures, the area would be surveyed for Comal Springs riffle beetles. In the event that beetles are found in the vicinity, efforts would be made to avoid impacts to spring openings. Efforts to control turbidity and limit disturbance of spring openings, as discussed above in Section 8.5, would also benefit the Comal Springs riffle beetle.

8.7 WILDLIFE

The Migratory Bird Treaty Act requires that Federal agencies coordinate with the USFWS if construction activity would result in the "take" of a migratory bird. If construction or clearing activities were scheduled during the breeding season (March 1-September 1), surveys would be performed to identify active nests. If construction activities would result in the "take" of a migratory bird, coordination with the USFWS and the TPWD would be conducted, and applicable permits would be obtained prior to construction or clearing activities. Another mitigation measure that would be considered is to schedule all construction activities outside the nesting season thus, negating the requirement for nesting bird surveys.

8.8 CULTURAL RESOURCES

Prior to any ground disturbing activity, Section 106 consultation would be completed with the SHPO and/or Texas Historic Commission (THC). Numerous cultural resources are known to occur throughout the project area and occur very near the surface. Through consultation with the SHPO and THC, the appropriate mitigation measures would be developed and implemented to minimize the impacts to those resources. An MOA would be developed between the Texas SHPO and interested Federal parties outlining the mitigation measures that need to be implemented to minimize impacts to historic properties from the implementation of the proposed action alternative. This MOA would be completed and signed by all involved Federal parties prior to implementation of the Proposed Action Alternative. If possible, the preferred mitigation measure would be avoidance.

SECTION 9.0
PROJECT IMPLEMENTATION

9.0 PROJECT IMPLEMENTATION

9.1 PROJECT SCHEDULE

The project schedule for the aquatic ecosystem restoration project is presented in Table 9-1.

Table 9-1. Project Milestone Schedule

Milestone	% Complete
Habitat Analysis	100
USFWS Planning Aid Letter	100
Complete ICA	100
Complete Alternative Formulation Briefing	100
Draft Report	100
Sponsor National Environmental Restoration Meeting	100
Start Public Review	0
Finish Public Review	0
Execute FONSI	0
Final Report	0
Request Section 206 Plans & Specs Funding	0
Initiate Plans & Specs	0
Initiate Construction	0
Complete Construction	0
Project Complete	0

The detailed schedule for the Plans and Specifications Phase, Construction Phase, and Close-out Phase are presented in Table 9-2.

Table 9-2. Schedule for Plans and Specifications Phase, Construction Phase, and Close-Out Phase.

Phase and Task Description
Plans and Specifications Phase
Initiate Plans and Specifications
95% Plans and Specifications
Execute PCA
Request Construction Funds
Construction Phase
Initiate construction
Construction Complete
Monitoring and Adaptive Management
Close-Out Phase
Initiate Project Close-out
Final Transition to Operations and Maintenance
Completion Report

The final Feasibility Report is scheduled for completion in September 2005. The following design phase will last approximately 6-12 months, construction will last approximately 2 years, and monitoring of implemented project features for approximately 2 years. Following the 2-year monitoring period, the project would be closed-out and the sponsor would then assume all operation and maintenance requirements associated with the project.

9.2 PROJECT COSTS

9.2.1 Cost Apportionment

Project costs would be shared between the Federal Government and the Local Sponsor, TxSt (Table 9-3). Under Section 206 guidance, the non-Federal, Local Sponsor interest shall provide 35% of the cost of construction of any project carried out under Section 206, including provision of all lands, easements, rights-of-way, and necessary relocations. Because recreation costs are less than 10% of the Federal restoration cost share, the recreation costs are shared 50/50 between the Federal and non-Federal, Local Sponsors. No more than $5 million in Federal funds may be allotted under a Section 206 project. For the Spring Lake Section 206 aquatic ecosystem restoration project, the Federal Government would be responsible for $1,536,509 and the Local Sponsor would be responsible for $846,773.

Table 9-3. Summary of Project Cost Apportionment

Project Item	Restoration Costs (65/35)	Recreation Costs (50/50)	Total Project Costs
Total Project Cost	**$2,299,122**	**$84,160**	**$2,383,282**
Federal Share	$1,494,429	$42,080	$1,536,509
Sponsor Share	$804,693	$42,080	$846,773
Sponsor Requirements			
Sponsor LERRD Credit	$283,000		
Cash Contribution	$471,693	$42,080	
Work-in-Kind Credit	$50,000		

9.2.2 Project Cooperation Agreement

The Project Cooperation Agreement (PCA) is a contract between the Federal Government and the non-Federal, Local Sponsor describing the rights and responsibilities of each party during project implementation, including cost sharing. The PCA would be executed after the receipt of Federal project approval and prior to advertisement of a construction contract. The project PCA would be a model Section 206 agreement in all aspects except for the addition of minor recreation features, which would require USACE Headquarters approval. Appendix M provides a draft PCA.

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 10.0
PUBLIC INVOLVEMENT

10.0 PUBLIC INVOLVEMENT

10.1 SPONSOR VIEWS

The purchase of the Aquarena Center in 1994 was undertaken as a measure on the part of TxSt to prevent the expansion of other commercial ventures from occurring at the site. This was an effort by TxSt to maintain and preserve the natural resources in the area. TxSt has made the commitment now to restore the site's natural resources rather than to repair or replace any of the existing park facilities. TxSt is supportive of the proposed project and has provided every indication that they are highly committed to the execution of this project. A Letter of Intent (LOI) stating the TxSt position is provided in Appendix N.

10.2 PUBLIC VIEWS AND COMMENTS

The draft DPR/EA will be made available for public review for a period of 30 days. The draft FONSI and DPR/EA will be sent to the USFWS, TPWD, Texas Historical Commission, TCEQ, and EPA; posted at the City of San Marcos Public Library, University Library, and Fort Worth District web site; and posted in a local news release for public review and comment. The Notice of Availability will be sent to addressees on the regulatory county mailing lists and to members of the Environmental and Recreation Assistance Committee (ENRAC). Proof of publication will be included in the final document. Comment letters received concerning the draft will also be included in the final document and changes will be incorporated into the final DPR/EA.

10.3 AGENCY COORDINATION

Consultation with Federal and state agencies has been on going since the inception of this project and would continue to occur through the final versions of this document. This would include contacts that are made during the development of the proposed action and writing of the DPR/EA. Formal and informal coordination have been or will be conducted with the following agencies:

- U.S. Fish and Wildlife Service (USFWS)
- U.S. Environmental Protection Agency (USEPA)
- U.S. Army Corps of Engineers (USACE)
- Federal Emergency Management Agency (FEMA)

- Natural Resource Conservation Service (NRCS)
- Texas State Historic Preservation Office (SHPO)
- Texas Parks and Wildlife Department (TPWD)
- Texas Commission on Environmental Quality (TCEQ)
- Texas State University, San Marcos (TxSt)
- Edwards Aquifer Authority (EAA)
- Guadalupe Blanco River Authority (GBRA)

10.4 REGULATORY REQUIREMENTS

The activities proposed for the Spring Lake Section 206 are compatible and consistent with the spirit and intent of the USACE ecosystem authorities. It is therefore anticipated that there are no policy issues of concern with this project.

The proposed project has been reviewed in accordance with Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899. In addition, Executive Order 11990, Protection of Wetlands and Executive Order 11988, Floodplain Management was considered during development of the proposed project. The USACE Regulatory Branch has reviewed the report and determined that the proposed project would not involve activities subject to the requirements of Section 10; however it would involve activities subject to the requirements of Section 404. The proposed construction activities would likely be authorized by a general permit, such as NWP 27 for Stream and Wetland Restoration Activities. The TCEQ has issued a water quality certification for NWP 27; therefore, no further coordination for Section 401 water quality certification is required.

There has been on-going coordination with USFWS, Edwards Aquifer Authority, Guadalupe Blanco River Authority, Texas Parks and Wildlife, and the SHPO. In response to the proximity of Federally listed endangered species within the project area, formal Section 7 consultation was conducted with the USFWS. A major part of NEPA compliance is to ensure that an adequate number of alternatives are considered during plan formulation, which is also the intent of this DPR/EA. It is anticipated that there would be no adverse or controversial comments that would necessitate conducting an environmental impact statement. At the close of the comment period, the Fort Worth District Engineer would sign a Finding of No Significant Impact, if appropriate.

SECTION 11.0
CONCLUSIONS

11.0 CONCLUSIONS

This DPR/EA documents the results of a study conducted under the authority of Section 206 of the WRDA of 1996, as amended (33 USC 2201). The purpose of the study was to develop a recommended plan for restoring the aquatic and riparian habitats of Spring Lake and the TxSt Aquarena Center area along the San Marcos River.

The NER or Recommended Restoration Plan would increase the habitat value of the study area over the life of the project by providing benefits to approximately 10 acres of floodplain habitat on the Aquarena Center peninsula, 9 acres of riparian corridor habitat along the shoreline of Spring Lake, and 22 acres of lacustrine habitat within the headwaters of the San Marcos River. The restoration of these distinct habitats would improve biodiversity and the habitat capacity for migratory and resident wildlife, increase connectivity of the riparian corridor, and limit the expansion and propagation of exotic vegetation. In addition, water quality within Spring Lake and the San Marcos River would improve through erosion reduction and filtration of polluted surface runoff from the TxSt golf course and Aquarena Center. The Recommended Restoration Plan would also provide educational and wildlife-viewing opportunities, improve habitat conditions for Federally listed species, and improve the general aesthetics and safety of the natural areas surrounding Spring Lake.

Total project costs for the recommended plan were determined through a series of evaluations based on average AAHUs and incremental costs. The total project costs associated with the recommended plan are estimated to be $2,383,282 including engineering plans and specifications, LERRDs, and post project monitoring. TxSt has been identified as the non-Federal, Local Sponsor of the recommended plan, and has been presented with the findings of this report. The total estimated project costs would be shared at 65% Federal and 35% non-Federal, Local Sponsor, except for recreation costs, which would be shared 50/50. TxSt has offered their support for the recommended plan, including the cost-sharing plan, and has agreed to assume responsibilities for all operation, maintenance, replacement, and repair costs.

An EA was integrated into this DPR to assess the possible impacts of the recommended plan. A public notice will be released prior to initiation of construction disclosing the availability of the EA. If appropriate, a FONSI would be issued after reviewing comments of the EA.

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 12.0
RECOMMENDATIONS

12.0 RECOMMENDATIONS

I propose that the recommended plan described in this Detailed Project Report be authorized for implementation under the authority of Section 206 of the WRDA of 1996, Public Law 104-303, as a Federal project, with such modifications as in the discretion of the Chief of Engineers may be advisable. The initial cost of this project is estimated to be $2,383,282.

Prior to the commencement of construction, local interests must agree to meet the requirements for Local Sponsor responsibilities as outlined in this report and future legal documents. Texas State University-San Marcos, Texas has demonstrated that they have the authority and the financial capability to provide all Local Sponsor requirements for the implementation, operation, and maintenance of the project. The recommendations contained herein reflect the information available at this time and current Department of the Army policies governing formulation of individual projects. They do not reflect the program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch.

John R. Minahan
Colonel, U.S. Army Corps of Engineers
District Engineer

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 13.0
LIST OF PREPARERS

13.0 LIST OF PREPARERS

The following people were involved in the preparation of this DPREA.

NAME	AGENCY/ ORGANIZATION	DISCIPLINE/ EXPERTISE	EXPERIENCE	ROLE IN PREPARING DPR/EA
Dr. Hank Jarboe	USACE	Biology	6 years EA/EIS, NEPA and related studies	USACE Technical Manager
Jeffry Tripe	USACE	Biology/Fisheries	5 years EA, NEPA, HEP and natural resources	USACE Technical Manager
Pat Fogarty	TxSt	Associate VP Facilities		Local Sponsor
Chris Ingram	Gulf South Research Corporation	Biology/Ecology	22 years EA/EIS studies	EA review
Suna Adam Knaus	Gulf South Research Corporation	Forestry/Wildlife	15 years NEPA and related studies	EA review
Michael Hodson	Gulf South Research Corporation	Ecology	4 years NEPA and natural resources	Report preparation and ICA
John Lindemuth	Gulf South Research Corporation	Anthropology/ Project Archaeologist	8 years archaeological studies	Cultural resources and socioeconomics
David Alford	Gulf South Research Corporation	GIS	2 years GIS experience	Graphics and ICA
Brad Yarbrough	Gulf South Research Corporation	Forestry/Wildlife	2 years in NEPA and related studies	HEP analysis, field surveys, and report preparation
Donna Bankston	Gulf South Research Corporation	Forestry	2 years in NEPA and related studies	Field surveys and report preparation
Eric Webb	Gulf South Research Corporation	Ecology	14 years in NEPA and related studies	Project Manager, report preparation, ICA

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 14.0
REFERENCES

14.0 REFERENCES

Brune, G. 2001. The Handbook of Texas Online. San Marcos Springs. http://www.tsha.utexas.edu/handbook/online/articles/print/SS/rps6.html. Last updated 23 July 2001.

Bureau of Economic Analysis (BEA). 2002. Bureau of Economic Analysis. Internet Website: http://www.bea.gov/. Last accessed 25 July 2002.

Cecil, P.F., and D.P. Greene. 2002. The Handbook of Texas Online: Hays County. Internet Website: http://www.tsha.utexas.edu/handbook/online/articles/print/HH/hch11.html. Last accessed 23 Nov 2004.

Correll, D.S., and M.C. Johnston. 1996. Manual of the Vascular Plants of Texas. Fourth Printing. The University of Texas at Dallas, Richardson, Texas.

Eckhardt, Gregg. A. 2002a. The Edwards Aquifer Homepage: San Marcos Springs. http://www.edwardsaquifer.net/sanmarcos.html. Last accessed 24 June 2002.

Eckhardt, Gregg. A. 2002b. The Edwards Aquifer Homepage: Laws and Regulations Applicable to the Edwards Aquifer. http://www.edwardsaquifer.net/rules.html. Accessed 25 July 2002.

Edwards Aquifer Authority. 2001. www.edwardsaquifer.org. Last accessed 2 April 2004.

Edwards Aquifer Research and Data Center (EARDC). 2002. Edwards Aquifer, The Final Thirst. Edwards Aquifer: What Is It? Last accessed 30 July 2002.

Federal Emergency Management Agency (FEMA). 2000. Final Environmental Assessment for the Spring Lake Dam Emergency Repairs Project. Prepared by Turner, Collie, and Braden, Inc. December 1999.

Federal Interagency Committee on Noise. 1992. Federal Agency Review of Selected Airport Noise Analysis Issues. Washington, D.C.

Groeger, Alan, Patrick Brown, Todd Tietjen, and Travis Kelsey. 1998. “Water Quality Trends in the San Marcos River.” *NewWaves* Volume 11, Number 2. June 1998. http://twri.tamu.edu/twripubs/NewWaves/v11n2/abstract-4.html. Last accessed 5 August 2002.

Nelson, J. 1993. Population size, distribution, and life history of *Eurycea nana* in the San Marcos River. M.S. Thesis, Southwest Texas State University, San Marcos, Texas.

Real Estate Center. 2002 Hays County, TX Employment. Internet Website: http://recenter.tamu.edu/. Last accessed 25 July 2002.

Robinson, R., W. Hansen, and K. Orth. 1995. Evaluation of Environmental Investments Procedures Manual. Interim: Cost Effectiveness and Incremental Cost Analyses. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS. IWR Report 95-R-1.

Saunders, K.S., K.B. Mayes, T.A. Jurgensen, J.F. Trungale, L.J. Kleinsasser, K. Aziz, J.R. Fields, and R.E. Moss. 2001. An evaluation of spring flows to support the Upper San Marcos River Spring ecosystem, Hays County, Texas. River Studies Report No. 16. Resource Protection Division, Texas Parks and Wildlife Department, Austin, Texas.

Shiner, J.L. 1983. Large springs and early American Indians. Plains Anthropologist, Journal of eth Plains Anthropological Society 28(99):1-7.

Slattery, R.N., and L.N. Fahlquist. 1997. Water quality summary of the San Marcos Springs Riverine System, San Marcos, Texas, July-August 1994. U.S. Geologic Survey Fact Sheet FS-059-97.

Smyrl, Vivian Elizabeth. 2001. The Handbook of Texas Online. San Marcos River. http://www.tsha.utexas.edu/handbook/online/articles/print/SS/rns10.html. Last updated 23 July 2001.

Texas Parks and Wildlife Department. 1990. Texas Outdoor Recreation Plan, Texas Parks and Wildlife Department. 29p.

Texas State Data Center and Office of the State Demographer. 2004. http://txsdc.tamu.edu/. Last accessed: 19 April 2004.

U.S. Army Corps of Engineers. 1987. Corps of Engineers Wetlands Delineation Manual. Wetlands Research Program Technical Report Y-87-1. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

U. S. Census Bureau. 2005. U.S. Census Bureau. Internet Website: http://www.census.gov. Last accessed 23 August 2005.

U.S. Department of Agriculture (USDA). 1984. Soil Survey of Comal and Hays Counties Texas. USDA Soil Conservation Service in cooperation with Texas Agriculture Experiment Station.

USDA. 2002. Hydric Soils of Texas. USDA Natural Resource Conservation Service. http://www.statlab.iastate.edu/soils/hydric/tx.html. Last accessed 22 July 2002.

U.S. Environmental Protection Agency (USEPA). 1973. Public Health and Welfare criteria for Noise. USEPA 550/9/73/002, U.S. USEPA, Washington, DC.

USEPA. 1974. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety. USEPA 550/9-74-004, U.S. USEPA, Washington, DC.

USEPA. 2005. USEPA - Green Book - Nonattainment Area Map. Online Resource: http://www.USEPA.gov/oar/oaqps/greenbk/mapnpoll.html

U.S. Fish and Wildlife Service (USFWS). 1996. San Marcos and Comal Springs and Associated Aquatic Ecosystems (Revised) Recovery Plan. Albuquerque, New Mexico.

USFWS. 2001. The USFWS Biological Opinion for the emergency repair of the Spring Lake dam to Ms. Kyle Mills and Mr. Wayne Lea. 30 January 2001.

USFWS. 2002. Endangered Species List. List of Species by County for Texas: Hays County. http://ifw2es.fws.gov/EndangeredSpecies/Lists/ListSpecies.cfm. Last accessed 23 July 2002.

Wegner, D.E. 1991. Safe play among protected species. Parks and Recreation, November: 42 44.

Whiteside, B., A. Groeger, P. Brown, and T. Kelsey. 1995. Physicochemical and Fish Survey of the San Marcos River, Report Submitted to Texas Parks and Wildlife Department, January 1994.

Vaughan, J.E. 1986. Population and autoecological assessment of *Zizania texana* Hitchc. (Poaceae) in the San Marcos River. Masters thesis. Southwest Texas State University, San Marcos, Texas.

THIS PAGE LEFT INTENTIONALLY BLANK