San Felipe Creek Master Plan

VOLUME I

Prepared for:

The San Felipe Creek Commissioners
& The City of Del Rio

City of
DEL RIO
Texas

and the

TEXAS WATER DEVELOPMENT BOARD

Prepared by:

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September 2012

NEI Project No. 8267/TWDB Contract No. 1004831077

Final Report

Engineering Oversight of the San Felipe Creek Master Plan

On August 11, 2005, the Texas Board of Professional Engineers (TBPE) issued a "Policy Advisory Opinion" on the aspects of water quality planning that are subject to the Texas Engineering Practice Act (TEPA). Under Texas State Law, the TBPE is authorized to issue advisory opinions and interpretations of the TEPA.

Based on this Policy Advisory Opinion, "Water Quality Planning Activities" that require professional engineers include the following:

- Feasibility studies regarding engineered water quality control measures, treatment technologies and treatment plants;
- Siting of engineered water quality management measures;
- Monitoring and evaluation of engineered water quality measures for assessment or adjustment of functional processes; and,
- Specification of engineered water treatment technologies.

In addition to these specific tasks, Texas licensed engineers are required to prepare the specifications, designs and perform construction monitoring of public works projects not exempted by the Act. Licensed professional engineers are required to perform the design of the listed activities for private works not exempted by the Act.

Based on this opinion, certain elements of this Plan include the "specification of engineered water treatment technologies", to the degree that certain minimum design requirements for water quality best management practices have been included in the Plan. This Plan does not involve feasibility studies for specific water quality control measures. The siting of specific water quality control measures included in this plan should be considered preliminary only, and final siting and design of any water quality control system will require the services of a professional engineer. I certify that the elements of this Plan determined by the TBPE under this Policy Advisory Opinion to constitute the practice of engineering have been performed under my direct supervision.

STATE OF TEXAS
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PROFESSIONAL ENGINEER

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September 18, 2012

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EXECUTIVE SUMMARY

INTRODUCTION & BACKGROUND

San Felipe Creek originates approximately six miles northwest of Farm Road 2523 in southeastern Val Verde County and flows towards the southwest for eighteen miles to its mouth on the Rio Grande. The creek flows through the center of the City of Del Rio in Val Verde County, Texas. San Felipe Creek is primarily supplied by water flowing from the San Felipe Springs at a flow rate that typically ranges from 50 – 90 million gallons per day. The creek is the sole source of drinking water for the City of Del Rio and Laughlin Air Force Base. The stream has always been a primary recreation attraction for the citizens of Del Rio.

The drainage basin for San Felipe Creek consists of rural lands as well as highly urbanized areas. The urbanized areas help to exert an influence on the character and quality of water that flows in the creek. A significant presence of invasive species now exists in San Felipe Creek including Arundo donax (giant reed) and armored catfish (*Hypostomus plecostomus).*

San Felipe Creek is also home to many unique animal species. Among them are the Devils River Minnow that has been listed as a threatened species by the United States Fish & Wildlife Service (USFWS) since 1999. The San Felipe Gambusia is a recently identified species that is known to reside only in San Felipe Creek and is currently listed as a threatened species by the Texas Park & Wildlife Department (TPWD).

Due to the importance of water quality in San Felipe Creek, both as the sole source of drinking water for the citizens of the area and as the primary habitat of animals in the area, it became apparent to the participants that there was a need for a regional water quality planning study to identify opportunities for protecting water quality throughout the drainage basin.

The boundaries of the project are confined to the drainage basin of San Felipe Creek which is located in Val Verde County. The primary focus of the master plan includes the area of the drainage basin within the City Limits including the area of the San Felipe Country Club golf course and that portion of San Felipe Creek from U.S. Highway 90 downstream to Round Mountain. The boundaries of the Project Area are shown in **Figure 1.** The "Planning Area" generally covers the portion of the San Felipe Creek drainage basin upstream of Round Mountain. This creates a planning area footprint of over 40 square miles which is shown on **Figure 2**.

PLANNING PROCESS

The project organization is divided amongst two primary sponsors, the City of Del Rio and the Texas Water Development Board (TWDB). The City of Del Rio designated its San Felipe Creek Commission as its primary contact during the planning process. Meetings were held during the course of the project in an effort to inform the Commissioners and the general public on the project findings, to update them on the progress of the planning effort, and to receive feedback from the Commissioners and the general public. A total of five public meetings were held for the project including meetings in October 2010, July 2011, November 2011, February 2012, and June 2012.

PROJECT GOALS & OBJECTIVES

Project Goals

For the San Felipe Creek Master Plan the following goals were identified during the planning process:

- As the sole source of drinking water for the City of Del Rio and Laughlin Air Force Base and the headwaters of San Felipe Creek, protecting the San Felipe Springs from water quality and quantity degradation is of paramount importance;
- Protection of both water quality and quantity is important for the maintenance of habitat for endangered species including the Devils River minnow that inhabit San Felipe Creek;
- Eradication of invasive species that have degraded both the water quality and quantity in San Felipe Creek. Specifically the eradication of the river cane and armored catfish and improving the habitat around Blue Hole;
- Continue to have San Felipe Creek as the centerpiece of Del Rio life; and,
- Provide amenities at or near San Felipe Creek which enhance public use of the Creek while providing water quality protection.

Project Objectives

For the San Felipe Creek Master Plan the following objectives have been identified:

- Adopt design standards that include requirements for Best Management Practices (BMPs) for water quality protection;
- Provide public facilities that encourage users of the creek to protect water quality in the creek;
- Maintain and repair existing facilities and provide recreational amenities that encourage responsible public use of the creek;
- Encourage the use of native vegetation so that riparian habitat is re-established along the creek which will provide significant ecological benefits by filtering pollutants, controlling soil erosion and supplying habitat for vegetation and wildlife;
- Working with the U.S. Fish and Wildlife Service, the U.S. Department of Agriculture, and the Texas Parks and Wildlife Department to develop a plan for eradication of invasive species in and around the creek and for the cleaning of Blue Hole;
- Assure that open space is for public use and as habitat for plants and wildlife while being maintained to protect adjacent neighborhoods; and,
- Work toward a balance of public access and habitat protection for San Felipe Creek through ordinance enforcement, enhanced maintenance, and public education.

WATER QUALITY ISSUES & BEST MANAGEMENT PRACTICES

Water Quality Issues:

San Felipe Creek is confronted with a number of water quality issues that have the ability to negatively impact the creek and the creek area. The main water quality issues identified during the planning process included:

- **Invasive, Non-Native Species** - San Felipe Creek is currently being impacted by non-native species including Arundo donax (a.k.a., Giant Reed or River Cane) and armored catfish (*Hypostomus* sp.);

- **Urbanization** - Urbanization refers to the overall shift or trend of an area from a more rural community to a more developed, or urbanized area; Urbanization results in increased construction activities which remove natural vegetation and can potentially increase erosion and sedimentation;
- **Lack of Riparian Buffer** - Streams and rivers are typically protected by a vegetated bank area containing native grasses, flowers, shrubs and trees, known as the "riparian buffer"; urbanization often results in degradation or reduction in this riparian buffer area; San Felipe Creek, particularly the stream reach between US Highway 90 and Round Mountain, is an example of the impact that urbanization can have on a riparian buffer;
- **Bank Erosion** - Bank erosion is a direct contributor to a decrease in water quality within a stream or river; the erosion of stream banks will add sediment to the water which directly impacts the habitat of a clear, flowing stream by adding suspended solids to the water;
- **Vegetation Management** - While undeveloped land left in its natural state can be an effective measure for maintaining water quality, other activities occurring on undeveloped land can have adverse impacts on water quality; the primary threats from undeveloped land subjected to human activity are excessive erosion/sedimentation from disruption of natural vegetation and excessive nutrients and biological constituents;
- **Stormwater / Non-point Source Pollution** - Stormwater non-point source (NPS) pollution occurs as a result of rainfall events; NPS pollution poses a direct threat to San Felipe Creek as stormwater from the surrounding areas discharge directly into the creek; and,
- **Lack of Water Quality Protection on Existing Development** - Over the years urbanized development within the San Felipe Creek drainage basin has occurred without the benefit of water quality protection measures which can allow the water quality of the creek to be negatively impacted.

Water Quality Best Management Practices (BMPs)

Watershed management and water quality protection measures typically include both "structural" and "non-structural" measures, with these measures typically referred to as "Best

Management Practices" (BMPs). The EPA has adopted the following definitions for structural and non-structural BMPs:

Structural BMPs *include engineered and constructed systems that are designed to provide for water quantity and/or water quality control of storm water runoff.*

Non-structural BMPs *include institutional and pollution-prevention type practices designed to prevent pollutants from entering storm water runoff or reduce the volume of storm water requiring management.*

For the San Felipe Creek Master Plan the following BMPs were selected as most appropriate for the project area:

Structural BMPs:

- Vegetation Enhancement
- Bank Stabilization
- Riparian Area Restoration
- Vegetative Filter Strips
- Pervious Pavement
- Biofiltration/Bioretention
- Hydrodynamic Separators

Non-Structural BMPs:

- Public Education
- Community Involvement
- Land Management/Ordinances
- Litter/Trash Pick Up
- Pet/Animal Waste
- Human Waste Control

PROJECT ALTERNATIVES

As outlined in the Project Goals and Objectives, the ultimate goal of the water quality protection measures presented in the Master Plan is to maintain or enhance the existing water quality and water quantity in San Felipe Creek. To accomplish this objective, the strategy has been to select measures that facilitate a decrease in anticipated pollutant loadings, minimize the potential for discharges into San Felipe Creek, or enhance the habitat in or near the creek. The measure selected include the following:

Control of Invasive Species:

Arundo donax Eradication

Recommendations for the eradication of *Arundo donax* include cutting the cane after flowering, which typically occurs in mid- to late summer, then removing the cut stalks and shredding them into pieces less than one inch in length; after waiting for new growth to occur in the next month, the cane should be sprayed with a combination of Rodeo (3% - 5% solution) and a surfactant; during the winter the dead biomass should be removed; this procedure should continue for several years until the cane is eradicated; the process is labor intensive and will require the commitment of significant financial resources.

Armored Catfish Eradication

The Armored catfish present in San Felipe Creek out compete native species for both food and habitat. Their activities also significantly contribute to the damage of the creek banks which has a negative impact on water quality by increasing the suspended solids in the water. There is currently no known effective eradication method, however, it is recommended that the City actively encourage on-going research and investigations into the control and elimination of this damaging pest.

Projects and Improvements:

The following proposed projects and/or improvements were recommended for the San Felipe Creek Area:

- **Bank Improvements:** includes the demolition, removal, reconstruction of some of the existing bank wall; in other areas it is recommended that the existing walls be removed and a more natural, riparian area established;
- **Creek Side Improvements:** includes new pervious parking surfaces, conversion of existing parking areas to pervious parking surfaces, public restrooms, community gardens, trash cans; pet waste stations;
- **Public Education:** includes the installation of public information kiosks along the creek area;

- **Hike & Bike Trail Improvements:** includes new hike and bike trails along the creek and also the conversion of existing trails from impervious surfaces to pervious surfaces; and,
- **Vegetation Management Areas:** includes the establishment of vegetation management areas along the creek to provide an organized structure for effectively managing the vegetated creek banks and upland areas located near the creek.

The San Felipe Creek project area was divided into six separate Project Areas A, B, C, D, E, and F as shown on **Figure 19** and the individual project are numbered according to their project area (i.e., A-1, C-12, etc..). Individual project descriptions and cost estimates are included in **Appendix G**.

PROJECT PRIORITIZATION

For prioritization purposes all of the individual projects have been placed in one of these four categories. It is recommended that the overall progression of project development proceed in the general order of: (1) Invasive Species Eradication; (2) Public Safety and Access and Citizen Well-being; (3) Water Quality; and, (4) Park and Miscellaneous Improvements.

PROJECT CATEGORIES

[Order of Preference ➔]

Invasive Species Eradication (1st)	➔	**Public Safety & Access (2nd)**	➔	**Water Quality (3rd)**	➔	**Park & Misc. Improvements (4th)**

While it is acknowledged that due to funding levels, budget cycles, available resources, and other considerations, some projects may be moved ahead of other lower-ranked projects, the overall direction of project development should generally follow the project rankings included in this master plan. Priority rankings of the individual projects under the above project categories are included in **Appendix F**.

Project Timelines

The establishment of exact timelines for construction of the individual projects along San Felipe Creek is difficult without also establishing a detailed annual construction budget. The annual construction budget will be dependent on City budgeting priorities and available revenue, federal and State funding opportunities including grant monies, and other opportunities for cost sharing including donations and local volunteer participation. The following Immediate, Short-Term, and Long-Term project categories have been established:

- **Immediate Projects** - includes those projects that are recommended for action as soon as funding can be made available; due to the high importance placed on Invasive Species Eradication by the residents of Del Rio the highest priority projects are limited to the eradication of *Arundo donax* along San Felipe Creek from the Highway 90 bridge to Tardy Dam;
- **Short-Term Projects** - includes those projects that have the potential to positively impact public safety and access along the creek, or will provide a significant impact to water quality within San Felipe Creek; a short-term project is considered to be a project that will be started within five years; based on public surveys, public comments, and on-site inspections of the creek area the projects of most importance from a water quality perspective are cane eradication, bank repair and stabilization projects, and vegetation enhancement projects; and,
- **Long-Term Projects** - includes those projects not previously included as an Immediate project or a Short-Term project; long-term projects will tend to have a marginal benefit to water quality, have a high construction cost, or are projects that replace a currently functional system or improvement (e.g., an existing asphalt parking lot).

PLAN IMPLEMENTATION

Financing Options

It is important to remember that due to the timing of applications and program requirements, it may not be possible to implement the different projects in order of their priority. For example if funding is obtained for trail rehabilitation and trail extensions prior to securing funding for invasive species eradication it would be advantageous to do the trail work first even though it may have a lower priority. Complete execution of the projects outlined and adopted as part of the Plan will hinge heavily on the understanding of the importance of flexibility in the implementation strategies.

Below are a list of different funding sources and options:

> **Local Funding:** Annual Budgeting Process; Public-Private Partnerships; Foundation Funding.
>
> **State and Federal Sources:** Texas Water Development Board; Texas Commission on Environmental Quality; Texas Parks and Wildlife Department; Texas Department of Transportation; Texas Department of Agriculture; U.S. Fish and Wildlife Service; U.S. Department of Agriculture; U.S. Department of Commerce; North American Development Bank/Border Environment Cooperation Commission; and the U.S. Environmental Protection Agency.

It is anticipated that there will be a limit to the availability of local resources to fund the proposed projects. The success and completion of the projects outlined in the final Master Plan will ultimately depend on the ability to secure combinations of financing from grants, low interest loans and donation from foundation funds.

Another important factor in the success of the Plan will be the continued fostering of strategic partnerships. The continued cooperation and success of these working relationships will be one of the driving forces behind securing funding for the individual projects.

CONCLUSIONS & RECOMMENDATIONS

Conclusions

San Felipe Creek has been the focal point of residents and visitors to the Del Rio area for thousands of years. The creek itself and the endangered species that live in the creek are particularly vulnerable to activities that occur in and around the creek area. To keep the creek and its surrounding areas healthy and vibrant for use by the creek's animal inhabitants, as well as local residents and visitors an organized effort of creek improvements and site development should be undertaken. By following an organized plan, including the recommendation in this

Master Plan, San Felipe Creek can be protected from harm and this area improved to allow the creek to once again become the focal point of this region of Texas.

Recommendations

The following is a summary of the major recommendations and includes a reference to the appropriate section of the Master Plan that discusses in detail the particular recommendation:

- **Coordinate** any planned improvement projects or other activities with local, State, and federal agencies (3,5,6, 5.3);
- **Elimination of invasive species** including Arundo donax (6.1, 9.3.1) and Armored catfish (6.2, 9.3.2);
- **Water quality best management practices (BMPs)** including structural BMPs (4.7.1, 9.4.1) and non-structural BMPs (4.7.2, 9.4.2);
- The following **Improvement Projects** should be pursued including Bank Improvements (9.5), Creek Side Improvements (9.6), Hike & Bike Trail Improvements (9.7), Infrastructure improvements (9.10), public education opportunities (9.9), and Land Management Strategies (9.10);
- **Project prioritization** which in general should follow the general order of: (1) Invasive Species Eradication; (2) Public Safety and Public Access improvements; (3) Water Quality improvements; and, (4) Park and Miscellaneous improvements; the developed individual project priority rankings should be used as a guide to determine the projects of highest-priority (10.2, 10.3);
- **Project time-frames** have been outlined as Immediate, Short-Term, and Long-Term; the timing of projects will most likely be determined by project funding, however, the projects should be completed in the most aggressive time-frame possible (10.4); and,
- **Project funding** should actively be pursued from all possible sources including local, State, and federal sources, the development of public/private partnerships, as well as individual and institutional donations (11.0).

1. BACKGROUND INFORMATION

1.1 Introduction & History of San Felipe Creek

Area Description, History & Reason for Planning Effort

San Felipe Creek originates approximately six miles northwest of Farm Road 2523 in southeastern Val Verde County and flows towards the southwest for eighteen miles to its mouth on the Rio Grande. The creek flows through the center of the City of Del Rio in Val Verde County, Texas. San Felipe Creek is primarily supplied by water flowing from the San Felipe Springs at a flow rate that typically ranges from 50 – 90 million gallons per day. The creek is the sole source of drinking water for the City of Del Rio and Laughlin Air Force Base. The stream has always been a primary recreation attraction for the citizens of Del Rio.

The drainage basin for San Felipe Creek upstream of the project area is approximately 25,800 acres (40.3 square miles) and consists of rural lands as well as highly urbanized areas. The urbanized areas help to exert an influence on the character and quality of water that flows in the creek. The stream has cut across limestone, shale, siltstone, and clay to form its valley. The native vegetation consists primarily of water-tolerant hardwoods and conifers, pecans, oaks, junipers, grasses, and mesquites. A significant presence of invasive species now exists in San Felipe Creek including Arundo donax (giant reed) and armored catfish (*Hypostomus plecostomus)*, which are now located in many areas within or along the banks of the creek.

Archeological evidence indicates that the creek has been a source of water for thousands of years. The creek was named by Spanish missionaries who arrived in 1635. The founding of the San Felipe Agricultural, Manufacturing and Irrigation Company in 1868 lead to the use of the creek as a source of irrigation water via a canal system and allowed the cultivation of several thousand acres of land. The canal system established is still in use today.

San Felipe Creek is home to many unique animal species. Among them are the Devils River Minnow that has been listed as a threatened species by the United States Fish & Wildlife Service (USFWS) since 1999. The San Felipe Gambusia is a recently identified species that is known to reside only in San Felipe Creek and is currently listed as a threatened species by the Texas Park & Wildlife Department (TPWD).

Due to the importance of water quality in San Felipe Creek, both as the sole source of drinking water for the citizens of the area and as the primary habitat of animals in the area, it became apparent to the participants that there was a need for a regional water quality planning study to identify opportunities for protecting water quality throughout the drainage basin. In December 2009 the City of Del Rio submitted an application to the TWDB to secure funding for this planning effort. In January 2011 the City of Del Rio contracted with Naismith Engineering, Inc., and its subconsultant CP&Y and the Rio Grande River Institute to prepare a master plan for the San Felipe Creek area. The City of Del Rio agreed to provide the matching funds necessary to apply for matching funds via a Research and Planning Grant from the TWDB.

1.2 Project Sponsors and Funding Sources

1.2.1 Project Sponsors

The Project Sponsors include the City of Del Rio and the TWDB.

1.2.2 Project Funding Sources

The total planning cost for the project was $140,000.00 of which $70,000.00 would be funded through the TWDB's Research and Planning Grant Program and the remaining $70,000.000 to be provide by the City of Del Rio.

1.3 Project Team

The project team consists of Naismith Engineering, Inc., CP&Y, Sul Ross State University - Rio Grande College, and the Rio Grande River Institute for Sul Ross State University - Rio Grande Research Center.

1.4 Definition of Planning Area

1.4.1 Project Boundaries

The boundaries of the project are confined to the drainage basin of San Felipe Creek which is located in Val Verde County. The primary focus of the master plan includes the area of the drainage basin within the City Limits including the area of the San Felipe Country Club golf course and that portion of San Felipe Creek from U.S. Highway 90 downstream to Round Mountain. The boundaries of the Project Area are shown in **Figure 1.**

1.4.2 Planning Area Definition, Description, and Characterization

The "Planning Area" generally covers the portion of the San Felipe Creek drainage basin upstream of Round Mountain. This creates a planning area footprint of over 40 square miles which is shown on **Figure 2**.

1.5 Description of Planning Process

1.5.1 Organization

The project organization is divided amongst two primary sponsors, the City of Del Rio and the TWDB. The City of Del Rio has designated its San Felipe Creek Commission as its primary contact during the planning process.

1.5.2 Meetings

Meetings were held during the course of the project in an effort to inform the Commissioners and the general public on the project findings, to update them on the progress of the planning effort, and to receive feedback from the Commissioners and the general public. A total of five public meetings were held for the project including meetings in October 2010, July 2011, October 2011, November 2011, and January 2012. Below is a complete list of the meetings that were held over the course of the planning period with the time and location of each meeting noted in parentheses. All meetings, including the San Felipe Creek Commissioners Meetings were open to the general public.

MEETING DATES, TIMES and LOCATIONS:

San Felipe Creek Commission Meetings -

- Kick-off First Public Meeting, **October 20, 2010** (Noon, City of Del Rio City Hall, Del Rio, Texas)
- Progress Meeting No. 1, **July 25, 2011** (Noon, City of Del Rio City Hall, Del Rio, Texas)
- Progress Meeting No. 2, **October 26, 2011** (10:00 a.m., City of Del Rio City Hall, Del Rio, Texas).

- Draft Master Plan Presentation, **February 16, 2012** (11:30 a.m., City of Del Rio City Hall, Del Rio, Texas).
- Final Master Plan Presentation, **June 28, 2012** (City of Del Rio City Hall, Del Rio, Texas).

Public Meetings -

- Kick-off First Public Meeting, **October 20, 2010** (5:30 p.m., City of Del Rio Convention Center, Del Rio, Texas)
- Public Meeting - Progress Meeting No. 1, **July 25, 2011** (5:30 p.m., City of Del Rio Convention Center, Del Rio, Texas)
- Public Meeting - Progress Meeting No. 2, **October 26, 2011** (5:30 p.m., City of Del Rio Convention Center, Del Rio, Texas).
- Public Meeting - Draft Master Plan Presentation, **February 16, 2012** (5:30 p.m., City of Del Rio Convention Center, Del Rio, Texas).
- Public Meeting - Final Master Plan Presentation, **June 28, 2012**) (City of Del Rio Convention Center, Del Rio, Texas).

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2. SAN FELIPE CREEK WATERSHED

2.1 Introduction & History

San Felipe Creek flows through the heart of the City of Del Rio and has been a focal point for this area of Texas for thousands of years. The Creek and its drainage basin are located in Val Verde County, with the majority of the drainage basin lying within the City's City Limits or its Extraterritorial Jurisdiction (ETJ), and the majority of the Creek lying within the City Limits. Creek flow is supplied mainly by a series of springs known collectively as San Felipe Springs and collectively these springs discharge an average of 50 to 90 million gallons of water a day making San Felipe Springs the fourth largest natural spring in Texas. This water serves as a source of drinking water, irrigation water, and provides a recreational opportunity that has been enjoyed by community residents for as long as anyone can remember. San Felipe Creek is home to the San Felipe gambusia, a fish that only occurs in San Felipe Creek and has been listed by the TPWD as a threatened species, as well as the Devils River Minnow, a fish listed by both the TPWD and the USFWS as a threatened species.

Archeological findings demonstrate that the Val Verde County area has been home to humans for thousands of years. As early as 1590, European explorers are known to have visited San Felipe Springs. In 1862 the Taylor family established the first permanent settlement along San Felipe Creek which is considered by many to be the founding of Del Rio. In the ensuing years the springs and the Creek have served as a source of water for travelers, missionaries, military, and settlers. The Creek was dammed by the San Felipe Agricultural & Mining Company (SFAMC) in the 1870's and through a series of canals provided irrigation to approximately 5,000 acres of land located south of the downtown area. Since that time the Creek has provided water for drinking and irrigation purposes, and as a source of power for the operation of gristmills, electric power plants, an ice plant, and other businesses and industries that located to the area.

The Balcones Escarpment runs along the southern and eastern edges of the Edwards Plateau, generally from north of Austin, southward to San Antonio, then westward toward Del Rio. This line of cracked and fractured limestone provides an ideal release point for water stored deep underground in a reservoir known as the Edwards Aquifer. The waters from San Felipe

Springs have dissected limestone, shale, siltstone and clay to form a valley and has created a creek that is characterized by a mostly rocky, gravelly bottom area lined by water-tolerant pecans, oaks, junipers, grasses, and mesquites.

San Felipe Springs is actually a series of ten or more springs that originate approximately three miles northeast of downtown Del Rio and extend for more than a mile along San Felipe Creek. Two major springs, known as the East (aka, Spring #3) and the West Spring (a.k.a., Spring #4) account for approximately 75 percent of the creek flow, and together provide the sole source of drinking water for the City of Del Rio and Laughlin Air Force Base. The Creek flows for an approximately 9 miles in a mostly southern direction, ultimately discharging into the Rio Grande downstream of the International Amistad Reservoir.

With portions of the creek's drainage basin lying within an urbanized area, the creek and its ecosystem are vulnerable to activities typical of such an area. Such activities can have a significant impact on the water supply and water quality of both San Felipe Creek and the Rio Grande downstream of Del Rio. San Felipe Creek is part of the Rio Grande Basin and is identified by the Texas Commission on Environmental Quality (TCEQ) as Segment 2313. In the past, the San Felipe Creek river segment has been identified by the TCEQ, or its predecessor agencies, as being water quality impaired.

Additional details on the history and characteristics of San Felipe Creek and the surrounding area is included in the Environmental Documentation (**Appendix A**) and the previously approved San Felipe Creek Vision Plan (**Appendix C**).

2.2 Geology, Geography, Climate & Demographics

2.2.1 Geology, Geography & Climate

The City of Del Rio is located in the southeast corner of Val Verde County at the crossroads of US Highways 277 and 90. The City lies along the southwestern edge of the Edwards Plateau, the northwestern edges of the south Texas brush country known as the Tamaulipan mezquital, and the eastern edge of the Chihuahuan Desert. The convergence of these three distinct ecosystems results in an area is characterized by a diverse mixture of desert shrub vegetation, grasses, and trees.

The Del Rio area is underlain by the Edwards Aquifer which is comprised of Edwards Limestone, which is a several hundred foot thick layer of porous, fractured rock that has the ability to store and convey significant quantities of water. The area terrain is generally level with some areas dissected by canyons and drainage channels. The downtown area is located approximately 3 miles from the Rio Grande and the international border with Mexico.

The climate is semi-arid with drought conditions present during parts of most years. The average annual rainfall is approximately 18 inches, with most of the rainfall occurring in the form of thunderstorms between the months of April through October. Even though it is located over 300 miles from the Gulf of Mexico the area is subject to airmasses that move in general northwesterly direction off the Gulf. Of particular concern are tropical weather systems that move in land and have the ability to produce large amounts of precipitation in a short period of time. The hottest time of year usually occurs in the month of August which has an average high temperature of 96.2 degrees and an average low temperature of 74.3 degrees. The coolest time of year usually occurs in the month of January which has an average high temperature of 62.8 degrees and an average low temperature of 39.7 degrees.

2.2.2 Demographics

Val Verde County has a total population of approximately 49,000 (US Census 2010). The City of Del Rio is the County Seat and currently has a population of approximately 35,591 (US Census 2010) with an estimated 11,298 households. The racial makeup is of the City was 84.6% White, 1.5% Black, 0.5% Native American, 0.5% Asian, 0.1% Pacific Islander, and 2.0% from two or more races. Persons of Hispanic or Latino origin comprised approximately 84.1% of the population. The median household income was $31,990, with approximately 23.9% of all person below the poverty line. Persons under 18 years of age comprised 29.4% of the population, which exceeded the 27.3% average for all of Texas. Persons 65 years of age or older comprised 13.2% of the population, which exceeded the 10.3% average for all of Texas.

2.3 Existing Development

The San Felipe Creek area has been under development for hundreds of years. However, the first permanent settlement of Del Rio has been credited to James Taylor and his wife Paula Losoya Taylor who established permanent residence near San Felipe Creek in 1862, known as San Felipe Del Rio. The community applied for a city charter in 1875; however the City was not officially incorporated until 1905. The boundaries for this new city included the areas of modern day downtown, as well as the area along San Felipe Creek.

The San Felipe Creek drainage basin has distinct areas of development. The area of the creek south of US Highway 90 is primarily single-family residential, with some municipal buildings, parkland property, light industrial uses, and agricultural operations. Much of the immediate bank areas in this portion of the creek include property owned or controlled by the City of Del Rio. Residential single-family development in this portion of the drainage area includes large sections with a developed density of 5 to 6 homes per acre. The neighborhoods bordering San Felipe Creek are mostly developed for the area of the creek up to 3 miles downstream of the US Highway 90 Bridge.

North of US Highway 90 the area of the drainage basin within the City Limits is a mixture of commercial properties, large-lot (estate lot) single-family residential (per zoning), and single-family residential. The northern portion of the drainage basin outside the City Limits primarily includes a large amount of undeveloped properties which are used for agricultural operations and some oil and gas development. Immediately north of the US Highway 90 Bridge across San Felipe Creek is the San Felipe Country Club which is located on approximately 88 acres of land and includes a nine hole golf course, club house, and swimming pool. The Country Club was organized in 1921 and the golf course property currently surrounds San Felipe Springs #1, #2, #3, and #4.

2.4 Floodplain

San Felipe Creek and its adjacent areas are directly impacted by floodwaters. Weather frontal systems may stall over the area or tropical weather systems from the Gulf of Mexico may occasionally drift inland, with each system having the capability of creating large rainfall rates that can significantly impact short-term stream flows.

One such event occurred in August of 1998 when the remnants of Tropical Storm Charley drifted inland from the Gulf of Mexico and stalled over the Del Rio area generating as much as 15 inches of rainfall in a 12-hour period. The rainfall resulted in a massive increase in the flow of San Felipe Creek sending a 5 foot wave of water down the creek. The floodwaters devastated the neighborhoods that adjoin San Felipe Creek, killing 9 people, destroying 200 homes, and damaging over 1,000 properties. The City is still recovering from this tragic event and evidence of flood damage can be seen along parts of the Creek.

The 100-year floodplain straddles San Felipe Creek and affects neighboring properties on either side of the creek. In addition to the 100-year floodplain, the floodway accounts for a large portion of the creek-side property of San Felipe Creek, particularly for that portion of the Creek downstream of US Highway 90. The approximate boundary of the existing 100-year floodplain is shown on the Existing Land Use Map (**Figure 3**).

2.5 FEMA Buyout Properties

As a result of the 1998 Flood created by Tropical Storm Charley, the City of Del Rio has worked with the Federal Emergency Management Agency to buy flood-prone or vulnerable properties along San Felipe Creek. The FEMA Buyout Program has included over several hundred individual properties and has resulted in the purchase of over 275 acres of land. As part of the participation agreement any building on the property is moved or demolished, and the vacant land is then restricted from further or future development in an effort to minimize possible damage from subsequent storm events. The approximate locations and boundaries of the FEMA Buyout Properties are shown on the Existing Land Use Map (**Figure 3**).

2.6 Zoning

Zoning is the process by which the City may designate or control a particular land use for properties within the City Limits. The zoning process provides the City the ability to control and encourage the type of development that will occur on a particular property, or within a certain boundary or area. Zoning also allows the City to group compatible land uses and to prohibit development or activities on properties that may be considered incompatible by adjoining property owners or area residents. The City's ability to zone property for a designated use only applies to those areas within the City Limits and is not applicable to areas outside the City, including those areas within the City's ETJ.

The portion of the San Felipe Creek drainage basin upstream of Round Mountain lies both inside and outside the City Limits and has a combined area of approximately 25,800 acres. At the present time approximately 3,162 acres (or 12%) of the drainage basin lies within the City Limits and approximately 22,638 acres (or 88%) lies outside the City Limits.

Current zoning in the San Felipe Creek drainage basin consists mainly of single-family residential areas including both small-lot and large-lot development. Also, present within the drainage basin are commercial and industrial properties. A copy of the City's current Zoning Map is included as **Appendix H**. Of particular importance is the significant amount of City-controlled property adjacent to San Felipe Creek. This City property includes parks, municipal buildings, open space, and recently acquired FEMA Buyout properties.

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3. PROJECT GOALS, OBJECTIVES, STRATEGIES & PRIORITIES

The development of a Water Quality Master Plan includes many elements both technical such as engineering and biology as well as policy issues. Working with the San Felipe Creek Commission ("Commission") and from public input at meetings during the planning process it is evident that there is a strong community desire to address both short and long term needs to protect water quality, continue public access and protect endangered species in San Felipe Creek. Establishing goals, objectives, strategies and priorities are a critical part of the plan. They form the basis of communicating with the public and provide a basis for decision makers to allocate resources to implement the plan. To assist in this process the following definitions are used as a guide in establishing goals, objectives, strategies and priorities.

3.1 Project Goals

Goals are an expression of what the Del Rio City Council, Commission and general public wishes to achieve in the protection of San Felipe Creek. Goals should be general in nature, reflect community values, and not detail specific actions necessary to achieve the goal. For the San Felipe Creek Master Plan the following goals have been identified:

- As the sole source of drinking water for the City of Del Rio and Laughlin Air Force Base and the headwaters of San Felipe Creek, protecting the San Felipe Springs from water quality and quantity degradation is of paramount importance.

- Protection of both water quality and quantity is important for the maintenance of habitat for endangered species including the Devils River minnow that inhabit San Felipe Creek.

- Eradication of invasive species that have degraded both the water quality and quantity in San Felipe Creek. Specifically the eradication of the river cane and armored catfish and improving the habitat around Blue Hole.

- Continue to have San Felipe Creek as the centerpiece of Del Rio life.

- Provide amenities at or near San Felipe Creek which enhance public use of the Creek while providing water quality protection.

3.2 Project Objectives

The objectives can be described as the milestones that need to be met in order to accomplish the goal. Objectives should be measurable and realistic. For the San Felipe Creek Master Plan the following objectives have been identified:

- Adopt design standards that include requirements for Best Management Practices (BMP's) for water quality protection for new development and where practicable retrofit existing improvements to implement BMP's.

- Provide public facilities that encourage users of the creek to protect water quality in the creek.

- Maintain and repair existing facilities and provide recreational amenities that encourage responsible public use of the creek.

- Encourage the use of native vegetation so that riparian habitat is re-established along the creek which will provide significant ecological benefits by filtering pollutants, controlling soil erosion and supplying habitat for vegetation and wildlife.

- Working with the U.S. Fish and Wildlife Service, the U.S. Department of Agriculture, and the Texas Parks and Wildlife Department to develop a plan for eradication of invasive species in and around the creek and for the cleaning of Blue Hole.

- Assure that open space is for public use and as habitat for plants and wildlife while being maintained to protect adjacent neighborhoods.

- Work toward a balance of public access and habitat protection for San Felipe Creek through ordinance enforcement, enhanced maintenance, and public education.

3.3 Project Strategies

Strategies are the details on how to implement the objectives.

3.4 Project Priorities

Projects identified in the plan need to be prioritized in order to allocate resources from the identified strategies.

3.5 Project Constraints

In order to develop project priorities and strategies for their implementation, the constraints that are facing the project must be identified. A project constraint is something that has the potential to influence or impact the potential strategies to be employed to meet the project goals. Project constraints include the existing floodplain, the FEMA Buyout Properties, existing zoning and land use, current City ordinances, land ownership and control, endangered and threatened species, invasive species, and financial considerations. Each identified constraint should be considered for its potential to impact any proposed project implementation strategies, projects, or other project related activities.

3.5.1 - Floodplain

The existing 100-year floodplain straddles San Felipe Creek throughout the project area (**Figure 3**). Such an occurrence is typical of a creek or river, however, the boundaries of the 100-year floodplain will significantly impact how a property is developed. Development of property within the 100-year floodplain must follow FEMA guidelines and must comply with applicable City ordinances and regulations. FEMA requirements stipulate that no residential structures may be constructed within the boundaries of the 100-year floodplain unless the building's lowest floor (including basements) is elevated to or above the elevation of the 100-year flood event (a.k.a., the "base flood event"). City of Del Rio Floodplain Protection ordinances require residential structures to have a finished floor elevation at least two (2) feet above the base flood elevation. Also, non-residential structures must be flood-proofed in accordance with FEMA requirements, while City Floodplain Protection ordinances prohibits the operation of any nonresidential use with the delineated FEMA floodplain.

To address the constraints presented by the 100-year floodplain it is recommended that any non-residential development proposed by this master plan be located outside the boundaries of the 100-year floodplain or flood-proofing of the proposed improvements should be required. As an alternative to flood-proofing, limiting construction of proposed improvements within the 100-year floodplain to ground-level improvements would satisfy typical FEMA requirements.

3.5.2 - FEMA Buyout Properties

As previously detailed in Section 2.5, the FEMA Buyout Program has included the purchase of several hundred individual properties for a total of over 275 acres of land (**Figure 3**). The program allows for the purchase of property, with the funding assistance from FEMA, that is vulnerable to damage by floodwaters or that may contribute to or exacerbate flooding conditions. Any property purchased as part of this program is owned by the City of Del Rio and the program requires that any building on the property must be moved or demolished. The vacant land is then restricted from further or future development with no permanent structures allowed on the property. The land must forever remain as open space.

The significant area of land along San Felipe Creek provides the City with numerous options with respect to its future use. FEMA regulations will allow the land to be used as open space, parks, trails, a wildlife or nature refuge, community gardens, greenways, or permeable parking areas. Gazebos would also be allowed on the property provided they were open-sided. As projects are planned these types of uses should be considered for the FEMA Buyout properties.

3.5.3 - Existing Zoning / Land Use

As summarized in Section 2.6, zoning is the process by which the City may designate or control a particular land use for properties within the City Limits. A property's zoning designation will allow certain development to occur on the property. The portion of the San Felipe Creek drainage basin that lies within the City Limits consists mainly of properties zoned for single-family residential development, including both small-lot and large-lot development. Also, present within the drainage basin are commercial, industrial properties, and multi-family residential properties. The current Zoning Map for the City of Del Rio has been included in **Appendix H**.

As project area planned for development within the zoned portions of the San Felipe Creek drainage basin, the project must be adapted to conform to the current zoning requirements for the property, or a request in the zoning designation will be required. For individual projects, the zoning of surrounding properties should be considered to ensure that the proposed development is consisted with the existing and proposed land uses in the area.

3.5.4 - Ordinances

The City has several existing ordinances that have the potential to impact any future projects or improvements planned within the San Felipe Creek drainage basin. Ordinances of significant importance have been identified and are summarized in Table 3.1 on the following page.

3.5.5 - Land Ownership/Control

Land ownership in the San Felipe Creek drainage basin is a mixture of public-owned and privately-owned properties. Depending on the owner, access to a particular property may be restricted. Land ownership should be considered when planning projects and control of the property should be obtained, either through ownership or an access easement, to ensure that the planned activities are allowed. This issue of land ownership will be particularly important during the process of invasive species eradication. Currently, there are large areas of invasive river cane along the banks of San Felipe Creek that are on private property. Prior to any eradication efforts, the City must work with the private property owners to ensure that access agreements are in place for any planned entrance by City crews or City-procured contractors. Where possible, the use of a public-private partnership is encouraged to allow access to property with respect to invasive species eradication.

Table 3.1. Applicable City Ordinances.

Ordinance No.	Ordinance Details
Chapter 7 - Art. IX.	**San Felipe Creek Master Plan Commission.** Establishes the Commission and details its structure, duties, and authority. Indicates that projects along San Felipe Creek within the Scope of the Master Plan shall be reviewed by the Commission prior to city council action.
Chapter 11.	**Flood Damage Prevention.** Restricts or prohibits construction within the designated floodplain/floodway in an effort to prevent or minimize flooding or flood damage/losses. New construction shall be designed and constructed to minimize flood damage.
Chapter 12.	**Food and Food Establishments.** Regulates eating and drinking establishments, food and drink vendors, caterers, and kitchens preparing food for sale, and mobile food units. Outlines requirements for review of construction plans & pre-operational/ regular inspections.
Chapter 16.	**Licenses and Business Regulations.** Outlines requirements for licenses and permits required by businesses or establishments within the City Limits.
Chapter 19.5.	**Parks, Recreation and Public Gathering Places.** Outlines regulations and standards for behavior, use, and activities within City parks, recreation and public gathering places. Establishes & details the duties of the San Felipe Creek Walk and Brown Plaza Associations.
Chapter 19.5 - Art. IV	**San Felipe Creek Walk Association.** Establishes the San Felipe Creek Walk Association to plan, manage, and coordinate activities conducted along the San Felipe Creek Walk area. Allows fees to be charged to individual, organizations, and concessionaires.
Chapter 20.	**Peddlers, Solicitors and Vendors.** Regulates vendors and solicitors including street vendors who sell merchandise within the City Limits.
Chapter 23.	**Sewers.** Regulates the discharge of wastes into public waters, as well as the City's sewer system, including fats, oils and greases. Establishes the requirements for a discharge permit. Regulates private sewage facilities.
Chapter 24.	**Solid Waste.** Regulates the collection and disposal of solid waste within the City Limits. Prohibits the collection or storage of solid waste materials on private property in an effort to keep waste materials out of public waters, and from creating a nuisance condition.
Chapter 29.	**Water.** Establishes rules and regulations for the City's water system, including the regulation of water wells, the operation of the City's distribution system, and for water conservation and drought contingency plans.
Chapter 30.	**Zoning.** Guides land development within the City Limits. Helps protect existing land owners, while retaining the City's rich historical heritage and protecting the environment. Ensures growth follows the City's Comprehensive Master Plan (the Del•RioPlan).

3.5.6 - Endangered/Threatened Species

San Felipe Creek plays host to threatened and endangered species. The Devils River Minnow has been listed as a threatened species by the United States Fish & Wildlife Service (USFWS) since 1999. The San Felipe Gambusia is a recently identified species that is known to reside only in San Felipe Creek and is currently listed as a threatened species by the Texas Park & Wildlife Department (TPWD). Additional information on these species and other threatened or endangered species known to be present in and around the project are discussed in more detail in the Environmental Documentation portion of this Master Plan included in **Appendix A.** The presence of these threatened species in the planning area will likely require that the type and extent of any planned improvements in and around the area of the creek must avoid having a negative impact on the habitat of the species in the creek.

During the development of this master plan a line of communication has been maintained with the USFWS staff members. As project development continues it will be important to continue these communication efforts. It will also be necessary to demonstrate to both federal and State agencies that planned improvements will result in positive impact on San Felipe Creek and the critical habitat the creek provides. The use of design and construction techniques that will help to minimize construction impacts and maintain or improve the creek habitat will be a key ingredient in the successful implementation of this Master Plan.

3.5.7 - Invasive Species

A significant presence of invasive species now exists in San Felipe Creek. Two of the most noticeable invasive species include Arundo donax (a.k.a., Giant Reed or River Cane), which is now located in many areas along the banks of the creek, and armored catfish (*Hypostomus* sp.) which appear to be present in almost all portions of the creek, especially in the section downstream of US Highway 90. These species are important due to their negative impact on the habitat of native species that live in and around the creek area. The Arundo donax is a significant water user and also out-competes other native vegetation in the riparian area of the creek, destroying the native habitat along the banks of the creek. The armored catfish may out compete the native species for food, and may also contribute to the destruction or damage of creek habitat due to their habit of burrowing into and under the bank area which can ultimately result in bank failure, which can contribute to an increase in suspended sediment in the creek and a loss of established riparian area.

The elimination of invasive species in the San Felipe Creek drainage basin could be an important part of improving the water quality of San Felipe Creek. The eradication of the Arundo donax would improve creek habitat by allowing native vegetation to grow in and around the creek area, and would also help in maintaining or increasing the creek flow by eliminating a significant source of water demand. As the Arundo donax is eliminated it will be important to encourage the establishment of native vegetation in these areas. **Appendix B** provides a more complete outline of the Arundo donax problem and offers recommendation on how to eradicate this species from the San Felipe Creek drainage basin.

Control of the armored catfish would help to eliminate a possible source of competition for food, and would significantly reduce the bank erosion and destruction currently occurring within the project area. At the present time this species is being studied to determine if a suitable population control method is possible.

3.5.8 - Financial Considerations

As with any master planning project, the identification of, and planning for, needed and desired projects is only part of the mission. For the San Felipe Creek area many of the proposed projects or programs identified during the planning process will have a significant cost associated with their implementation. As the master plan moves from the planning stage to the implementation stage, the focus will be on obtaining the financial resources necessary to allow the plan to become a reality. The construction of individual projects or the initiation of new programs will have to be planned and scheduled to accommodate the financial constraints facing the City and local community.

4. WATER QUALITY

4.1 Definition of Water Quality

The definition of water quality can development of the Master Plan. For planning purposes water quality can be defined as the condition of water, as affected by chemical, physical, biological and habitat factors, and its hydrological regime, for use as a drinking water supply, for protection and propagation of wildlife, and for aesthetic and recreational use within the area of concern.

Water quality is often times a subjective term that has no universal definition among scientist, engineers, and land planners. However, the use of certain water quality parameters allows for the assessment, monitoring, and control of water quality. Some of the more common water quality parameters are solids, dissolved oxygen, nutrients, pathogens, petroleum hydrocarbons, metals, synthetic organic compounds, and physical parameters (i.e., temperature, pH, conductivity, etc…).

San Felipe Creek provides and supports critical habitat for the plants and animals living in and around the creek area. This habitat is most notably found to have the following characteristics: fast-flowing, spring-fed aquifers; high quality, pollutant-free waters; gravel stream bottom; and, diverse plant & animal biomass.

4.2 Existing Water Quality Regulatory Programs

There are many existing regulatory programs in place that deal with water quality and water quality issues. Although there are numerous specific water quality regulatory programs at both the federal and state level, the major programs pertaining to this planning effort are summarized below. More information on the specific requirements of each program can be obtained from the implementing agency.

4.2.1 TCEQ TPDES Regulations

The Texas Pollutant Discharge Elimination System (TPDES) regulations are state requirements instituted based on the federal Clean Water Act (CWA) and the Texas Water Code (TWC). The TCEQ has been officially delegated federal permitting authority for the

TPDES program under the National Pollutant Discharge Elimination System (NPDES). This means that the TCEQ administers the permitting and enforcement program for all NPDES discharges (all point source wastewater discharges and certain storm non-point source discharges) in the state.

The regulations require that a combination of "structural" and "non-structural" controls be utilized under the terms of an individual permit or other regulatory approvals, including permits by rule and general permits. These regulations include requirements for public notice and public involvement in the regulatory approval process. These regulations govern numerous types of discharges, including point source wastewater discharges and storm water non-point source discharges.

4.2.1.a - Point Source Wastewater Discharges

TCEQ TPDES regulations govern all point source wastewater discharges in the state, including domestic and industrial wastewater. These discharges are required to meet the treatment standards and effluent quality identified in the regulations.

The TCEQ has established Critical Water Quality Parameters listed in Chapter 7: Texas Surface Water Quality Standards, Chapter 307, §§307.1-307.10, required to allow human use and maintain aquatic life. These standards also include maximum threshold criteria for specific toxic materials for aquatic life protection. Parameters included in the TCEQ Water Quality Standards for specific stream segments in each river basin include: 1) chlorides; 2) sulfates; 3) total dissolved solids; 4) dissolved oxygen; 5) pH; 6) indicator bacteria; 7) temperature; and 8) flow criteria below which some of these previous standards (1-7) will not apply. The standards also list acute and chronic criteria for 39 different toxic materials.

4.2.1.b - Municipal Storm Water Discharges

In the early 1990's, EPA adopted the Phase I Storm Water Regulations. Among other things, these regulations governed storm water non-point source (NPS) pollution from large (greater than 100,000 population) municipal separate storm sewer systems (MS4s). Under Phase I, MS4s were defined as publicly owned separate storm sewers that are located in an incorporated municipality or county with a population of 100,000 or more. The owners and/or operators of these MS4s were required to obtain individual permits, characterize their storm water, institute certain monitoring and control measures, and conduct public education.

In 1999, the EPA adopted the Phase II Storm Water Regulations, which extended storm water NPS regulation to smaller MS4s in defined urbanized areas. Under Phase II, the definition of an MS4 was expanded to include any storm water conveyance or system of conveyances that is operated by a public entity within these defined areas. While the Phase II storm water regulations do not require cities to obtain individual permits, they must characterize their storm water and develop, implement, and enforce a Storm Water Management Plan (SWMP), designed to reduce the discharge of pollutants from their MS4 to the "maximum extent practicable." The TCEQ issued a general permit (TXR0400000) to be used by all small MS4s on August 12, 2007 wishing to obtain coverage through a general permit.

At the present time, the City of Del Rio is not subject to either the Phase I or Phase II general permits. However, the EPA and TCEQ continue to promulgate regulations that could potentially affect the City with regards to the operation of a storm water collection system. The City should continue to monitor these regulatory agencies in order to stay abreast of the latest rule making activities.

4.2.1.c - Industrial Site Storm Water Discharges

In addition to regulating municipal NPS storm water discharges, Phase I of the EPA's storm water regulations also governed a wide range of industrial site discharges. The list of regulated industrial activities was expanded in the Phase II storm water regulations. These industrial discharges are subject to numerous technical standards. The TCEQ has currently issued a general permit that can be used to cover discharges from industrial facilities meeting certain conditions. Industrial storm water dischargers can also obtain an individual TPDES permit, in lieu of utilizing a general permit. Both the individual and general permits require permittees to characterize their storm water and institute certain control measures. Industrial discharges obtaining coverage through a general permit are required to notify any applicable MS4s that may receive their storm water discharges.

4.2.1.d - Construction Site Storm Water Discharges

The TCEQ issued the Construction General Permit (CGP) on March 5, 2008 that regulates discharges from many construction activities. (TCEQ CGP No. TXR150000). Based on this permit, construction activities that generate runoff that goes into or adjacent to any surface water in the state are regulated according to the area of land disturbed. In general, all construction activities which disturb at least 1 acre of land are regulated under this permit. This 1 acre threshold applies to all parts of sites with a "common plan of development", even if they are not constructed at the same time. The requirements of this provision apply regardless of the type or sequencing of construction. The application of this provision to commercial and multi-family residential construction is straightforward. However, this provision also governs all construction (including individual residences) within a typical residential subdivision, even if the residences are constructed well after the construction of the common development components (e.g. streets, drainage facilities, etc) is completed.

Current federal and state regulations require controls to be implemented to prevent storm water discharges from construction sites from adversely impacting water quality. TCEQ rules and regulations prohibit discharges from construction sites that "would cause or contribute to a violation of water quality standards or that would fail to protect and maintain existing designated uses." These regulations also require all control measures to be "adequately maintained to effectively reduce or prohibit erosion". Owners and operators are required to "describe and ensure the implementation of practices that will be used to reduce the pollutants in storm water discharges associated with construction activity at the construction site and assure compliance with the terms and conditions" of the regulations. Erosion and sediment controls must be designed to retain sediment on-site to the extent practicable with consideration for local topography, soil type and rainfall.

4.2.1.e - TCEQ OSSF Program

The Texas On-Site Sewage Facility (OSSF) Program is based on the Texas Health and Safety Code and is administered by the TCEQ. These regulations govern the installation, operation and maintenance of OSSF's including septic tanks, irrigation systems, proprietary treatment systems and others. The program utilizes primarily "structural" controls, is implemented through a permit program, and can be delegated to qualified local governments. In the planning area Val Verde County is the authorized agent that implements the TCEQ OSSF program.

4.2.1.f - Federal Endangered Species Program

The federal endangered species programs are administered by the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) and are based primarily on the federal Endangered Species Act (ESA). The programs have several different elements. The first element is a "Listing Program" which includes procedures to evaluate and list "threatened" and "endangered" species, as mandated by the ESA. In instances where the implementing agency identifies a species as endangered, a Species Recovery Plan (SRP) is to be developed. Another element of the programs is a review of "Federal Actions" to avert or minimize their impact on endangered species. This requires all federal agencies to aid conservation efforts for endangered species and to consult with USFWS on direct federal actions, actions using federal funds, and the issuance of permits under federal programs, including delegated states. A third element of the programs is to prohibit the taking of endangered species. The implementing agency is allowed to adopt provisions to prohibit the taking, possession, sale, or transfer of certain endangered species, to allow the issuance of incidental take permits, and to coordinate Habitat Conservation Plans (HCPs).

In compliance with the ESA the USFWS prepared and published the Devils River Minnow Recovery Plan in 2005. This plan was developed to provide guidance and offer recommendations on efforts that may ultimately lead to the de-listing of the Devils River Minnow. A copy of this plan has been included in this report as **Appendix D**.

4.2.1.g - Other State Water Quality Programs

In addition to the programs presented above, there are several other state programs with a partial focus on water quality. These are listed below with a basic description of the regulated activities:

- Texas Oil and Gas Environmental Program – administered by the Railroad Commission of Texas (RRC), regulates the exploration and production of oil, gas and geothermal resources and the disposal and clean-up of associated wastes.
- Texas Municipal Solid Waste Program – administered by the TCEQ, regulates the transportation, storage, processing and disposal of municipal solid waste (garbage)
- Texas Petroleum Storage Tank Program - administered by the TCEQ, regulates the installation, operation and pollution from petroleum storage tanks
- Texas Industrial and Hazardous Waste Program – administered by the TCEQ, regulates the handling, transportation, storage, processing and disposal of hazardous and non-hazardous industrial solid waste
- Texas Agricultural and Silvicultural Water Quality Management Program – administered by the Texas State Soil and Water Conservation Board (TSSWCB), is a voluntary program to control pollution from certain agricultural operations.

4.2.1.h - Other Federal Water Quality or Related Programs

In addition to the programs presented above, there are several other federal programs with a partial focus on water quality, that have not already been covered under another federal or state program. These include:

- Federal Spill Prevention, Control and Countermeasure (SPCC) Program - administered by the U.S. EPA, regulates the storage and handling of petroleum products and hazardous materials.
- Federal Superfund Program – administered by the EPA, requires the compilation and management of the National Priorities List (NPL) for contaminated sites, governs the clean-up of those sites and outlines the Emergency Planning and Community Right-to-Know program.

- Federal Toxic Substances Control Program – administered by the EPA, regulates the creation, use, transportation, storage, processing and disposal of toxic substances.
- National Wetlands Program – administered by the U.S. Army Corps of Engineers, regulates construction activities, dredging and placement of fill in jurisdictional wetlands and navigable waterways.
- National Floodplain Program – administered by the Federal Emergency Management Agency (FEMA), regulates construction activities and development in floodplains.

4.3 Identification of Water Quality Issues Associated with San Felipe Creek

Based on the goals and objectives established for the Plan, there are many potential water quality threats and many different types of pollutants that may affect water quality. Many of these threats or pollutants result in some way from human activity. The major threats identified by the consultant team are presented below.

4.3.1. Invasive, Non-Native Species

Invasive, non-native species have the potential to negatively impact water quality. As outlined in **Appendix A** and Section 3.5.7, San Felipe Creek is currently being impacted by non-native species including Arundo donax (a.k.a., Giant Reed or River Cane) and armored catfish (*Hypostomus* sp.) which appear to be present in almost all portions of the creek, especially in the section downstream of US Highway 90. The Arundo donax uses a significant amount of water and drives out other native vegetation in the riparian area of the creek. The armored catfish appear to damage the bank areas contributing to erosion and bank stability issues. Each of these species contributes to negatively impacting water quality by increasing the amount of suspended solids introduced into the creek and by reducing the ability of the riparian area to act as a buffer or filter.

4.3.2. Urbanization

Urbanization can threaten water quality in several ways. As used in this plan, the term urbanization refers to the overall shift or trend of an area from a more rural community to a more developed, or urbanized area. Urbanization often results in more impervious cover, which increases storm water runoff rates and volumes, decreases recharge, and decreases base flow in streams. Urbanization also increases the resident population, introducing more human activity into an area. This increase in human activity often results in additional pollutant loadings from storm water runoff, the generation of more wastes (solid and liquid), and an increased use of potentially harmful materials in the newly urbanized area. Urbanization results in increased construction activities which remove natural vegetation and can potentially increase erosion and sedimentation.

As areas change from undeveloped to developed, increases in pollutant loadings to surface water and groundwater and reductions in recharge and infiltration correspond directly to increases in development intensity. In general terms, as development intensity increases, water quality impacts also increase. In the current practice of water quality planning, the intensity of development is most often described by using the percentage of impervious cover resulting from the development. Impervious cover consists of buildings, streets, driveways, parking lots, and other types of impervious surfaces that generally increase the amount of rainfall which turns to runoff and correspondingly decreases the amount of infiltration (recharge).

While there is some disagreement among the scientific community on whether impervious cover is actually the source of additional pollutant loading or whether it is an indicator parameter tied to additional human activity, the threat to water quality posed by urbanization has consensus agreement among the scientific community. This threat in general is acknowledged by the existence of a number of federal and state regulatory programs intended to control the effects of urbanization on water quality through restrictions on land development.

For the planning area, urbanization of the San Felipe Creek drainage basin can be traced back to the Taylor Family's establishment of a settlement along San Felipe Creek in 1862. Since that time the area has seen the construction of homes, shopping centers, schools, roadways, parks, restaurants, convenience stores, and other developments typical of a growing community. At the present time, approximately 12 percent of the San Felipe Creek drainage basin upstream of Round Mountain lies within the City Limits, while 88 percent of the basin lies outside the City Limits. Of the area outside the City Limits, much of it is currently undeveloped.

4.3.3. Lack of Riparian Buffer

In undeveloped areas streams and rivers are typically protected by a vegetated bank area containing native grasses, flowers, shrubs and trees. This area has been termed the "riparian buffer" since the vegetation serves to reduce or mitigate, in a sense "buffer", the potentially harmful effects of sediment, phosphorous, nitrogen, pesticides and other pollutants from reaching the water. A healthy riparian area also provides habitat for animals, helps to reduce water temperatures, reduces flood water velocities thereby aiding in stream bank stabilization and minimizing damage to surrounding properties, and increases dissolved oxygen levels in the water.

As urbanization begins to occur in and around a stream, the riparian area is often degraded or reduced, either through direct construction activities (e.g., bank improvements, channelization, land clearing) or through the secondary impacts attributed to urbanization (e.g., increased stormwater flow rates or volumes). San Felipe Creek, particularly the stream reach between US Highway 90 and Round Mountain, is an example of the impact that urbanization can have on a riparian buffer. Eroded areas, little to no vegetation, invasive non-native species, concrete or stone bank improvements, typify a good portion of the creek bank in this area. This lack of a healthy, native riparian area makes the creek more vulnerable to impacts on San Felipe Creek's water quality by the sediment and pollutant loads constructed by stormwater runoff.

4.3.4 Bank Erosion

Bank erosion is a direct contributor to a decrease in water quality within a stream or river. The erosion of stream banks will add sediment to the water which directly impacts the habitat of a clear, flowing stream by adding suspended solids to the water. Bank erosion also leads to a loss of riparian vegetation which will reduce the stream's ability to buffer the impacts of sediments and pollutants, and can also be a contributor to additional bank erosion.

4.3.5. Vegetative Management

While undeveloped land left in its natural state can be an effective measure for maintaining water quality, other activities occurring on undeveloped land can have adverse impacts on water quality. The majority of undeveloped land that is subjected to human activity is utilized for either agriculture or recreation. The primary threats from undeveloped land subjected to human activity are excessive erosion/sedimentation from disruption of natural vegetation and excessive nutrients and biological constituents.

4.3.6. Stormwater /Non-Point Source Pollution

Stormwater non-point source (NPS) pollution occurs as a result of rainfall events. When human activities or natural processes result in pollutants being present at or near the land surface, these pollutants can be taken up by storm water runoff and can result in NPS pollution. The impacts of NPS pollutants vary widely and depend on the following general factors:

- Topography
- Land surface characteristics
- Human activities or natural processes taking place
- Types of pollutants present

In the United States, NPS pollution has been documented to occur from urbanized areas, industrial/commercial areas, developing areas, agricultural areas, and areas affected by natural disasters (e.g. forest fires, volcanic eruptions, etc.)

Until relatively recently, storm water NPS discharges in the U.S. have been largely unregulated. In the early 1990's, EPA adopted the Phase I Storm Water Regulations, which attempted to address NPS pollution from industrial activity, construction sites greater than five (5) acres in size and from large (greater than 100,000 population) cities. In 1999, the EPA adopted the Phase II Storm Water Regulations, which extended storm water NPS regulation to additional industrial/commercial activities, smaller construction sites (greater than one [1] acre in size) and smaller cities in defined urbanized areas. Many states, including Texas, have been delegated the authority to implement these federal regulatory programs.

Further discussion of storm water NPS pollution is subdivided by the general types of activities that contribute to storm water NPS pollution.

4.3.6.a - Construction Storm Water Discharges

As discussed previously (Section 4.2.1.d), existing regulations govern storm water discharges from construction sites as small as one (1) acre. These regulations require that operators control the discharge of pollutants from the site using a variety of measures. In actual practice, many of the control measures specified in the current regulations are improperly used or improperly operated. In many instances, even when otherwise properly used, certain technologies are inappropriate in certain circumstances. In general, the failure to use the appropriate measures and the failure to properly install, inspect, maintain, and repair the measures used to control storm water discharges from construction sites poses a significant threat to water quality in the planning area, and specifically to San Felipe Creek.

While many different types of pollutants may be discharged from construction sites, the primary pollutant discharged is sediment in the form of suspended solids. The Natural Resource Conservation Service (NRCS) has identified sediment from eroded soil as having the ability to adversely impacting water quality, mainly due to significant changes in the appearance (aesthetics) and chemical characteristics of rainfall runoff. Sediment with the potential to adversely affect water quality can be transported from construction sites in several different ways, including the direct discharge of sediment in storm water, the transport soil, mud, or dirt from construction sites on vehicle tires, through spillage onto roadways and areas outside of control measures, and through accumulated dust which blows off the site. Sediment which leaves the site through one of these mechanisms is then exposed to the elements and can be transported in storm water runoff during the next rain event.

4.3.6.b - Other Storm Water NPS Discharges

Other types of storm water NPS discharges can also pose a threat to water quality in the planning area. Discharges from industrial activities and from urbanized areas are currently governed by TCEQ's storm water programs. The potential pollutants typically found in NPS discharges from industrial activities are similar to those described above for point source discharges. Potential NPS pollutants resulting from urban areas have also been described previously under the discussion on Urbanization. In addition to these two regulated areas, other types of storm water NPS discharges can pose water quality threats. Discharges from agricultural activities can also generate significant amounts of pollutants. Failing to utilize proper tilling and erosion control practices can result in significant sediment generation from areas under cultivation. The sale of agricultural chemicals (primarily pesticides and nutrients) is stringently regulated and their use is controlled through educational processes (e.g. labeling, training, advertising, etc.) However, in areas where these controls are not diligently enforced, significant pollutants can be generated from the improper use of these chemicals. These other storm water NPS discharges also pose a threat to water quality in the planning area.

4.3.7. Lack of Water Quality Protection on Existing Development

While current science indicates to us the threat posed by urbanization, this threat has not always been identified and understood. Based on this lack of understanding, development has been allowed to occur in many areas of the Planning Region without the benefit of water quality protection measures. As presented in the discussion on Urbanization, this development has resulted in additional impervious cover which increases storm water runoff rates and volumes, and has introduced more human activity, resulting in additional pollutant loadings. While more recent developments may incorporate some limited water quality protection measures, the vast majority of the existing development in the Planning Region incorporates little or no water quality protection measures. The existence of this previous development, with no water quality protection measures, poses a threat to water quality in the Planning Region. The same potential pollutants and general types of threats identified in the section on Urbanization, including reduction of recharge and base flow replenishment, apply to existing development with no water quality protection measures.

4.3.8. Point Source Discharges

Point source discharges result from a limited number of activities, but in most areas account for a majority of the non-storm water flows into hydrologic systems. Almost all point source discharges result from the treatment of either domestic wastewater or from industrial/commercial process wastewater. While many different types of pollutants exist in domestic wastewater, the major threat to water quality stems from the excessive discharge of biological constituents (e.g. bacteria, viruses, etc.) and nutrients (e.g. phosphorous, nitrates, etc.) The make-up and character of industrial/commercial process wastewater varies greatly and can include a wide range of chemical, biological, and nutrient constituents.

Point source discharges of wastewater were among the first environmental concerns to be regulated on a national level. Beginning in the early 1970's, the United State Congress established the Environmental Protection Agency (EPA) and initially charged the agency with evaluating and regulating point source discharges. In the intervening time, the EPA and various state-level agencies have identified and regulated most point source discharges.

For the planning area few, if any, permitted point source discharges are known to occur, however, there may be some non-permitted point source discharges in the area. Due to the historic regulation at the federal and state levels, very little local-level regulation of point source discharges has occurred in the planning area. In addition, there is currently little or no legal authority for local entities to regulate point source discharges.

4.4 Identification of Impact of Water Quality on Habitat Restoration & Protection

Typically, rivers, streams and creeks found in natural conditions serve as a complex ecosystem providing a diverse habitat for a large number of plants and animals. A properly functioning stream riparian area can help reduce pollutant load to the creek, can assimilate a variety of pollutant loads to the creek, can provide temporary storage of floodwaters, can lessen damage caused by floodwaters by reducing water velocities, can contribute to the recharge of groundwater resources, and can provide a diverse habitat for plant and animal species.

As stated previously, for centuries San Felipe Creek has provided and supported critical habitat for the plants and animals living in its drainage basin. The creek habitat is characterized by fast-flowing, spring-fed aquifers; high quality, pollutant-free waters; gravel stream bottom; and, diverse plant & animal biomass. Improving the water quality in San Felipe Creek will provide for an improved habitat for San Felipe Creek and its associated bank areas.

4.5 Water Quality Goals

For the San Felipe Creek Master Plan general water quality goals that can be established for the creek and its drainage basin include:

- Reduce Pollution to the Creek;
- Reduce Erosion - to both bank and upland areas;
- Reduce Trash and Litter accumulation in the creek area; and,
- Keep San Felipe Creek from being listed on the TCEQ's 303(d) List (for identified water quality impaired stream segments in the State).

Based on its 2005 Devils River Minnow Recovery Plan the USFWS has established the following goals for improving or maintaining the habit in San Felipe Creek:

- Protect adequate stream & spring flows
- Reduce pollutants (point/non-point)
- Manage Non-Native Species
- Improve riparian area

4.6 Identification of Water Quality Best Management Practices Appropriate for San Felipe Creek

4.6.1 What is a Best Management Practice?

A Best Management Practice (BMP) is a practice determined to be the most efficient, practical, and cost-effective measures identified to control a particular activity or to address a particular problem. Non-point source pollution BMPs are specific practices or activities that are used to reduce or control impacts to a water body from nonpoint sources, most commonly by reducing the loading of pollutants into the drainage basin or waterway. BMPs are separated into two distinct groups, structural and non-structural.

4.6.2 Structural Best Management Practices

Structural BMPs include engineered and constructed systems that are designed to provide for water quantity and/or water quality control of storm water runoff. Structural BMPs typically require extensive construction or installation of the proposed BMP and regular, routine maintenance is often required.

4.6.2.a – Vegetation Enhancement & Management

Healthy, abundant vegetative ground cover slows and filters surface sediment from storm runoff, prevents erosion, and improves infiltration of water into the soil. More sediment is deposited on the land rather than carried into streams or water impoundments, and more water is retained in the riparian zone for slow release to the streams as base flow. Conversely, a lack of, or poor quality, vegetative cover can result in an increase in the sediment and pollutant load discharged to a local water body, increasing the turbidity and adversely impacting the quality of the water in the river, stream or lake.

Practices such as removing invasive species and propagating/re-establishing native plant communities will provide storm water runoff quality similar to undeveloped land in its natural state. Proper vegetative management may include the improvement or enhancement of the soil profile including the introduction of additional soil and/or organic material (e.g., topsoil and compost material), the improvement of the soil structure (e.g., soil retention blankets, plastic geogrid materials, etc…), the planting of native grasses and plants, and routine maintenance and care of these vegetative areas. A schematic of a typical vegetation enhancement soil structure, along with recommendations on preferred grasses to use in the San Felipe Creek area, is shown on **Figure 4**.

4.6.2.b – Stream Bank Stabilization / Riparian Area Restoration / Erosion Control

Similar to the lack of high quality vegetative cover, eroded bank areas of a stream or pond have a direct impact water quality. The eroded sediment will increase the turbidity of the water and will settle on the bottom areas which may contribute to a loss in habitat. The erosion of the bank area also reduces the riparian area along the banks of the water body. A healthy riparian area, with a variety of grasses, plants and trees, is very effective at reducing the sediment and pollutant load to the creek. The loss of riparian area will negatively impact a water body's ability to reduce or eliminate pollutants from stormwater.

Stream bank stabilization can include a variety of including sediment retention blankets, geogrid plastic soil retention systems, structural gabions or wall systems. However, the use of the most natural and environmentally sensitive stabilization system should be encouraged. A typical geogrid/geomat soil reinforcement system schematic is shown in **Figure 5**. A typical rock gabion structural system is shown in **Figure 6**.

The restoration of the riparian area should include a variety of native vegetation including grasses, shrubs and trees. The goal of any type of riparian restoration efforts should be a diverse area of native vegetation that closely mimics those areas found in natural, undeveloped areas. The use of native grasses and shrubs should be included along the entire length of the creek. The use of trees should be encouraged and maximized to the greatest extent possible. In an urban areas, the use of trees may need to be managed in an effort to avoid reduced sight-lines which may create possible security concerns, or where their use may lead to a reduction in the stormwater conveyance capability of the stream or river and therefore cause a concern of potential increase flooding issues.

4.6.2.c – Pervious Pavement

Pervious pavement systems include the use of pervious concrete, pervious asphalt, gravel pavement systems, or other similar systems. These systems are typically described by a structural, load-bearing surface, coupled with an underlying layer capable of temporarily storing stormwater prior to its release by infiltration or through a controlled drainage structure. The use of these systems can reduce both the rate and the amount of stormwater flowing to the creek, reducing the pollutant load to the creek and increasing recharge to groundwater. A typical pervious concrete pavement system for a parking area is shown in **Figure 7**. A similar-type pervious gravel pavement system for a parking area is also shown in **Figure 7**. In general, a pervious gravel pavement system is less expensive to construct than a similar-sized pervious concrete pavement system. A pervious concrete pavement system for a hike and bike trail is shown in **Figure 8**.

4.6.2.d – Vegetative Filter Strips

As their name implies, vegetative filter strips are areas of land where storm water is discharged for the purpose of utilizing the vegetation to trap sediment and other pollutants.

As standalone BMPs, vegetative filter strips are limited in that they can only accommodate sheet flow and not concentrated flow. If there is a need to discharge concentrated flow to a vegetated filter strip, adequate provisions should be incorporated to dissipate the energy and properly distribute the flow. The removal efficiency of these strips varies depending on the pollutant loading and the size of the strip, but they generally provide partial removal of suspended constituents and limited removal of dissolved constituents. Even though the recharge potential is lower with vegetative filter strips, when constructed in the recharge zone, their design should include recharge limitation features. In most instances, vegetative filter strips are intended to work in series with other structural BMPs. Typical layouts for vegetative filter strips adjacent to a roadway or a parking lot are shown in **Figure 9**, while a schematic for a vegetative filter strip is shown in **Figure 10**. A vegetative filter strip can be an important tool in mitigating the water quality impacts caused by paved parking areas, sidewalks, or hike and bike trails. If property designed and constructed, it is possible to utilize a vegetative filter strip BMP for treatment of storm water runoff from impervious surfaces as an alternative to the pervious pavement systems described in Section 4.6.2.c.

4.6.2.e – Biofiltration / Bioretention Systems

Bio-retention systems are similar to retention/irrigation systems in that they capture storm water for subsequent reuse. However, this reuse takes place inside the retention system through the support of vegetation and benthic and aquatic organisms. Capture is accomplished using structures such as wet ponds or basins with adequate capacity to prevent discharge. These systems are also very effective at controlling a wide variety of pollutants, including both suspended and dissolved constituents.

Biofiltration/bioretention facilities are ideal for treating stormwater runoff from developed areas including parking lots, streets and roof areas. The systems can be sized for small or large flow volumes; however, their use is typically targeted for smaller sized drainage areas. Typical biofiltration/bioretention system layouts are shown in **Figures 11** and **12**. Typical cross sections for a biofiltration/bioretention system are shown in **Figure 13**.

4.6.2.f – Hydrodynamic Separators

Hydrodynamic separators are gravity, flow-through proprietary structures that include a settling unit that can effectively remove sediments and other pollutants that are often found in stormwater runoff. The units typically treat a point-source discharge of stormwater which make them an effective method of treatment for stormwater from bridges, curb cuts, and inlets. The units require no power and are relatively compact, so they provide a viable option for retrofitting existing developments with an effective stormwater BMP.

Hydrodynamic separators are most effective at settling or separating heavier particulate matter, solids, floatables, or trash, and are less effective at capturing dissolved pollutants or small particulates. A typical schematic for a hydrodynamic separator is shown in **Figure 14**; however each manufacturer has a different configuration and design for their particular unit. An important component in the success of such an installation is the proper sizing of the unit, which is typically based on peak stormwater flows. Manufacturer's sizing recommendations and guidelines should be followed for each individual installation.

Hydrodynamic separators come in a variety of configurations that are manufactured by a number of different companies. The units are relatively expensive to purchase and also require regular maintenance. Maintenance is generally in the form a vacuum truck pumping out the collected contents from the settling unit often on a monthly or quarterly basis, depending on the nature and amount of solids collected by the unit.

4.6.2.g – Water Quality Ponds

Water quality ponds are a form of stormwater BMP that uses a constructed pond or basin to collect and treat stormwater generated by a defined drainage area. Water quality ponds include a variety of different treatment options including sedimentation/filtration, extended detention, constructed wetlands, retention/irrigation systems, and number of others. These types of facilities are known to provide a high level of treatment.

However, water quality ponds often take up a considerable amount of land space and require adequate fall from the pond surface to the discharge point to allow for gravity flow, and require a higher level of maintenance than many other stormwater BMPs. A typical configuration for a water quality pond is shown in **Figure 15**.

4.6.3 Non-Structural Best Management Practices

Non-structural BMPs include institutional and pollution-prevention type practices designed to prevent pollutants from entering storm water runoff or reduce the volume of storm water requiring management. Non-structural BMPs typically do not require extensive construction of proposed improvements, however, they do often times require extensive coordination, administration, and oversight.

4.6.3.a – Public Education

One of the most effective and economical of the non-structural BMPs is public education. Programs and activities that help to educate the general public on ways to reduce or eliminate sources of pollution are one of the simplest and cost-effective methods to positively influence the quality of water in neighboring streams, rivers, and lakes. The goal of a public education campaign or project is for people to gain an understanding of how their actions can affect water quality and to encourage them to take responsibility for those actions.

Public education activities can include the following:

- **Lawn and Garden Activities** - Programs that encourage composting, decreased fertilizer and pesticide use, water use efficiency, practical turf and lawn management strategies, appropriate plant selection, and soil analysis/improvement;
- **Proper Disposal of Household Hazardous Wastes** - Programs that educate citizens on impacts of hazardous household materials and alternatives to toxic chemicals; initiatives to provide disposal opportunities for paints, paint thinners, solvents, motor oil, antifreeze, and other chemicals;
- **Pet Waste Management** - Education to encourage pet owners who live in concentrated residential areas or areas where the waste could not be properly assimilated to collect and properly dispose of their pet's waste;

- **Trash Management** – Programs that educate citizens on impacts of garbage and control measures, including source reduction (alternative packaging, waste reduction, alternative chemicals, recycling etc,) and community clean-up programs;
- **School Programs** - Programs that educate school age children on non-point source pollution, water supply, and the importance of healthy streams, rivers, and lakes; programs could encourage field visits and activities to provide a hands-on, up close experience for the participants.

Educational information can be produced in the form of door hangers, mailers for inclusion with monthly water bills, informational signs and kiosks, and brochures and handouts. Although in some instances producing original educational materials may be necessary or desired, it is recommended that the community rely on materials prepared from other agencies or organizations in an effort to minimize the expense and the effort necessary to produce these types of materials.

4.6.3.b – Community Involvement

Community involvement is a key ingredient in the success of the water quality initiatives. Community involvement is often coupled with public education activities. Ideas to encourage community and citizen participation can include the "adoption" of certain, defined park areas by organizations or groups, a community-wide trash pickup day, a household hazardous waste collection day, park cleanup day, or other similar activities. These initiatives provide an opportunity to involve and educate citizens in the activities and actions that directly impact the areas they see every day. Citizen participation also encourages a sense of ownership that can affect people's attitudes and actions throughout the year.

4.6.3.c – Land Management / Ordinances

Land use strategies, land management requirements, and ordinances can all be effective tools in controlling and mitigating certain activities that have the ability to adversely impact water quality. Within drainage basins an effective land management strategy can ensure that the land is developed in a manner that protects both the quantity and quality of water in the local streams and rivers.

4.6.3.c.i - Clustering/Low Impact Development

Clustering is the concept of concentrating the impervious cover within a tract of land to maximize separation from the impervious areas to potentially sensitive receptors, such as streams and critical environmental features. Clustering allows development of properties while helping to reduce the overall impact of the development on the local water bodies. Clustering creates buffer zones and areas that, when effectively managed, will directly impact the pollutant load generated by a developed area.

The concept of Low Impact Development (LID) has many elements common to clustering, however the underlying premise of LID is to take a holistic approach to design that minimizes the overall impact of development on a site. Instead of removing pollutants, LID concepts reduce runoff volumes, thereby reducing the impacts from the associated runoff, and further reducing the need for conventional structural BMPs. LID includes the following essential elements:

- Minimizing Impervious Areas
- Directed Growth (through land use ordinances and zoning)
- Sensitive Area Protection
- Open Space Preservation

While these concepts can be applied on a broad scale, the general concepts can also be applied to design on an individual site. For instance, minimizing contiguous impervious areas allows the surrounding pervious areas to more effectively offset the effects of increased runoff from the pervious areas. This process, in turn reduces the need for structural BMPs. Since they rely less on structural BMPs and more on the interaction of several different water quality protection measures working together, the use of LID procedures reduces the water quality risk from the catastrophic failure of a single BMP. For this reason, water quality plans often encourage the use of a LID approach over the more high impact designs which rely heavily on the use of structural BMPs.

4.6.3.c.ii - Impervious Cover Limits

Impervious cover consists of buildings, streets, driveways, parking lots, and other types of impervious surfaces. Typically, an increase amount of impervious cover leads to an increase in the amount of rainfall which turns to surface runoff and correspondingly decreases the amount of infiltration (recharge) to groundwater. In general, as the amount of impervious cover increases there is a measurable decrease in water quality of stormwater flows.

The concept of limiting impervious cover within a drainage basin can be one tool to help achieve improved water quality within the basin. However, localized impacts may occur from localized areas of higher intensity development within a particular site. For this reason, impervious cover limits should typically be used in conjunction with other stormwater BMPs to control the effects from the developed areas, and are not intended to be utilized as the sole water quality protection measure for site development.

4.6.3.c.iii - Land-use restrictions

Land use restrictions can be an effective tool in managing the development of land throughout a drainage basin. Typically, land use restrictions prohibit or limit a property or area from hosting certain activities that have been found to be detrimental to water quality, the environment, or neighboring properties. Land use restrictions can include the prohibition of waste disposal wells (disposal of liquid wastes by underground injection), feedlots or concentrated animal feeding operations, land disposal of Class I industrial wastes (landfills or land application sites), the use of sewage holding tanks as part of an organized sewage collection system, municipal solid waste landfill facilities, new municipal and industrial wastewater discharges.

Local jurisdictions, where and when appropriate, can develop land-use restrictions to prohibit some or all of these types of activities. In addition to these prohibitions, a local jurisdiction should also consider the development of restrictions on industrial facilities. Industrial facilities often concentrate operations and chemicals which can pose a serious threat to water quality. New industrial facilities would typically be restricted through their need to obtain a wastewater discharge permit; however, local jurisdictions should consider the explicit prohibition on industrial land-uses in vulnerable drainage basins.

4.6.3.c.iv - Zoning/Use limitations

In addition to certain land-use prohibitions, a City has the power to restrict the location of certain activities through zoning and/or use-limitations. These zoning powers may only be applied to the land inside the City Limits. The restriction of development throughout a drainage basin is an effective tool in managing and improving surface water quality.

4.6.3.d – Litter/Trash Pick Up Programs

Organized litter/trash pickup programs are an easy way to provide effective control of solid waste that may be illicitly deposited in and around the creek area. Volunteers may be targeted from specific organizations (schools, service organizations, clubs, etc…) or solicited from the general population. The concentrated efforts of a large number of persons can provide a source of labor that would be difficult for the City to match. Additional trash bins along streams and rivers, and throughout park areas can help encourage the proper disposal of trash and solid waste. Often times, an organized litter/trash pick up program ties its activities to a public education program that helps citizens and visitors better understand the negative impacts litter can have on the environment and water quality, and also encourages individuals to actively manage their own trash during picnics, outings, and public gatherings.

4.6.3.e – Pet/Animal Waste Control

Pet/animal waste control can include a combination of public education activities and installation of pet waste stations. Pet waste stations can include both a trash can and waste bags that facilitate and encourage the pickup of pet waste. The pet waste stations must be spaced so the distance between stations is not so great that it discourages waste collection. These stations must also be serviced on a regular basis to ensure that the waste is collected and the waste bags are resupplied.

4.6.3.f – Human Waste Control

Human waste control can be effectively managed by a combination of public education and the installation of adequate public restroom facilities and trash receptacles. For park areas public restrooms should be located in known high traffic areas and should be adequately spaced to ensure easy access for park visitors. The installation of an adequate number of trash cans will help to provide a convenient, proper method for solid waste disposal. A targeted, public service campaign can be an effective tool in educating the public on the proper method of disposal of trash, diapers, and other such materials.

4.6.3.g – City Operation & Maintenance Practices

Impacts to water quality can be influenced by routine operation and maintenance practices followed by City crews and staff. Fertilizing type, frequency of application, rate of application, and location of application can all influence the amount of residue and nutrients that ultimately impact water resources. Pesticide usage can also impact water bodies with the timing and rate of application of prime importance. Other practices that can result in an impact to water quality are mowing heights, vehicle maintenance, trash collection schedules, street sweeping programs, and other often routine activities.

4.6.3.h – Agricultural Practices

Improper agricultural practices also have the ability to adversely impact water quality. The primary threats from agricultural operations include excessive erosion/sedimentation from over-grazing and improper tillage, excessive nutrients from improper fertilizer application and excess nutrients and biological constituents from improper animal waste management.

The following measures are recommended agricultural practices that help in minimizing the impacts of agricultural operations within a drainage basin:

Controlled Grazing – utilizing structural fencing and administrative rotation practices to evenly distribute grazing activity across the property, to avoid concentrating animal byproducts and vegetative disruption in the same areas over the long-term. This practice is also intended to balance forage consumption by grazing animals with plant biomass production in a manner that provides a portion of the plant resources for conservation purposes and maintenance of a healthy plant community;

Distributed Watering – similar to controlled grazing, the objective is to distribute watering activities around the property to avoid concentrating animal activity and byproducts in the same areas over the long-term;

Topsoil/Nutrient Maintenance and Enrichment – ensuring that the topsoil and grasses have adequate nutrients to support grazing and prevent the adverse impacts of over-grazing;

Weed/Invasive Plant Control – managing and controlling the propagation of weeds/invasive plants to ensure that soil nutrients are available for grasses and minimizing the need for supplemental nutrient application;

Select appropriate crops - choose crops which can be sustained from natural precipitation, and avoid the need for irrigation or additional water application;

Minimize the use of pesticides and nutrients - use the correct chemicals for the job and follow proper application procedures for each chemical used; and,

Use conservation practices (e.g. contour farming, hedgerow planting, crop rotation, etc...) - use appropriate conservation practices to minimize erosion/sedimentation as much as possible.

4.7 Recommendations for Water Quality Protection Measures for San Felipe Creek

Selection of appropriate BMPs depend on a combination of effectiveness, reliability, construction costs, maintenance costs, and aesthetics.

4.7.1 Structural BMPs

For the San Felipe Creek planning area the use of the following structural BMPs are recommended:

- **Vegetation Enhancement/Management**
  The bank areas of San Felipe Creek have many locations that have little to no vegetative cover. Proper or improved vegetative practices will help to improve the water quality of San Felipe Creek by reducing the amount of sediment that is deposited in the creek. The improvement of vegetation throughout the drainage basin should be encouraged. Concentration of efforts in and around the areas near the creek will have the most positive impact on water quality. It is recommended that the City

improve the vegetative cover on City controlled property near San Felipe Creek by improving the soil structure and by the use of appropriate grasses and native plants.

- **Bank Stabilization**

The elimination of eroded bank areas along San Felipe Creek will improve water quality by reducing the sediment load to the creek, increasing the amount of healthy riparian area along the creek bank, and by improving the ability of the riparian area to more effectively remove sediment and pollutant loads before they reach the creek.

Stream bank stabilization can include a variety of treatments including sediment retention blankets, geogrid plastic matting, structural gabions or wall systems. As previously stated, the use of the most natural and environmentally sensitive stabilization system should be encouraged. Each proposed project will require evaluation by qualified professionals to ensure that the proposed improvements will withstand the effects of floodwaters and will not suffer from potential damage by the invasive species known to inhabit the area including armored catfish and nutria.

The goal of for the establishment of the riparian area along San Felipe Creek should be for a diverse, esthetically pleasing environment that blends in with the surrounding areas and is compatible with the intended land use by the public.

Figures 5 and **6** show examples of stream bank stabilization techniques that should be encouraged along the banks of San Felipe Creek. While no specific distance has been established for the riparian area, its distance from the edge of the creek should be maximized to the greatest extent practical. A goal of a 50 foot riparian area from the edge of the creek should help serve as a guide to future revisions and improvements to the bank areas. Within this 50 foot buffer area the use of impervious surfaces should be minimized and the use of a diverse, native plant species should be encouraged.

- **Riparian Area Restoration**

  The restoration of the riparian area should include a variety of native vegetation including grasses, shrubs and trees. The use of native grasses and shrubs should be included along the entire length of the creek. The use of trees may be minimized in select areas where their use may reduce sight-lines and thereby create possible security concerns, or in areas where the reduction in stormwater conveyance caused by additional trees may be a concern. The use of trees should be encouraged and maximized to the greatest extent possible. To the maximum extent possible, riparian area restoration should be undertaken at the same time as bank stabilization efforts. An example of a typical riparian area is shown in **Figure 16**.

- **Vegetative Filter Strips**

  As previously discussed, vegetative filter strips are areas of land where storm water is discharged for the purpose of utilizing the vegetation to trap sediment and other pollutants. The use of vegetative strips and buffers should be maximized throughout the San Felipe Creek area. Vegetative filter strips are typically limited due to the need for sheet flow onto the BMP area; however, their use around paved parking areas and other impervious cover areas should be encouraged. **Figures 9** and **10** show typical layouts and cross sections for vegetative filter strips. A minimum vegetative filter strip width of 15 feet should be provided, however the width of the vegetated area should be maximized to the greatest extent practical.

- **Pervious Pavement**

  Possible short-term projects along San Felipe Creek that may utilize a pervious pavement system include new parking areas, new hike and bike trails, new sidewalks, and other future paved areas. Long-term projects along San Felipe Creek that can potentially use pervious pavements include the replacement of most impervious surfaces including existing parking lots, existing sidewalks, and existing hike and bike trails. Examples of pervious pavement systems are shown in **Figures 7** and **8**.

- **Biofiltration/Bioretention**

  For the San Felipe Creek area these types of facilities should be located away from the creek area and preferably up gradient from the creek since the filtration system should be located above the seasonal high groundwater table. Typical biofiltration/bioretention systems are shown in **Figures 11, 12** and **13**.

- **Water Quality Ponds**

  Water quality ponds include a variety of different treatment options, however for the San Felipe Creek area the use of constructed wetlands systems and/or sedimentation/filtration systems would appear to be the best options.

  This type of BMP may be impractical for much of the San Felipe Creek drainage basin; however its use should be evaluated and considered for the undeveloped land that dominates the upstream portion of the drainage basin and for the FEMA Buyout Properties along the lower end of the project area. A typical schematic of a water quality pond is shown in **Figure 15**.

4.7.2 Non-Structural BMPs

For the San Felipe Creek planning area the use of the following structural BMPs are recommended:

- **Public Education**

  Programs and activities that help to educate the citizens of Del Rio, park users, and visitors on ways to reduce or eliminate sources of pollution are one of the simplest and cost-effective methods to positively influence the quality of water in the San Felipe Creek.

- **Community Involvement**

  Ideas to encourage community and citizen participation include a "Friends" of San Felipe Creek campaign, a community-wide trash pickup day, a household hazardous waste collection day, park cleanup day, or other similar activities.

- **Land Management/Ordinances**

  Land use strategies, land management requirements, and ordinances can all be effective tools in controlling and mitigating certain activities that have the ability to adversely impact water quality in San Felipe Creek. In the San Felipe Creek drainage basin a large amount of the land upstream of the San Felipe Country Club property is either undeveloped or minimally developed. This area should be the focus of local efforts to ensure that the land is developed in a manner that protects both the quantity and quality of the flow from the San Felipe Springs.

Clustering/Low Impact Development

Clustering is the concept of concentrating the impervious cover within a tract of land to maximize separation from the impervious areas to potentially sensitive receptors, such as streams and critical environmental features. The concept of Low Impact Development (LID) has many elements common to clustering; the underlying premise is to take a holistic approach to design that minimizes the overall impact of development on the site.

It is recommended that the City consider the adoption of an ordinance that specifically encourages the use of clustering or LID within the City and surrounding areas.

Impervious Cover Limits

As stated previously, as the amount of impervious cover is increased over a drainage basin the surface water runoff typically increases, the amount of water infiltrating into the ground decreases, and there is a measurable decrease in water quality of the stormwater runoff. The City may consider limiting the percent of impervious cover on undeveloped properties. However, any impervious cover limits should not be imposed without requiring stormwater BMPs, implementation of land use restrictions, and additional land management strategies.

Land-use restrictions

The City should consider the development of a land use restriction ordinance that specifically prohibits activities detrimental to water quality. Such activities would include waste disposal wells (disposal of liquid wastes by underground injection), feedlots or concentrated animal feeding operations, land disposal of Class I industrial wastes (landfills or land application sites), the use of sewage holding tanks as part of an organized sewage collection system, municipal solid waste landfill facilities, new municipal and industrial wastewater discharges. Also restriction on the establishment of industrial facilities within the San Felipe Creek drainage basin should also be considered.

Zoning/Use limitations

The City has the power to restrict the location of certain activities through zoning and/or use-limitations within the City Limits. Much of the San Felipe Creek drainage basin within the City Limits is zoned for single-family residential use. The City has and should continue to monitor land use within its jurisdiction and make efforts to appropriately control land use to positively affect the quantity and quality of the water generated by San Felipe Springs.

- **Litter/Trash Pick Up**
  It is recommended that an organized litter/trash pickup program run by community volunteers be established to provide additional man-power for trash and debris collection along the creek area. This volunteer effort would supplement the City's existing collection efforts by City Parks and Recreation staff. The effort could organize regularly scheduled clean up days (i.e., monthly, quarterly, semi-annual), target specific areas of the creek.

- **Pet/Animal Waste Control**
  The City should actively implement a pet/animal waste control program that includes a combination of public education activities and installation of pet waste stations. Pet waste stations should be located at reasonable intervals along the creek to allow and encourage the proper disposal of animal waste. An organized public education

program should be implemented that details the reasons for pet waste disposal, both at home and on City property.

- **Human Waste Control**

  New public restrooms should be located along San Felipe Creek to serve park visitors, and existing public restrooms along the creek should be renovated. Additional trash cans should be provided in all park areas. A targeted, public service campaign is suggested on the benefits and the proper method of disposal of trash, diapers, and other such materials.

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5. ENDANGERED & THREATENED SPECIES

5.1 History and Background Information

San Felipe Creek provides an ideal habitat for human, animal, and plant species. The fast-flowing, spring-fed waters provide an abundant source of high quality water that helps provide a solid foundation for the support of a diverse ecosystem.

For additional information on the history of the area surrounding San Felipe Creek and the City of Del Rio can be found in **Appendix A** (CP&Y Environmental Document - Sections I, II, and VIII), **Appendix C** (San Felipe Creek Commission - San Felipe Creek Vision Plan), as well as Sections 1.0 and 2.0 of this report.

5.2 Threatened and Endangered Species

A number of threatened, endangered or candidate species have been identified as occurring in Val Verde County, Texas. These species have been identified by either federal or State agencies and are currently found on these agencies databases for Val Verde County.

Two of the species most important to San Felipe Creek include the Devils River Minnow and the San Felipe Gambusia. The Devils River Minnow was listed as threatened by the USFWS on October 20, 1999. The species was the focus of the USFWS's Devils River Minnow Recovery Plan that was published in September 2005 (see **Appendix D**). The San Felipe Gambusia is a new species recently discovered in 1997. The species is known only to exist within San Felipe Creek in Val Verde County and is currently listed as threatened by the TPWD.

Additional information and discussion on threatened and endangered species known to existing in and around the project area can be found in **Appendix A** (CP&Y Environmental Document - Section V) and **Appendix D** (USFWS Devils River Minnow Recovery Plan).

5.3 Agency Consultations

San Felipe Creek provides habitat that is important to the survival of many plants, animals that are found nearby. The creek also provides an ideal environment that has been welcoming to human occupation for thousands of years.

Having previously identified the Devils River Minnow as a threatened species in San Felipe Creek the USFWS must be consulted prior to construction of improvements in or around the creek area. During this planning effort the USFWS has been included in project meetings, telephone conversations, and e-mails as part of an effort to keep the agency up to date on the latest project developments. Details of the on-going USFWS coordination efforts have been documented and outlined by CP&Y in Section VI of **Appendix A** (CP&Y Environmental Document) of this master plan.

Furthermore, as detailed in Section VII of **Appendix A**, a U.S. Army Corps of Engineers (USACE) individual permit will likely be necessary prior to initiation of any construction work in and around the creek area, including bank demolition and reconstruction.

In the future, as the City moves this project forward from the planning phase to the design, and ultimately to the construction phase(s), coordination with State and federal agencies will be critical to the success of the overall project. At a minimum, consultation with USFWS, USACE, Texas Parks and Wildlife Department (TPWD), Texas Historical Commission (THC), Texas Archeological Research Laboratory (TARL) should be anticipated. The coordination efforts should be initiated prior to the design of any proposed improvements planned for within or near the creek area.

For activities that occur in the creek itself, such as dredging or other similar activities, permits from the TPWD, USACE, and TCEQ will likely be required. Consultation and approval of the project by the USFWS, FEMA, and the local floodplain administrator must be obtained prior to beginning construction activities.

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6. INVASIVE SPECIES

6.1 Invasive Species

San Felipe Creek is host to a number of invasive species. Invasive plant species include *Arundo donax* (also known as giant reed or river cane), elephant ears, and chinaberry. Invasive animal species known to inhabit the area include armored catfish (*Hypostomus sp.*).

The presence of invasive species can be a significant issue with respect to efforts to maintain water quality within San Felipe Creek and its drainage basin. Invasive species have a negative impact on existing water quality by destroying native habitat and out-competing native species for food, and in some cases, by causing physically damaging creek area. Such impacts can lead to a loss of riparian area which serves as a filter for stormwater prior to entering the creek. For these reasons, the elimination of invasive species in the San Felipe Creek drainage basin can be an important key to improving and maintaining the water quality of San Felipe Creek.

6.2 Arundo donax

Giant Reed was introduced to the region from Europe in the 1600s as a source of animal feed and for use in home and shelter construction. The eradication of this invasive species would help to improve creek habitat by allowing native vegetation the ability to more easily grow in and around the creek area and would aid in increasing creek flow by eliminating a significant source of water demand.

Appendix B provides a more complete outline of the Arundo donax problem and offers recommendation on how to successfully eradicate this species from the San Felipe Creek drainage basin.

6.3 Armored Catfish

Armored catfish (*Hypostomus plecostomus*) are an invasive species that appear to be present in almost all portions of San Felipe Creek. Negative impacts from armored catfish include out-competing native species for food, impacting native populations by reducing the available food source and even eating the eggs of other fish as they scour the bottom area feeding on algae and other plant materials. These fish appear to be a major contributor to bank erosion and instability due to their habitat of burrowing into and under the bank area which increases turbidity in the creek and ultimately results in bank failure. Such activities lead directly to an increase in the sediment load of San Felipe Creek and can result in a loss of suitable habitat for the threatened and endangered species that live in and around the creek.

The Armored catfish has no known predators. While elimination and control of the Armored catfish is desired, at this time there is no effective way to significantly reduce their numbers in San Felipe Creek. The City should encourage State and federal agencies to research the existing problem and develop a suitable solution to control and eliminate the fish from San Felipe Creek.

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7. HABITAT RESTORATION & PROTECTION

7.1 Existing Habitat Along San Felipe Creek

San Felipe Creek has been dissected out of limestone, shale, siltstone and clay layers to create a creek that is characterized by a mostly rocky, gravelly bottom area with an abundance of high-quality, fast-flowing water emanating from San Felipe Springs. The water in the creek is low in turbidity with very low levels of suspended solids or organic matter.

The natural bank areas of San Felipe Creek are lined with a mixture of water-tolerant pecans, oaks, junipers, grasses, and mesquites that provides a natural riparian area capable of hosting an abundance of birds and animals. However, invasive species, particularly Arundo donax, or Giant Reed, dominates a large portion of the riparian area in the portion of the creek from San Felipe Country Club downstream to the Rio Grande. Along some stretches of San Felipe Creek bank stabilization or bank improvement projects have resulted in creek bank areas typified by vertical or sloping walls of concrete, stone, and other materials.

Additional details on the existing habitat along San Felipe Creek is outlined in **Appendix A** (Environmental Documentation - by CP&Y), **Appendix C** (San Felipe Creek Vision Plan), and **Appendix D** (Devils River Minnow Recovery Plan - USFWS).

7.2 Critical Habitat in Need of Restoration

Over time improvements along San Felipe Creek have resulted in a reduction or loss of the natural riparian area that helps to serve as a buffer and filter for stormwater that enters the creek from the surrounding, increasingly urbanized areas. These areas are particularly evident along the portion of the creek from San Felipe Country Club downstream to the Rio Grande. Restoration of this riparian buffer for select portions of the creek will help reduce the amount of sediment and pollutants entering the creek which should aid in improving water quality in the creek.

7.3 Critical Habitat in Need of Protection

San Felipe Creek critical habitat includes the riparian areas that exist along some portions of the creek banks, the high quality water emanating from San Felipe Springs and flowing in the creek, the quantity of water flowing in the creek, and the rocky, gravelly bottom area of the creek.

7.4 Recommended Habitat Restoration & Protection Strategies

The following strategies are recommend to help restore and protect critical habitat along San Felipe Creek:

7.4.1 Invasive Species Eradication

Invasive species eradication is one strategy that can play an effective part in the restoration of critical habitat along San Felipe Creek. Identified invasive species include giant reed (*Arundo donax)*, elephant ears (*Alocasia macrorrhiza*), chinaberry (*Melia azedarach*), and armored catfish (*Hypostomus plecostomus*). A detailed plan for the eradication of *Arundo donax* from San Felipe Creek is outlined in **Appendix B**.

Any invasive species eradication efforts should be closely coordinated with State and federal agencies that may be willing to participate in, or offer assistance with, these on-going efforts. Federal agencies such as the Office of Homeland Security, the Border Patrol Agency, the USFWS, and the United Stated Department of Agriculture (USDA) should be contacted on a regular basis to see if they are interested in assisting.

In particular the USDA's Agricultural Research Service's (ARS) Beneficial Insect Research Unit (BIRU) is very active in researching and investigating new and effective control methods. These latest efforts include releasing various insects to biologically control and limit the growth of Arundo donax. These efforts can complement the eradication efforts outlined in Appendix B, which include cutting and chemical treatment. It is recommended that a line of communication be established with the USDA's ARS office in Weslaco, TX so that the latest information on eradication efforts can be shared between the City and the USDA:

USDA - ARS
2413 E Highway 83
Weslaco, TX 78596
(956) 969-4803
(Dr. John Goolsby - initial contact)

7.4.2 Protection of Native Vegetation

In areas of San Felipe Creek where the bank/riparian areas include natural vegetation, this vegetation should be protected and encouraged to grow and flourish. Earth disturbing activities in these areas should be confined to as small a footprint as possible and the native vegetation should be cared for in a manner that protects it from damage. Any on-going maintenance efforts, including mowing, should only be undertaken after a proper schedule and method have been outlined that does not adversely affect the long-term growth of the native vegetation.

7.4.3 Bank Stabilization / Erosion Control

For portion of San Felipe Creek that have bank erosion problems these areas should be stabilized in a manner that improves their stability and eliminates long-term erosion problems. Efforts should include the removal of existing collapsed creek walls, followed by bank improvements. Where possible, the bank improvements should mimic natural conditions as much as possible. In areas of the creek where a more structural-type solution is necessary, the use of pervious concrete, gravel pavement systems, rock gabions, and other design and construction methods that are as environmentally friendly as possible should be utilized.

7.4.4 Riparian Area and Vegetation Enhancement

To the maximum extent practical the riparian area should be allowed and encouraged along San Felipe Creek. In existing areas lacking suitable, native vegetation an organized effort to enhance and improve the vegetative cover should be undertaken.

7.4.5 Water Quality Protection Strategies (Structural and Non-Structural Best Management Strategies)

Existing habitat within and adjacent to San Felipe Creek is threatened by the effects of urbanization of the surrounding area which includes the addition of impervious surfaces, the increase in population, the increase in construction activities, and an increase in both point and non-point source pollutants. In an effort to restore and protect existing habitat, non-point source Best Management Practices (BMPs) are specific practices and activities that can be used to reduce or control impacts to a water body. By reducing or controlling these potential impacts, critical habitat within the watershed can be restored and protected.

In the case of San Felipe Creek the use of both Structural and Non-Structural BMPs can help protect water quality within the creek and aid in preserving existing habitat. Appropriate Structural BMPs have been discussed in detail in Section 4.6.2 of this plan with the recommended Structural BMPs listed in Section 4.7.1. Similarly, Non-Structural BMPs have been discussed in detail in Section 4.6.3 of this plan with the recommended Non-Structural BMPs listed in Section 4.7.2.

In summary, Structural BMPs recommended for the San Felipe Creek area include the following:

- Vegetation Enhancement & Management;
- Stream Bank Stabilization / Riparian Area Restoration;
- Pervious Pavement;
- Vegetative Filter Strips;
- Biofiltration/Bioretention Systems;
- Hydrodynamic Separators; and,
- Water Quality Ponds.

Non-Structural BMPs recommended for the San Felipe Creek area include the following:

- Public Education;
- Community Involvement;
- Land Management/Ordinances;
- Litter/Trash Pick Up Programs;
- Pet/Animal Waste Control;
- Human Waste Control; and,
- City Operation & Maintenance Practices.

By using these BMPs the impacts of urbanization can be reduced which will help restore and preserve the critical habitat along San Felipe Creek.

8. INVENTORY & NEEDS ASSESSMENT

8.1 Existing & Compatible Land Uses Along San Felipe Creek

The San Felipe Creek drainage basin has a mixture of land uses. Within the portion of the drainage basin inside the City Limits properties include those zoned by the City as small-lot single-family residential, large-lot single-family residential, multi-family residential, commercial, commercial-historical, and industrial. A current City of Del Rio Zoning Map is included in **Appendix H**. Land areas within the basin, but outside the City Limits are not subject to the City's zoning ordinances. At the present time the majority of the land area outside the City Limits is undeveloped and currently utilized for agricultural use, while smaller portions are properties used for light industrial activities, commercial properties, and residential properties.

The San Felipe Creek drainage basin upstream of Round Mountain lies both inside and outside the City Limits and has a combined area of approximately 25,800 acres. At the present time approximately 3,162 acres (or 12%) of the drainage basin lies within the City Limits and approximately 22,638 acres (or 88%) lies outside the City Limits.

The lower end of the San Felipe Creek drainage basin, downstream of San Felipe Creek Country Club includes a variety of land uses, but is mostly dominated by residential areas, along with park and City-owned properties. South of US Highway 90 properties adjacent to the creek consist of a considerable amount of city-owned, city-controlled land.

Much of the property along and adjacent to San Felipe Creek lies within the 100-year floodplain. Property within the 100-year floodplain is subject to restrictions on any improvements proposed for the property.

The current land and properties along San Felipe Creek include a mixture of properties including single-family, city owned and controlled properties, properties within the 100-year floodplain. While properties along the creek lend themselves to a variety of improvements, the zoning of a property may need to be revised prior to initiation of the project.

8.2 Existing Park & Recreational Improvements Along San Felipe Creek

Parks and recreational improvements within a community provide opportunity for residents to gather, individually or in groups, to enjoy the outdoors, participate in leisure or athletic activities, socialize with neighbors, and come together as a community. The City of Del Rio has constructed parks and recreational improvements throughout the City to provide residents with such opportunities.

Water quality of a water body is impacted by previous development activities and on-going activities that occur on the land near or adjacent to the water body. For San Felipe Creek, especially for the stretch of creek south of US Highway 90, a significant potential for water quality impact exists from the City parks and recreational improvements already in place.

Existing development along San Felipe Creek includes a variety of improvements. Among the improvements constructed, some of the most popular and heavily used are the parks and recreational improvements that have been constructed in City parks and City-owned property located south of US Highway 90. **Figure 17** shows the existing City parks located along San Felipe Creek. These improvements include hike and bike trails, playscapes, picnic areas, baseball fields, soccer fields, swimming pools, creek-side bank improvements, sidewalks, buildings, parking areas, and other improvements typical of a municipal park site.

8.2.1 Park Improvements

Existing parks and recreational improvements are listed in **Table 8-1** on the following pages and are also shown on **Figure 18**. Many of the park improvements listed in the table and shown on **Figure 18** have been taken in part from the City's Parks, Recreation & Open Space Master Plan 2011-2020 for the City of Del Rio document prepared by TRC Engineers, Inc. and the City's Parks and Recreation Department. A copy of the plan has been included as **Appendix I**. Additional information on existing parks and recreation facilities is also included in Chapter Four - Parks and Recreation of the Del•RioPlan developed by Kendig Keast Collaborative, a copy of which is included as **Appendix J**.

Table 8-1 - Existing Park & Recreation Improvements Along San Felipe Creek[1]

Park No.[2]	Park Name	Amenities[1]	Quantity[1]	Condition[1]	Comments
2	**Abe Barrera Memorial Park**	Volleyball Courts	1	Poor	One of the oldest parks in Del Rio. Park improvements would include repairs to the existing sand court and a new volleyball net. The remaining park equipment could use repairs as well as new trash cans and new BBQ pits.
		Picnic Tables	4	Fair	
		BBQ Pits	3	Poor	
		Trash Cans	4	Fair	
		Swing Sets	1	Poor	
3	**Amphitheater**	Park Benches	4	1 Excellent, 3 Good	
		Trash Cans	2	Good, Fair	
		Restrooms	1	Good	
		Picnic Tables	3	Excellent	
4	**Blue Hole / Horseshoe Park**	Facilities included in Moore Park (#17) total			Adjacent to Moore Park. Along with Moore Park these are two of the most frequently used parks by residents coming to access San Felipe Creek.
5	**Blue Star Park**	Trash Cans	1	Good	Adjacent to Blue Hole/Horseshoe Park (#4) and Moore Park (#17).
6	**Brown Plaza**	Park Benches	26	Good	One of the original parks of Del Rio. This park continues to serve as a cultural focal point for citizens and as a community gathering place for special events and holidays.
		Trash Cans	4	Good	
		Brick Fountains	2	Good	
		Light Posts	7	Good	

1 - Summary of existing improvements were taken from Table 6-1 of the City of Del Rio's Planning & Capacity Building Study (2010-2020) and Table 2 of the Parks, Recreation and Open Space Master Plan (2010-2020). Both documents were prepared by TRC Engineers, Inc. (TBPE Firm No. F-8632). The Parks, Recreation and Opens Space Master Plan has been included as **Appendix I.**

2 - Park numbers included in table are from the City of Del Rio's Park Guide Map. This map has been included as **Appendix K.**

Table 8-1 - Existing Park & Recreation Improvements Along San Felipe Creek[1] (cont.)

Park No.[2]	Park Name	Amenities[1]	Quantity[1]	Condition[1]	Comments
8	**Camp Del Rio**	Walking Trail	1	Poor	Goals posts on soccer field are in poor condition.
		Soccer Field	1	Fair	
		Bleachers	4	Good	
		Trash Cans	3	Good	
16	**Hogan Park (baseball field)**	Baseball Field	1	Good	Bleacher siding in fair condition. Field has lights and is host to many youth baseball games.
		Trash Cans	2	Fair	
		Dumpster	1	Good	
		Bleachers	4	Good	
17	**Moore Park**	Open Space			Heavily used park, particularly during the warm weather months. Provides excellent access to San Felipe Creek.
		Walking Trail			
		Park Benches	13	11 Good,2 Fair	
		Trash Cans	14	8 Good, 6 Fair	
		BBQ Pits	14	9 Good, 4 Fair, &	1 Poor
		Picnic Tables	25	24 Good, 1 Fair	
		Basketball Court	0.5	Poor	
		Pool w/ Bathhouse	1	Excellent	
		Volleyball Courts	2	Poor	
		Water Fountain	1	Poor	
		Dumpster	1	Good	

1 - Summary of existing improvements and some comments were taken from Table 6-1 of the City of Del Rio's Planning & Capacity Building Study (2010-2020) and Table 2 of the Parks, Recreation and Open Space Master Plan (2010-2020). Both documents were prepared by TRC Engineers, Inc. (TBPE Firm No. F-8632). The Parks, Recreation and Opens Space Master Plan has been included as **Appendix I**. Comments pulled directly from the Master Plan are included in quotations.
2 - Park numbers included in table are from the City of Del Rio's Park Guide Map. This map has been included as **Appendix K.**

Table 8-1 - Existing Park & Recreation Improvements Along San Felipe Creek[1] (cont.)

Park No.[2]	Park Name	Amenities[1]	Quantity[1]	Condition[1]	Comments
20	**Riverside Park**	Along Creek			Arundo donax (River Cane) dominates this stretch of San Felipe Creek.
23	**Romanelli Park**	Open Space			Park has a significant amount of open space.
		Stone Monuments	6	Good	
		Flagpoles	3	Good	
		Park Benches	5	Excellent	
		Trash Cans	4	Fair	
		BBQ Pits	4	Fair	
		Picnic Tables	5	Excellent	
22	**Roosevelt Park (baseball field)**	Baseball Field	1	Good	This field serves as the home field for the Del Rio High School baseball team.
		Concession Stand	1	Fair	
		Restrooms	1	Fair	
23	**Rotary Park**	Open Space			This park is frequently used by area residents.
		Covered Pavilion	1	Good	
		Park Benches	7	3 Fair, 4 Poor	
		Trash Cans	4	3 Good, 1 Fair	
		Large BBQ Pit	1	Good	
		BBQ Pits	4	Good,Fair,2 Poor	

1 - Summary of existing improvements and some comments were taken from Table 6-1 of the City of Del Rio's Planning & Capacity Building Study (2010-2020) and Table 2 of the Parks, Recreation and Open Space Master Plan (2010-2020). Both documents were prepared by TRC Engineers, Inc. (TBPE Firm No. F-8632). The Parks, Recreation and Opens Space Master Plan has been included as **Appendix I.** Comments pulled directly from the Master Plan are included in quotations.

2 - Park numbers included in table are from the City of Del Rio's Park Guide Map. This map has been included as **Appendix K.**

Table 8-1 - Existing Park & Recreation Improvements Along San Felipe Creek[1] (cont.)

Park No.[2]	Park Name	Amenities[1]	Quantity[1]	Condition[1]	Comments
23	**Rotary Park (cont.)**	Picnic Tables	17	Fair	
		Playscapes	2	Excellent, Poor	
		Basketball Court	1	Good	
		Volleyball Courts	1	Good	
		Soccer Field	1	Poor	
24	**San Felipe Lion's Hut[3]**	Playscape	1		This park was not listed in the City's Master Plan, however it is included on the City's Park Guide Map (**Appendix K**).
		Building	1		
25	**San Felipe Lion's Park**	Open Space			
		Picnic Tables	6	4 Good, 2 Fair	
		Trash Cans	6	Good	
		Playscape	1	Good	
		Swing Set	1	Fair	
26	**Severiano Perez Parkway**	Open Space			
		Park Benches	4	1 Good, 3 Fair	
		Trash Cans	3	Good	
		BBQ Pits	2	1 Good, 1 Fair	

1 - Summary of existing improvements and some comments were taken from Table 6-1 of the City of Del Rio's Planning & Capacity Building Study (2010-2020) and Table 2 of the Parks, Recreation and Open Space Master Plan (2010-2020). Both documents were prepared by TRC Engineers, Inc. (TBPE Firm No. F-8632). The Parks, Recreation and Opens Space Master Plan has been included as **Appendix I.** Comments pulled directly from the Master Plan are included in quotations.
2 - Park numbers included in table are from the City of Del Rio's Park Guide Map. This map has been included as **Appendix K.**
3 - San Felipe Lion's Hut amenities, quantities, and condition were not listed in the Parks, Recreation and Open Space Master Plan document.

Table 8-1 - Existing Park & Recreation Improvements Along San Felipe Creek[1] (cont.)

Park No.[2]	Park Name	Amenities[1]	Quantity[1]	Condition[1]	Comments
26	**Severiano Perez Parkway (cont.)**	Picnic Tables Water Fountain Playscapes Swing Set Slides Light Posts	2 1 2 1 1 3	Good Poor Excellent Fair Fair Good	
	Skate Park (adjacent to Severiano Perez Parkway)	Skate Course Walking Trail Basketball Court Park Bench Trash Cans	 1 1 2	Good Poor Fair Poor Fair	This park was listed in the City's Master Plan; however it is not included on the City's Park Guide Map (**Appendix K**). The park sets adjacent to the Severiano Perez Parkway.
28	**State Park**	Facilities included in Moore Park (#17) count			
	Joe Ramos Center	Basketball Court Cafeteria Recreation Room	1 1 1	Excellent Excellent Excellent	The Joe Ramos Center was listed in the City's Master Plan, however it is not included on the City's Park Guide Map (**Appendix K**).
	San Felipe Country Club[4]	Golf Course	9 holes		A significant amount of Arundo donax (River Cane) is present along the banks of San Felipe Creek (East and West Forks) within the golf course property.

1 - Summary of existing improvements and some comments were taken from Table 6-1 of the City of Del Rio's Planning & Capacity Building Study (2010-2020) and Table 2 of the Parks, Recreation and Open Space Master Plan (2010-2020). Both documents were prepared by TRC Engineers, Inc. (TBPE Firm No. F-8632). The Parks, Recreation and Opens Space Master Plan has been included as **Appendix I.** Comments pulled directly from the Master Plan are included in quotations.
2 - Park numbers included in table are from the City of Del Rio's Park Guide Map. This map has been included as **Appendix K.**
4 - San Felipe Country Club is a private development and not part of the City's park system.

8.2.2 Existing Hike and Bike Trail Improvements

A hike and bike trail system provides an easily accessible activity center capable of providing citizens of all ages a focus point for exercise and recreation. A developed trail system can serve as a link between existing parks and neighborhoods providing area residents a direct route between centers of activity. For the citizens of Del Rio, the trail system along San Felipe Creek provides this community connection.

The Mayor Dora Alcala Hike and Bike Trail runs along the banks of San Felipe Creek between the Moore Park area just south of US Highway 90 to a point just downstream of Tardy Dam. The trail ranges in width from approximately 6 to 10 feet. The trail is comprised primarily of asphalt with portions of the trail, through some parts of Moore Park, being constructed of flagstone. The length of trail along this portion of the creek totals approximately 5,450 feet (1.03 miles), which includes approximately 1,100 feet of flagstone trail along the right bank of San Felipe Creek between US Highway 90 and Bedell Avenue. The existing Mayor Dora Alcala Hike and Bike Trail along San Felipe Creek is shown on **Figure 18**.

8.3 Existing Infrastructure Improvements Along San Felipe Creek

In additional to park and recreational improvements, and the hike and bike trail, numerous infrastructure improvements have been installed along San Felipe Creek. These improvements include restrooms, sidewalks, parking lots, trash cans, drainage structures, drinking fountains, and other improvements typically found in park site areas.

Many of these improvements are shown on **Figure 18** and are included in the inventory of existing park improvements listed in **Table 8-1**. Additional information on many of these improvements can be found in the Parks, Recreation and Open Space Master Plan 2010-2020 by TRC Engineers, Inc. and the City's Parks and Recreation Department included as **Appendix I**, as well as Chapter 4 of the Del•RioPlan prepared by Kendig Keast Collaborative includes as **Appendix J**.

8.4 Existing Educational & Public Information Amenities Along San Felipe Creek

Signs and educational exhibits provide a simple and economical . The developed portions of San Felipe Creek have several informational signs and historical markers that provide the general public information about the creek, applicable City ordinances that may affect activities along the creek, as well as educate them on past historical events or activities that pertain to the area.

Above pictures show Historical Markers and other Informational Signs along San Felipe Creek.

8.5 Current Organized Activities and Events Along San Felipe Creek

A number of organized activities and events are held throughout the year along San Felipe Creek. Each of these activities and events have the potential to impact water quality in San Felipe Creek. Events that draw visitors to the creek or nearby parks may impact water quality within the creek both during the event and afterwards. Organized activities, including routine litter pick up and other organized events, can positively impact the water quality within the creek by keeping potential pollutants out of the creek. A summary of current organized activities and events in the San Felipe Creek drainage basin are listed in **Table 8-2** below.

Table 8 - 2 - Current Organized Activities and Events Along San Felipe Creek

Item No.	Activity/Event	Location	Comments
FESTIVALS / CELEBRATIONS			
1	Fourth of July	Amphitheater (main focus)	Annual celebration including fireworks, food vendors and parade
2	Cinco De Mayo	Brown Plaza	Celebration of Mexican heritage and culture
3	Dieciseis de Septiembre	Brown Plaza	Celebration of Mexican Independence from Spain
VOLUNTEER ORGANIZATIONS			
4	San Felipe Creek Commission	San Felipe Creek	Commissioners nominated by City Council; Operates under City Ord. 2006-010.
5	Volunteer Del Rio Program	City Wide	Program designed to connect volunteers with volunteer opportunities
6	City Litter Pick Up	City Wide	Organized annual event. Labor provided by volunteers.
ON-GOING ACTIVITIES			
7	Residential Solid Waste & Brush Pick Up	City Wide	City weekly trash collection service. Brush/yard trimmings collected monthly.
8	Recycling	City Wide	City recycling center & recycle trailer (trailer travels on designated schedule)
9	Trash Pick Up (City Parks & Rec. Dept.)	Parks	Routine park trash collection by City Parks & Rec. Dept. staff

8.6 Needs Assessment

The planning process included a needs assessment of the desired. Input with regard to the planning area was received through public meetings, a public questionnaire/survey, and from public comments.

8.6.1 Public Meetings

Public meetings were an integral part of the planning process. The meetings were intended to inform the San Felipe Creek Commissioners and the general public on the planning process and to provide one avenue for input from the Commissioners or individuals. Formal meetings included a Kick-off meeting and two subsequent planning meetings:

Kick-Off Meeting - October 20, 2010;
1st Planning/Progress Meeting - July 25, 2011;
2nd Planning/Progress Meeting - October 26, 2011.

The 1st and 2nd Planning Meetings included a San Felipe Commissioners Meeting, held during normal business hours, and a separate Public Meeting held in the evening in order to make it easier for area residents to attend the meeting. Each of the meetings was open to the general public, however most residents attended the evening Public Meeting. Each meeting included a presentation. The presentations for the meetings have been included in **Appendix L**.

8.6.2 Public Survey

A public survey was prepared and distributed in order to solicit opinions and priorities from area residents. The public survey allowed residents to prioritize their desires for the San Felipe Creek area. A blank copy of this survey form is included as **Appendix M**.

Results from these surveys have been included in **Table 8-3** on the following page. Based on these results, the overwhelming issue was the eradication of invasive species from San Felipe Creek, with over one-third of the survey respondents listing it as their number one priority for the Creek area.

Table 8 - 3 - Public Survey Results Summary

Item Rank	Avg. Rank	Total #1 Votes	Item
1	3.7	12	Remove brush and **invasive species** along San Felipe Creek
2	4.0	3	**Additional restrooms** and trash barrels along the trails and park grounds
3	4.9	3	Provide improvements that would facilitate the use of the creek for **tubing and kayaking** while protecting endangered species that live in San Felipe Creek
4	5.1	--	Provide **greater amenities** at existing parks, such as playground equipment, picnic areas, restrooms, parking
5	5.8	2	Additional **pavilions** and facilities for **group gatherings**
6	6.0	2	**Expand hike & bike trails**
7	6.0	1	Provide **new parks** and recreational facilities along San Felipe Creek
8	6.1	1	Provide facilities that can be used for **outdoor group activities** including festivals, concerts, etc.
9	6.2	--	Provide **educational facilities** to teach about the ecology of San Felipe Creek and natural areas
10	6.7	--	Retain open space for **bird watching**, habitat protection

8.6.3 Public Comments

Public comments were received from the public survey forms that were completed and returned by area residents. The comments included a number of suggestions and ideas that could apply to this water quality master plan. A summary of the public comments received has been included in **Table 8-4** on the following page.

Table 8 - 4 - Public Comments

Comment No.	Comment
1	The City should increase surveillance and enforce laws and regulations which punish citizens who litter…
2	Consider hosting a small vessel water parade in conjunction with a city/fundraiser event.
3	Good quality health dept-inspected food and beverage (non-alcoholic) concessions at key nodes of park development (such as food trucks), small but properly equipped kitchens (rented by contract concessioners) at 2 or 3 centrally-located food courts (Rotary Park, San Felipe Lions Park, Moore Park).
4	The "No Mow Zones" are not accomplishing their intended purpose; The "No Mow Zones" need to go away and true vegetation management principles need to be used instead.
5	Create a nature trail on the southern part of San Felipe Creek to include the area of Round Mountain.
6	Extend and identify hike and bike trails, from the San Felipe H/B Trail with a route running through the City streets that takes you near most all of the historic sites.
7	Do away with the "No Mow Zones"; these areas are nothing but a nuisance and fire hazard, and also harbor unwanted animals.
8	Separate "Protecting Endangered Species" from "Recreational Activities" (kayaking and tubing).
9	More police patrols/bike patrols.
10	This creek is the most important for my roots of family; where my family grew up; they are gone, but I am here to support San Felipe Creek.
11	Flood control; more dams.
12	Figure out where you can have commercial development to meet needs of visitors to creek.
13	Keep kayaks below Tardy Dam to protect swimmers.
14	Remove as few existing walls as possible.
15	Lighting??
16	More trees for shade in playground areas.
17	Create a dog park at one of the FEMA spaces in San Felipe Creek
18	What we have is a good start, but adding and improving the facilities, trails, river, etc… will be great to the community. It will also have a positive effect on tourism in Del Rio.

9. PROJECT ALTERNATIVES & RECOMMENDATIONS

9.1 Strategies for Selection of Alternatives & Recommendations

As outlined in Section 3.1, Project Goals, Objectives, Strategies & Priorities, the ultimate goal of the water quality protection measures presented in this Plan is to maintain or enhance the existing water quality and water quantity in San Felipe Creek. To accomplish this objective, the strategy has been to select measures that facilitate a decrease in anticipated pollutant loadings, minimize the potential for discharges into San Felipe Creek, or enhance the habitat in or near the creek.

For ease of recognition of individual projects the project area was divided into Areas A through F. These project areas are shown on **Figure 19**. The location of the individual projects are shown by number in **Figure 20**. These project numbers correspond to the numbers listed in the individual project descriptions and project cost estimates included in **Appendix G**.

9.2 Rationale for Selection of Best Management Practices

Watershed management and water quality protection measures typically include both "structural" and "non-structural" measures. As detailed in Section 4.6, in current water quality planning practice, these measures are typically referred to as "Best Management Practices" (BMPs). The EPA has adopted the following definitions for structural and non-structural BMPs:

Structural BMPs *include engineered and constructed systems that are designed to provide for water quantity and/or water quality control of storm water runoff.*

Non-structural BMPs *include institutional and pollution-prevention type practices designed to prevent pollutants from entering storm water runoff or reduce the volume of storm water requiring management.*

The approach to protect water quality outlined in this Master Plan is a combination of both structural and non-structural BMPs. Although most people's perception of water quality protection measures is limited to classic structural BMPs, the effective use of non-structural

BMPs can reduce the need for the use of traditionally more costly structural BMPs. As activities continue to occur within the San Felipe Creek drainage basin, a combination of structural and non-structural BMPs working together will provide the most effective protection to water quality and quantity within San Felipe Creek. The following sections in this Master Plan outline specific projects and programs that can be initiated throughout the area to effectively provide a positive long-term impact to San Felipe Creek.

9.3 Control of Invasive Species

9.3.1. Arundo donax Eradication

Recommendations for the eradication of *Arundo donax* are detailed in Appendix B. In summary, the recommendations are to cut the cane after flowering, which typically occurs in mid- to late summer, then remove the cut stalks and shred them into pieces less than one inch in length. After waiting for new growth to occur in the next month, the cane should be sprayed with a combination of Rodeo (3% - 5% solution) and a surfactant. During the winter the dead biomass should be removed. This procedure should continue for several years until the cane is eradicated.

Cutting the cane can be accomplished by manual or mechanical means. Manual cutting can be by hand or gasoline-powered trimmer with a brush attachment. Mechanical cutting is typically by a tractor or brush-hog. Mechanical cutting is often not possible near the creek. The use of Rodeo near the creek should be under taken with care to prevent, or minimize, the amount of chemical entering the aquatic environment. When working in areas within San Felipe Creek or along the bank directly adjacent to the waters of the creek the USFWS has encouraged a wick application method using foam applicators, or similar type system, should be considered to avoid directly spraying Rodeo into the open water areas.

Arundo donax covers almost 40 acres of land from the San Felipe Country Club to Round Mountain. Based on an estimated chemical cost of almost $200 per acre of giant reed treated, the expected cost of the chemicals is approximately $8,000.

The use of chemicals will allow for a more complete and effective killing of the Arundo donax. In fact, it would likely be economically infeasible to eradicate the giant reed from such a large area, due to the difficulty in killing the plant through only mechanical means. However, even with the use of chemicals this operation will be very labor intensive. With an expected kill rate as low as 60%, an extended, multi-year effort will be needed to significantly impact the existing spread of giant reed along San Felipe Creek.

In an effort to quantify the expected labor cost an estimate was prepared for both manual and mechanical cutting of the cane. Table 9.1 below details the expected cost of cane eradication efforts over the first five years of the program. To simplify calculations, the following year's cost is estimated at 60% of the previous year (to simulate a 60% kill rate). The cost estimates for both the manual and mechanical cutting are included in **Appendix E**.

Table 9-1. Arundo donax Eradication Costs (for the entire 40 acres of cane estimated to be located along San Felipe Creek & for the 2 acres estimated to be located between US Hwy 90 and Round Mountain). Subsequent years assume a 60% reduction in previous years cost.

Type of Cutting	$/acre	Year 1	Year 2	Year 3	Year 4	Year 5	Total
40 acres - Manual	$ 43,750	$ 1,750,000	$ 700,000	$ 280,000	$ 112,000	$ 44,800	**$ 2,930,550**
40 acres - Mechanical	$ 28,875	$ 1,155,000	$ 462,000	$ 184,800	$ 73,920	$ 29,568	**$ 1,934,163**
2 acres - Manual	$ 43,750	$ 87,500	$ 35,000	$ 14,000	$ 5,600	$ 2,240	**$ 188,090**

The above costs show that the labor necessary to eradicate the giant reed from San Felipe Creek will be significant. Once started, this effort must be on-going, although as can be seen in **Table 9-1**, the labor expense is expected to drop significantly after the first few years of the program. However, **Table 9-1** does indicate that the elimination of Arundo donax from the section of San Felipe Creek between US Highway 90 downstream to Round Mountain is manageable. The approximately two acres of river cane in this area could be effectively managed for much less than the entire length of San Felipe Creek. By working on this section of the creek the City could, in a relatively short period of time, eradicate the cane from the area of the creek most heavily used by the general public. However, the City should continue to look toward the future and maintain a long term goal of eradicating the river cane from the portion of San Felipe Creek within the city limits.

9.3.2. Armored Catfish

The armored catfish present in San Felipe Creek out compete native species for both food and habitat. Their activities also significantly contribute to the damage of the creek banks which has a negative impact on water quality by increasing the suspended solids in the water. It is recommended that the City actively encourage on-going research and investigations into the control and elimination of this damaging pest.

9.3.3. Water Fowl

To reduce the presence of fecal coliform on San Felipe Creek it is recommended that the domestic water fowl located along the creek be relocated.

9.3.4. Nutria

Along banks of San Felipe Creek, nutria have created a by damaging the creek banks which contributes to an increase in suspended solids and materials added to San Felipe Creek. It is recommended that an active program of pest control be instituted in an effort to control the nutria and other rodents that may be contributing to the damage of the creek banks.

9.4 Recommended Water Quality Improvements

9.4.1 Structural Best Management Practices (BMPs)

As detailed in Section 4.7.1 the following structural BMPs are recommended for use along San Felipe Creek:

- Vegetation Enhancement
- Bank Stabilization
- Riparian Area Restoration
- Vegetative Filter Strips
- Pervious Pavement
- Biofiltration/Bioretention
- Hydrodynamic Separators

9.4.2 Non-Structural Best Management Practices (BMPs)

As detailed in Section 4.7.2 the following non-structural BMPs are recommend for use along San Felipe Creek:

- Public Education
- Community Involvement
- Land Management/Ordinances
- Litter/Trash Pick Up
- Pet/Animal Waste
- Human Waste Control

The proposed improvements are intended to satisfy the recommendations for both Structural and Non-Structural BMPs. Except for some park and miscellaneous infrastructure projects included as part of the proposed projects, the overwhelming majority of projects included in this Master Plan will directly impact the water quality of San Felipe Creek.

9.5 Recommended Bank Improvements

Suspended solids play a significant role in impacting the water quality along a creek. In the case of San Felipe Creek collapsed walls and eroded banks contribute to an overall decrease in water quality in the creek. As a result, improvements to the stream bank can provide a positive impact on water quality and the wildlife that inhabits the creek. **Figure 21** details bank improvements proposed for San Felipe Creek. More details are provided in the individual project descriptions included in **Appendix G**.

Bank improvements recommended include the demolition, removal, and reconstruction of some of the existing creek bank walls, particularly those located in Moore Park. For other locations it is recommended that the existing damaged walls be removed and an improved riparian area be established. **Figure 22** outlines the different types of creek banks being proposed for construction. The emphasis is on establishing a more natural riparian area when possible, however, in traditional high traffic areas the damage to the riparian area would likely be severe making the construction of structural walls a more logical, and ecologically suitable choice.

Table 9-2. Cost Summary of Proposed Bank Improvements along San Felipe Creek (cost information from Individual Project Descriptions/Cost Estimates in **Appendix G**).

Project Area	Total Length of Bank Improvements (LF)	Project Costs
A	9,160	$ 195,000
B	6,240	$3,094,000
C	4,190	$2,343,000
D	1,620	$757,000
E	2,910	$441,000
F	5,050	$390,000
TOTAL	29,170	$7,220,000

Along selected creek banks the use of Focused Access Features is proposed as an entry way to the creek. In most cases, these Focused Access Features are proposed for installation along stretches of the creek that have an established riparian area, or will have a riparian area established as part of the proposed bank improvements. The Focused Access Features will allow access to the creek by park site visitors without damaging the creek's natural or improved riparian area. By targeting pedestrian foot traffic to these selected sites the bank areas along the creek will be subject to less damage by pedestrians which will result in a healthier and fully functional riparian area. By minimizing damage to the riparian area a significant savings in operational and maintenance costs for this area of the creek should be realized. **Figure 23** details the location and estimated cost of these proposed improvements. **Figure 23** also details the location of proposed Kayak Put-In/Take-Out areas. A schematic of a typical Focused Access Feature is shown in **Figure 24**. As shown, the Focused Access Feature is intended to provide access in compliance with the Texas Department of Licensing and Regulation's (TDLR) Texas Accessibility Standards (TAS). During the design phase for the portion of the creek that includes a Focused Access Feature, it will be important to coordinate the design of the project with a Registered Accessibility Specialist (RAS) and the TDLR to ensure that the proposed design meets the requirements of the TAS and the provides the access desired by area residents and visitors to San Felipe Creek.

Along San Felipe Creek there are a number of footbridges that provide improved access to park site visitors. Many of these bridges have been in place for a significant amount of time. Over the years sever of the bridges have suffered from bank erosion around the bridge footing and are in need of significant repair. **Figure 25** details the bridge improvements proposed under this master plan.

Another significant source of non-point source pollution around the San Felipe Creek area is soil and suspended matter produced by areas that have little to no vegetation. To alleviate this problem several vegetation "enhancement" projects are proposed. These projects would include the spreading of soil and compost, and in some cases the use of soil retention blankets. These projects are outlined and detailed in **Figure 26**.

9.6 Recommended Creek Side Improvements

Improvements are also proposed outside the creek bank areas of San Felipe Creek. The proposed improvements include a number of non-point source pollution BMPs including pervious concrete, bioretention/biofiltration systems and hydrodynamic separators, public education kiosks, trash cans, pet waste stations, and public restrooms. The following figures detail the proposed improvements:

Figure 27 - Proposed Projects - New Pervious Parking Areas
Figure 28 - Proposed Projects - Convert Existing Parking Areas to Pervious Pavement
Figure 29 - Proposed Projects - Bioretention/Biofiltration
Figure 30 - Proposed Projects - Hydrodynamic Separators
Figure 31 - Proposed Projects - Public Education Kiosks
Figure 32 - Proposed Projects - Trash Cans
Figure 33 - Proposed Projects - Pet Waste Stations
Figure 34 - Proposed Projects - Public Restrooms
Figure 35 - Proposed Projects - Community Gardens

Figures 27 and **28** detail the installation of pervious concrete for new parking areas, as well as the conversion of existing parking areas from an impervious driving surface to one of pervious concrete. The installation of pervious concrete near San Felipe Creek will significantly reduce the suspended solids runoff currently entering the creek. Furthermore, the volume of runoff will be reduced and the pervious parking systems should increase the amount of water percolating into the ground. As an alternative to pervious concrete, a gravel pavement system could be used. A gravel pavement system normally uses a structural grid system, typically made of plastic, to support and contain the gravel/rock surface. An example of such a system is shown in **Figure 7**. In general, gravel pavement systems are less expensive to install than pervious concrete. It should be noted that for cost estimating purposes the master plan utilizes pervious concrete unit costs.

9.7 Recommended Hike & Bike Trail Improvements

Proposed hike and bike trail improvements are detailed on **Figure 36**. These improvements include the installation of approximately 5,750 linear feet of new hike and bike trails of pervious concrete. The proposed hike and bike trail improvements also include approximately 6,695 linear feet of hike and bike trail that will be converted from an impervious surface material, asphalt or stone, to pervious concrete. The estimated total cost for these projects is approximately $1,123,000 that results in the improvement of over 12,445 feet of hike and bike trail. If construction costs are a concern, the installation of a conventional concrete or asphalt hike and bike trail surface, along with a properly designed and constructed vegetative filter strip, should be considered an acceptable alternative to a pervious concrete trail.

9.8 Recommended Infrastructure Improvements

A number of infrastructure improvements are outlined in this master plan. Significant among those are proposed repair and upgrade to Tardy Dam (Project Nos. D-22 and D-23). Also included are miscellaneous projects including the repair/upgrade of existing park signs, rehabilitation of existing picnic and park areas, and relocation or lowering of existing pipelines that cross San Felipe Creek.

9.9 Recommended Educational Opportunities

Educational opportunities for the community will be provided as a result of several of the proposed projects. The most significant include informational signs and kiosk to be located along San Felipe Creek. **Figure 31** provides additional details on the cost and location of the proposed kiosks.

9.10 Recommended Land Management Strategies & Opportunities

The City of Del Rio has an opportunity to effectively manage the San Felipe Creek drainage basin in a manner that promotes and establishes good land management strategies. A number of recommendations from the City's Del•RioPlan (the Comprehensive Plan) show be instituted including the identification and protection of priority conservation areas, such as the San Felipe Creek watershed, the promotion and management of wise stormwater management techniques, demonstration gardens, as well as other items outlined in Chapter 4 - "Parks and Recreation" of the Del•RioPlan.

9.10.1 Vegetative Management Areas

Along San Felipe Creek there is an opportunity for the City to better manage and promote the growth of a healthy riparian area. In the past there were areas along the creek known as "No Mow Zones" as established by the City of Del Rio's Management Plan for San Felipe Creek and the Devils River Minnow in 2003. Over the years, the term "No Mow Zone" has developed a negative connotation among area residents due to the unsightliness created by the uncontrolled weeds, trees and, bushes, as well as the presence of *Arundo donax*, that have grown up and now cover much of these areas.

The Vegetative Management Areas should include those areas where the City is committed to establishing a riparian area. Instead of "no mow" zones areas, it is recommended that the City actively manage the Vegetative Management Areas in a controlled, somewhat limited manner, in an effort to more positively promote the establishment of a functional riparian area. The City should evaluate on an annual basis the designated Vegetative Management Areas and if appropriate, should change or alter the maintenance of these areas to better nurture the riparian environment. As a guide, a Fact Sheet on the establishment and maintenance of the Vegetative Management Areas has been developed and is included as **Appendix N.**

10. PROJECT PRIORITIZATION

As outlined in **Section 9.0**, a large number of necessary and desired projects have been identified for the San Felipe Creek area. However, based on limited financial resources available the identified projects are competing for those resources. A means of prioritizing the individual projects was necessary to provide guidance on the general order of project development that will allow the City to maximize the benefits to the Creek and the local residents. **Section 12.0** of this master plan outlines project conclusions and recommendations for this Master Plan, however many recommendations on project prioritization and timing can be found throughout this section.

10.1 Project Category Prioritization

Based on the results from the public surveys outlined in Section 8.6.2, along with input received during the San Felipe Creek Commissioner's meetings and the public meetings held as part of this planning process, the proposed individual project could be sorted into one of four major project types. The major project categories identified included: (1) Invasive Species Eradication; (2) Public Safety and Access; (3) Water Quality; and, (4) Park and Miscellaneous Improvements.

For prioritization purposes all of the individual projects have been placed in one of these four categories. It is recommended that the overall progression of project development proceed in the general order of: (1) Invasive Species Eradication; (2) Public Safety and Access and Citizen Well-being; (3) Water Quality; and, (4) Park and Miscellaneous Improvements.

PROJECT CATEGORIES

[Order of Preference ➔]

Invasive Species Eradication (1^{st})	➔	**Public Safety & Access (2^{nd})**	➔	**Water Quality (3^{rd})**	➔	**Park & Misc. Improvements (4^{th})**

While it is acknowledged that due to funding levels, budget cycles, available resources, and other considerations, some projects may be moved ahead of other lower-ranked projects, the overall direction of project development should generally follow the project rankings included in this master plan.

10.1.1 Invasive Species Eradication

Based on citizen surveys and public comments Invasive Species Eradication is by far the highest ranked priority of the four identified project categories. The eradication of *Arundo donax* along San Felipe Creek will improve public safety, will improve both water quantity and water quality within the creek. Coupled with removal of the armored catfish this will improve the habitat of endangered and other species living in and around the creek, and will provide for a more usable and esthetically pleasing creek area.

10.1.2 Public Safety, Public Access & Citizen Well-being

Along San Felipe Creek there are a number of public safety issues created by collapsed sidewalks, walls, and eroded areas. In some places, public access to walk or ride on sidewalks and walkways along the creek or within the park areas has been compromised. In an effort to protect park visitors and the general public the Public Safety and Access category of projects is recommended as the second highest priority of the four project categories.

10.1.3 Water Quality

As discussed in previous sections of this master plan water quality in San Felipe Creek is of critical importance to endangered species, other animal and plant species living in and around the creek area, and public use. This category of projects includes bank improvements to San Felipe Creek, vegetation enhancement, and stormwater BMPs. The Water Quality category of project is recommended as the third highest priority of the four project categories.

10.1.4 Park & Miscellaneous Improvements

Several of the indentified projects along the San Felipe Creek area include park improvement projects and other miscellaneous site improvement projects. While all of these identified projects are important, based on public survey results and comments this category ranks behind the other three major project categories. In some cases, it may be convenient to group an individual park project with other, higher priority projects, to expedite the construction of the project and to possibly benefit from reduced overhead costs.

10.2 Individual Project Rankings

In an effort to provide guidance on the prioritization of individual projects along San Felipe Creek, a ranking criteria was developed. The ranking criteria includes six individual categories. Each project was ranked from one to five (one being the worst or least desired and five being the best or most desired) for each of the six categories. An overall score was totaled and the average ranking was calculated. The projects were then listed from highest ranking to lowest ranking among the four major project categories.

Appendix F includes a summary sheet of the individual categories ranked, along with a complete listing of the ranked projects. Details of the individual ranking criteria for the six categories is included below.

10.2.1 Public Safety & Access

Public safety and public access were evaluated for each individual project identified. The individual project were ranked according to the following criteria:

- 5 - Project main purpose is to address an existing public safety issue or hazard (i.e., collapsed wall, broken sidewalk, or other hazard) or public access;
- 4 - Project will address public safety or public access;
- 3 - Project may partially, or indirectly, address an existing public safety hazard or access;
- 2 - Project only somewhat addresses an existing public safety hazard or access; and,
- 1 - Project will likely not improve public safety, public access, or citizen well-being.

10.2.2 Long-Term Impact on Endangered Species

Endangered species are an important part of the ecology of San Felipe Creek. The Devils River Minnow and the San Felipe gambusia live in the creek and can be sensitive to impacts from activities and development near the creek. Individual projects were ranked according to the likely long-term impact the project would have on endangered species within San Felipe Creek according to the following criteria:

5 - Project implemented will have a major, long-term positive impact on the endangered species within San Felipe Creek;

4 - Project implemented will have a long-term positive impact on the endangered species within San Felipe Creek;

3 - Project implemented will have little to no long-term impact on the endangered species within San Felipe Creek;

2 - Project implemented will have a long-term negative impact on the endangered species within San Felipe Creek; and,

1 - Project implemented will have a major, long-term negative impact on the endangered species within San Felipe Creek.

10.2.3 Impact on Water Quality

The water quality of San Felipe Creek is important to the public that visit the creek area, endangered species that inhabit the creek, and the creek's riparian area. Individual projects were ranked according to the likely long-term impact the project would have on the water quality in San Felipe Creek according to the following criteria:

5 - Project implemented will have a major, long-term positive impact on the water quality in San Felipe Creek;

4 - Project implemented will have a long-term positive impact on the water quality in San Felipe Creek;

3 - Project implemented will have little to no long-term impact on the water quality in San Felipe Creek;

2 - Project implemented will have a long-term negative impact on the water quality in San Felipe Creek; and,

1 - Project implemented will have a major, long-term negative impact on the water quality in San Felipe Creek.

10.2.4 Existing Level of Degradation Within Project Area

For some areas of San Felipe Creek the existing conditions help contribute undesirable contaminants into San Felipe Creek. These contaminants are mainly in the form of soil, dirt, and other suspended solids or particulates. For each individual project area the existing level of degradation was evaluated and ranked according to the following criteria:

5 - A very high-level of degradation exists within the project area (i.e., no vegetation, totally exposed soil/dirt/particulates) resulting in definite, negative impacts to water quality;

4 - A significant level of degradation exists within the project area (i.e., little vegetation, large areas of exposed soil/dirt/particulates) resulting in negative impacts to water quality;

3 - Some level of degradation exists within the project area (i.e., some areas lacking vegetation, areas of exposed soil/dirt/particulates) resulting in negative impacts to water quality;

2 - A small amount of degradation exists within the project area (i.e., small areas lacking vegetation, small areas of exposed soil/dirt/particulates) resulting in minimal impacts to water quality;

1 - Very little, if any, degradation exists within the project area (i.e., good vegetation, no exposed soil/dirt/particulates) resulting in very little to no impacts to water quality;.

10.2.5 Project Cost

The estimated project costs have been summarized in the Individual Project Descriptions included in **Appendix G**. Based on these estimated project costs the following points were given to individual projects:

5 - Project cost of less than or equal to $10,000
4 - Project cost between $10,000 - $50,000
3 - Project cost between $50,000 - $100,000
2 - Project cost between $100,000 - $250,000
1 - Project cost of $250,000 or more.

10.2.6 Expected Impact on Required Maintenance

Maintenance of existing improvements in and around the San Felipe Creek area takes a significant amount of resources including financial, man-power, and equipment. A significant concern of City officials is the amount of maintenance that will be required for any new improvements constructed along the creek. Based on a project's likelihood to increase or decrease the requirement maintenance from existing levels, the following points were given to individual projects:

5 - Finished project can be expected to eliminate, or greatly reduce on-going maintenance currently provided by City crews within the project area:
4 - Finished project can be expected to reduce on-going maintenance currently provided by City crews within the project area:
3 - Finished project can be expected to maintain on-going maintenance currently provided by City crews within the project area:
2 - Finished project can be expected to increase on-going maintenance currently provided by City crews within the project area: and,
1 - Finished project can be expected to significantly increase on-going maintenance currently provided by City crews within the project area.

Table 10-1. Scoring Criteria Summary for Project Prioritization (Project Rankings)

		PROJECT SCORING		
1.	**Public Safety & Public Access**	**HIGH:** Project as implemented to address an existing public safety issue or a hazard of concern to park visitors.	**MEDIUM:** Project as implemented may partially address an existing public safety issue/concern, although may not be primary purpose for project.	**LOW:** Project implementation will not likely address public safety or citizen welfare.
		5 **4**	**3**	**2** **1**
2.	**Long-Term Impact on Endangered Species**	**POSITIVE:** Project as implemented will have a long-term positive impact on endangered species within the San Felipe Creek drainage basin.	**NEUTRAL:** Project as implemented will have limited or no long-term impact on endangered species within the San Felipe Creek drainage basin.	**NEGATIVE:** Project as implemented will likely have a long-term negative impact on endangered species within the San Felipe Creek drainage basin.
		5 **4**	**3**	**2** **1**
3.	**Impact on Water Quality**	**POSITIVE:** Project as implemented will/should improve water quality within San Felipe Creek.	**NEUTRAL/NONE:** Project as implemented will have a negligible impact or no impact on the water quality of San Felipe Creek.	**NEGATIVE:** Project as implemented is likely to have a negative impact on the water quality of San Felipe Creek.
		5 **4**	**3**	**2** **1**
4.	**Existing Level of Degradation within Project Area**	**HIGH:** Project Area has a high level of degradation resulting negative impacts to water quality.	**MEDIUM:** Project Area has some level of degradation resulting in impacts to water quality.	**LOW:** Project Area has very little to no level of degradation resulting in impacts to water quality.
		5 **4**	**3**	**2** **1**
5.	**Project Cost**	**LOW:** <$10k	**MEDIUM:** $50k - $100k	**HIGH:** $250k+
		5 **4**	**3**	**2** **1**
6.	**Expected Impact on Required Maintenance**	**LOW:** Upon completion, finished project will eliminate or greatly reduce the existing level of maintenance provided by City crews within the project area.	**MEDIUM:** Upon completion, finished project will maintain the existing level of maintenance provided by City crews within the project area.	**HIGH:** Upon completion, project will likely require an increase in the existing level of maintenance provided by City crews within the project area.
		5 **4**	**3**	**2** **1**

10.3 Prioritization of Individual Projects

Appendix F includes a summary table of the individual projects sorted by the four major project categories outlined in Section 10.1: (1) Invasive Species Eradication; (2) Public Safety, Public Access and Citizen Well-being; (3) Water Quality; and, (4) Park and Miscellaneous Improvements. Within these major project categories the individual projects are listed from highest to lowest priority using the scoring system described in Section 10.2. In developing funding plans and project schedules, these rankings should be used as a guide to identify the projects of most benefit to the creek and creek visitors. It is acknowledged that other factors may influence the order in which projects are constructed including project timing, budgets, funding opportunities, and other issues.

10.4 Project Timelines

The establishment of exact timelines for construction of the individual projects along San Felipe Creek is difficult without also establishing a detailed annual construction budget. The annual construction budget will be dependent on City budgeting priorities and available revenue, federal and State funding opportunities including grant monies, and other opportunities for cost sharing including donations and local volunteer participation.

What can be established as part of the master plan process is an overall timeline for project completion based on the idea that individual projects fall into the category of Immediate, Short-Term, or Long-Term projects. The listing of projects in the Project Prioritization table included in Appendix F also includes a notation on whether a project is considered an Immediate, Short-Term, or Long-Term project. The following summary includes details on the projects or type of projects that are intended to fit into the selected project category:

10.4.1 Immediate Projects

Immediate Projects are those projects that are recommended for action as soon as funding can be made available. Due to the high importance placed on Invasive Species Eradication by the residents of Del Rio, through their answers on the public surveys and their comments during the public meetings, the highest priority projects are limited to the eradication of *Arundo donax* along San Felipe Creek from the Highway 90 bridge to Tardy Dam. This portion of San Felipe Creek includes Project Areas B, C, and D. Although, in general, it is recommended that the river cane eradication proceed from upstream to downstream, which would mean that Project Area A should be the first area addressed, since most visitors to San Felipe Creek populate the Project Areas B, C, and D, it is recommended that cane eradication first begin in these areas.

10.4.2 Short-Term Projects

In most cases the projects identified as short-term projects are those that have the potential to positively impact public safety and access along the creek, or will provide a significant impact to water quality within San Felipe Creek. In reality, short-term projects may include those that are easily completed, that are in high demand by the general public, or those that have received funding from a State or federal agency. A short-term project is considered to be a project that will be started within five years.

Based on public surveys, public comments, and on-site inspections of the creek area the projects of most importance from a water quality perspective are cane eradication, bank repair and stabilization projects, and vegetation enhancement projects. A definite short-term project would be the eradication of Arundo donax in Project Areas A, E, and F. High ranking Public Safety projects and Water Quality projects, listed in the Project Prioritization tables in **Appendix F**, should also be considered short-term projects.

10.4.3 Long-Term Projects

In general, long-term projects are those projects not previously included as an Immediate project or a Short-Term project. These project are those that will tend to have a marginal benefit to water quality, have a high construction cost, or are projects that replace a currently functional system or improvement (e.g., an existing asphalt parking lot). While all of these projects will be a benefit to the San Felipe Creek area, the high-cost of some projects will require that they be placed on hold until funding is secured.

10.5 Estimated Project Costs

Project costs have been estimated for all the individual projects indentified. Each project is described in detail in **Appendix G**, along with a detailed cost estimate. Cost estimates presented are at the planning level and their accuracy should fall within the estimated project contingency. Unknown or unforeseen site conditions could affect the final project costs. For future budgeting purposes the costs estimates are conservative in order to ensure adequate resources are available for planned projects. Due to the uncertainty of the exact field conditions for each individual project the project planning costs include a 25% contingency. The unit costs used in these estimates generally represent current construction costs found in the Del Rio area or within the State of Texas.

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11. PLAN IMPLEMENTATION STRATEGIES

11.1 Financing Options

When discussing the financing options for the projects outlined in this Plan it is important to remember that due to the timing of applications and program requirements, it may not be possible to implement the different projects in order of their priority.

For example if funding is obtained for trail rehabilitation and trail extensions prior to securing funding for invasive species eradication it would be advantageous to do the trail work first even though it may have a lower priority. Complete execution of the projects outlined and adopted as part of the Plan will hinge heavily on the understanding of the importance of flexibility in the implementation strategies.

Below are a list of different funding sources and options:

11.1.1 Local Funding:

- Annual Budgeting Process can provide additional funding for enhanced maintenance, annual capital improvements. It is important to realize that as facilities and activities are expanded it is important to recognize that operations and maintenance costs to the City will increase.

- Bond issuance by the City to provide funding for improvements that improve San Felipe Creek. These bonds could be secured through a tax levy or potentially funding through the local hotel-motel tax collections.

- Public-Private Partnerships include working with potential business interests, local irrigation company, or non-profit corporations. This type of partnership could be developed on a comprehensive or case by case basis. For instance, if a hotel were to be constructed within the watershed of the project area the city could apply for funding through the Texas Capital Fund for utility extensions or other public improvements. As part of this funding package the private partner could provide improvements to San Felipe Creek that would provide amenities that would benefit the public.

- Foundation Funding for environmental and/or recreational improvements. There are several foundations which can provide limited grants for public recreational improvements. Typically, these foundations base their awards on a case by case basis and often will participate as a partner in a specific project or projects.

11.1.2 State and Federal Sources:

Texas Water Development Board (www.twdb.state.tx.us)

- **Clean Water State Revolving Fund (CWSRF)** The CWSRF is a federally subsidized loan and grant program that has a set aside Green Project Reserve (GPR) to fund projects that increase energy efficiency or for addressing non-point source pollution issues. The funds can be used for planning, design and implementation of these projects. Eligible projects include the implementation of Best Management Practices including restoration of riparian habitat, improving the quality of runoff, reduction of impervious cover, bio-retention and establishment or restoration of permanent riparian buffers, floodplains, wetlands or other natural features including vegetated buffers or soft bio-engineered stream banks.

  The application process is to submit a project description and cost estimate for the Intended Use Plan (IUP) by March 1 of each year. The proposed project is than ranked against other projects from around the state and in early spring the rankings are made public and applications are invited in the fall of each year. Projects are expected to be completed within 3 years after the loan/grant closing.

- **Development Fund-2 (D-Fund 2)** The D-Fund 2 account is a loan program using state authorization. Eligible projects include design, permitting, and construction of drainage, flood control and/or water quality improvements and treatment works such as permeable surfaces. There is no set time for submitting an application and potential projects are processed on a first come, first served basis.

Texas Commission on Environmental Quality (www.tceq.state.tx.us)

- **Section 319 Nonpoint Source Storm Water Quality Funding and BMP's** is a grant program administered by the Texas Commission on Environmental Quality (TCEQ) for projects that implement plans that are designed to improve water quality from nonpoint sources of pollution. The grants are for 60% of project costs and can be used for design and construction of eligible project components. The TCEQ calls for applications in the early summer and awards grants in the early fall. If a grant is awarded it must be completed within 3 years after the award. Matching funds can come from local sources or through the CWSRF. Other federal grant programs are usually not eligible as a source of matching funds.

Texas Department of Transportation (TxDOT) (www.txdot.state.tx.us)

- **Transportation Enhancement Program** TxDOT administers the federally funded program, which provides opportunities for non-traditional transportation related activities. Projects should go above and beyond standard transportation activities and be integrated into the surrounding environment in a sensitive and creative manner that contributes to the livelihood of the communities, promotes the quality of our environment, and enhances the aesthetics of our roadways. Projects undertaken with enhancement funds are eligible for reimbursement of up to 80 percent of allowable costs. Eligible projects can be for pedestrian and/or bicycle improvements as well as to mitigate pollution from highways.

Texas Parks and Wildlife Department (TPWD) (http://www.tpwd.state.tx.us/)

- **Outdoor Recreation Grant** The 82nd Texas Legislature has suspended all Texas Recreation and Parks Account (TRPA), and all Large County & Municipality Recreation and Parks Account funding for the FY 2012-2013 biennium. If funds are restored for the next biennium this program can provide up to 50 percent of allowable costs up to a maximum of $500,000. Eligible projects include park and recreation amenities including playgrounds, open space, play fields, hike and bike trails and protection of unique habitat. This is a competitive program and applications are accepted twice a year and grant awards are made in January and August of each year.

- **Trail Grant Program** is a federally funded program that provides up to $200,000 for trail improvements with the local sponsor required to provide a minimum match of 20% for a total project cost of $250,000. These funds can be used for trail restoration, rehabilitation, or resurfacing; development of trail-side and trail-head facilities; provision of features which facilitate access and use of trails by persons with disabilities; land acquisition by easement or fee simple title; educational signage; environmental mitigation to mitigate or minimize impact to the natural environment.

U.S. Fish and Wildlife Service (http://www.fws.gov/)

- **Habitat Conservation Plan (HCP)** provides a 75% grant with a 25% local matching requirement. Through the development of regional HCPs, local governments incorporate species conservation into local land use planning, which streamlines the project approval process and facilitates economic development. Established in fiscal year 2001, the Habitat Conservation Planning Assistance Grants program provides funding to States to support the development of HCPs. Planning assistance grants may support planning activities such as document preparation, public outreach, baseline survey's and inventories.

Texas Department of Agricultural (http://www.texasagriculture.gov/)

- **Infrastructure Development Fund** is a federally funded program administered by the Texas Department of Agriculture to assist rural communities in promoting economic development by making grant funds available to assist in infrastructure development to expand employment opportunities. Starting in 2010, applications are accepted at any time and awarded monthly. A Webinar overview of the 2010 TCF program changes is available online through the Texas Capital Fund program link at http://www.texasagriculture.gov/. The standard maximum award is $750,000 with two jumbo awards of $1,000,000 offered each program year. The minimum award is $50,000. The sponsor has 3 years to complete the project. This program could assist a new or expanding business by helping to cover the costs for water quality protection measures to protect San Felipe Creek.

U.S. Department of Commerce (http://www.eda.gov/)

- **Economic Development Administration** provides grant funding for public works projects that are tied to job creation or job retention. There funding can be used for infrastructure development similar to the Infrastructure Development Fund. Grants can be between 50-80 percent of the costs of the project.

North American Development Bank/Border Environment Cooperation Commission (NADB/BECC) (www.nadb.org/) (http://www.cocef.org)

- **Community Assistance Program (CAP)** provide grant and loan funding for infrastructure projects within 100 km of the international border. The funding for these grants are from portfolio earnings at the NADB and are not an ongoing program. Grants are for 90% of the project costs up to a maximum grant of $500,000. The current request for project proposals ends February 3, 2012.

Environmental Protection Agency (EPA) (http://www.epa.gov/)

- **Urban Waters Program** The goal of these Urban Waters Small Grants is to fund research, studies, training, and demonstration projects that will advance the restoration of urban waters by improving water quality through activities that also support community revitalization and other local priorities. Grants are limited to $60,000 and can be used for community education, planning or design. A $2,500 local match is required.

- **Border 2012 Initiative** is a program funded by the EPA and administered by the Border Environment Cooperation Commission (BECC) and is limited to areas located within 100 km. of the international border. Program funds can be used for activities that advance the goals of the group including water quality protection. Grants are limited to a maximum of $100,000. While no matching funds are required applicants are strongly encouraged to leverage the funding through cooperative agreements with local, regional or state partners.

11.2 Resource Allocation Options

It is anticipated that there will be a limit to the availability of local resources to fund the proposed projects. The success and completion of the projects outlined in the final Master Plan will ultimately depend on the ability to secure combinations of financing from grants, low interest loans and donation from foundation funds.

It will also be important to focus on leveraging federal, State and local funds to maximize the return on investment and minimize local costs associated with the proposed projects outlined in the final Master Plan.

11.3 Adaptive Land Uses Along San Felipe Creek

A significant focus of this planning effort included the identification of adaptive land uses most appropriate for the San Felipe Creek area. The adaptive land uses would need to ensure the protection of endangered species, protect the integrity of the established floodplain, and allow public access to the creek area. Other factors that affect public use and development along San Felipe Creek include, but are not limited to, the public's understanding of the value of the creek and the need to protect the resource, public safety, impact of invasive species on creek use, zoning regulations, and existing adjacent land uses along the creek. These factors will influence the potential public and private uses of property along San Felipe Creek and will directly impact the potential adaptive land uses.

Existing policy issues will have a direct impact on adaptive land uses along San Felipe Creek including the 100-year floodplain boundary, current City ordinances, public-private partnerships, development compatibility with surrounding neighborhoods, incorporation of FEMA Buyout Properties into the City park system, financial commitments for public education and safety, and the encouragement of eco-tourism and biological diversity.

As property along the San Felipe Creek area is developed it will be necessary to maintain a focus on and a commitment to the protection of water quality and threatened and endangered species. Existing City ordinances will likely need to be amended and new ordinances adopted to incorporate requirements for appropriate structural and non-structural water quality best management practices, land management strategies and techniques. It is recommended that the City consider that following criteria in developing ordinances to protect water quality within the planning area:

- Adopt buffer zones and setbacks consistent with the Regional Plan and existing agreements with U.S. Fish and Wildlife Service and Texas Parks and Wildlife Department.
- Require riparian restoration for projects that affect the banks of the creek.
- Allow for new development to implement off site riparian restoration and structural and non-structural BMP's that would accomplish the goals of the Regional Plan.

- A pollution prevention plan should be filed with the City to assure that there is no pollutant runoff from a site during construction.
- New development must show that a minimum of 80% of the increased Total Suspended Solids (TSS) annual loading can be removed prior to runoff leaving a site after the completion of construction. The measures to control the discharge of pollution should be consistent with Best Management Practices identified in the guidance documents from the US Environmental Protection Agency (EPA), US Department of Agriculture and the Texas Commission on Environmental Quality (TCEQ). These documents can be found at the following wed sites:
  http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

  http://www.tceq.texas.gov/waterquality/nonpoint-source/mgmt-plan/index.html

  http://directives.sc.egov.usda.cov/viewerFS.aspx?hid+21433

- Alternative engineering solutions to achieve compliance can be provided by the developer as part of the site development plan. This will allow for individual design solutions to be developed for an individual site.
- If a site has 20% or less of impervious cover other permanent BMP's are not required. In reviewing the proposed site plan the use of pervious materials to reduce impervious cover should be noted. This exemption should be noted in the county deed records, with a notice that if the percent impervious cover increases above 20% or land use changes, the exemption for the whole site as described in the property boundaries may no longer apply and property owner must notify the City of the change.
- Because of the nature of the area there should be some flexibility in allowing mixed use developments. Since the development alternatives discussed in this section are for both permanent and seasonal uses there should be some flexibility in zoning regulations to accommodate these uses.

The potential commercial land use of the San Felipe Creek area identified during this planning process included food trailers or other "mobile" venders. Because of their mobility, these businesses could be located within the 100-year floodplain provided they are not permanent structures and have the ability to be moved outside the floodplain on short notice. If the City decides to allow this type of development along San Felipe Creek it is recommended that the following guidelines be considered: a stabilized pad and utility services should be available to the individual vendors, trash pickup should be the responsibility of the vendors, those vendors selling food and drink should provide seating areas, vendors should have the ability to relocate within one hour, appropriate water quality best management practices should be implemented, and density should be limited. Should development of the San Felipe Creek area include recreational vehicle parks the City should consider requiring full utility hook-ups for each vehicle, a limitation of the length of time an individual vehicle can use the facility, and detailed emergency evacuation procedures during emergency situations.

Appendix Q includes a more thorough discussion on possible adaptive land uses along San Felipe Creek.

11.4 Strategic Partnerships

Another important factor in the success of the Plan will be the continued fostering of strategic partnerships. The continued cooperation and success of these working relationships will be one of the driving forces behind securing funding for the individual projects. An example of the importance of one of these strategic partnerships would be the U.S. Fish and Wildlife Department. Their understanding of the different projects outlined in the Plan and the prioritization of the different projects will help solidify agency funding as well as assistance should the various regulatory constraints set in place to protect the endangered species create roadblocks for any of the proposed projects.

In addition to the strategic partnerships with the different local, State, and federal agencies it will also be important to continue building and nurturing working relationships with local volunteer groups and local community organizations. The expansion of City cosponsored group activities must be addressed through policy decisions by the City Council. If the decision is to expand group activities and festivals along San Felipe Creek sufficient resources will need to be allocated on an ongoing basis to meet the capital and operational costs associated with the programs and/or events. A policy decision will need to be made by the City Council if there will be a service fee to partially or fully recover those costs.

12. CONCLUSIONS & RECOMMENDATIONS

12.1 Conclusions

San Felipe Creek has been the focal point of residents and visitors to the Del Rio area for thousands of years. The creek itself and the endangered species that live in the creek are particularly vulnerable to activities that occur in and around the creek area. To keep the creek and its surrounding areas healthy and vibrant for use by the creek's animal inhabitants, as well as local residents and visitors an organized effort of creek improvements and site development should be undertaken. By following an organized plan, including the recommendation in this Master Plan, San Felipe Creek can be protected from harm and this area improved to allow the creek to once again become the focal point of this region of Texas.

12.2 Recommendations

Detailed recommendations have been included throughout the Master Plan. The following is a summary of the major recommendations and includes a reference to the appropriate section of the Master Plan that discusses in detail the particular recommendation:

- **Coordinate** any planned improvement projects or other activities with local, State, and federal agencies (5.3); in particular the presence of a federal endangered species in the creek, the Devils River minnow, makes active coordination with the USFWS essential to the success of any planned project in and around the creek area (3.5.6);

- **Elimination of invasive species** including Arundo donax (6.1, 9.3.1) and Armored catfish (6.2, 9.3.2); including coordination of efforts amongst State and federal agencies, particularly the efforts of the USDA's Agricultural Research Service's (ARS) Beneficial Insects Research Unit (BIRU) in Weslaco, TX;

- **Water quality best management practices (BMPs)** including structural BMPs (4.7.1, 9.4.1) and non-structural BMPs (4.7.2, 9.4.2);

- The following **Improvement Projects** should be pursued including Bank Improvements (9.5), Creek Side Improvements (9.6), Hike & Bike Trail

Improvements (9.7), Infrastructure improvements (9.10), public education opportunities (9.9), and Land Management Strategies (9.10);

- **Project prioritization** which in general should follow the general order of: (1) Invasive Species Eradication; (2) Public Safety and Public Access improvements; (3) Water Quality improvements; and, (4) Park and Miscellaneous improvements; the developed individual project priority rankings should be used as a guide to determine the projects of highest-priority (10.2, 10.3);

- **Project time-frames** have been outlined as Immediate, Short-Term, and Long-Term; the timing of projects will most likely be determined by project funding, however, the projects should be completed in the most aggressive time-frame possible (10.4); and,

- **Project funding** should actively be pursued from all possible sources including local, State, and federal sources, the development of public/private partnerships, as well as individual and institutional donations (11.0).

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FIGURES

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FIGURE 1

PROJECT AREA MAP
SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

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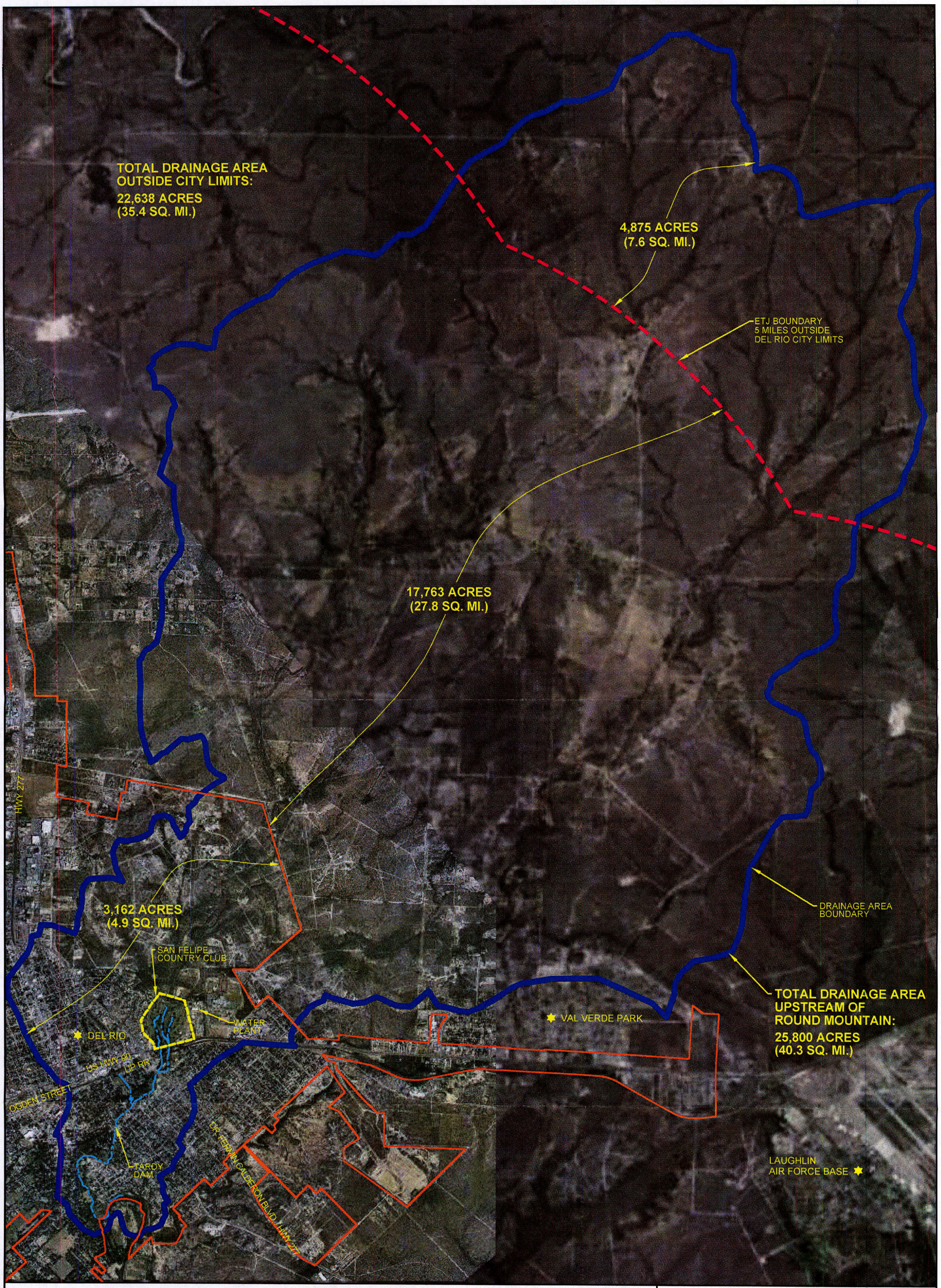
Checked By:	DBF	Project No.:	8267	Date:	06/28/11	Rev.:	06/26/12	Of



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0 2000 4000
SCALE IN FEET

0 1/2 1
SCALE IN MILES

LEGEND

- DRAINAGE AREA BOUNDARY
- SAN FELIPE CREEK CENTERLINE
- DEL RIO CITY LIMITS
- ETJ BOUNDARY

NOTE:

THE 5-MILE EXTRATERRITORIAL JURISDICTION (ETJ) BOUNDARY HAS BEEN ESTABLISHED FOR CITIES WITH A POPULATION OF 5,000 OR MORE AND ARE LOCATED IN A COUNTY BORDERING THE RIO GRANDE (TEXAS LOCAL GOVERNMENT CODE 212.001).

% OF DRAINAGE AREA INSIDE CITY LIMITS = 12 %
% OF DRAINAGE AREA OUTSIDE CITY LIMITS = 88 %
% OF DRAINAGE AREA OUTSIDE ETJ = 19 %

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FIGURE 2
SAN FELIPE CREEK DRAINAGE
AREA / PLANNING AREA MAP
CITY OF DEL RIO, TEXAS

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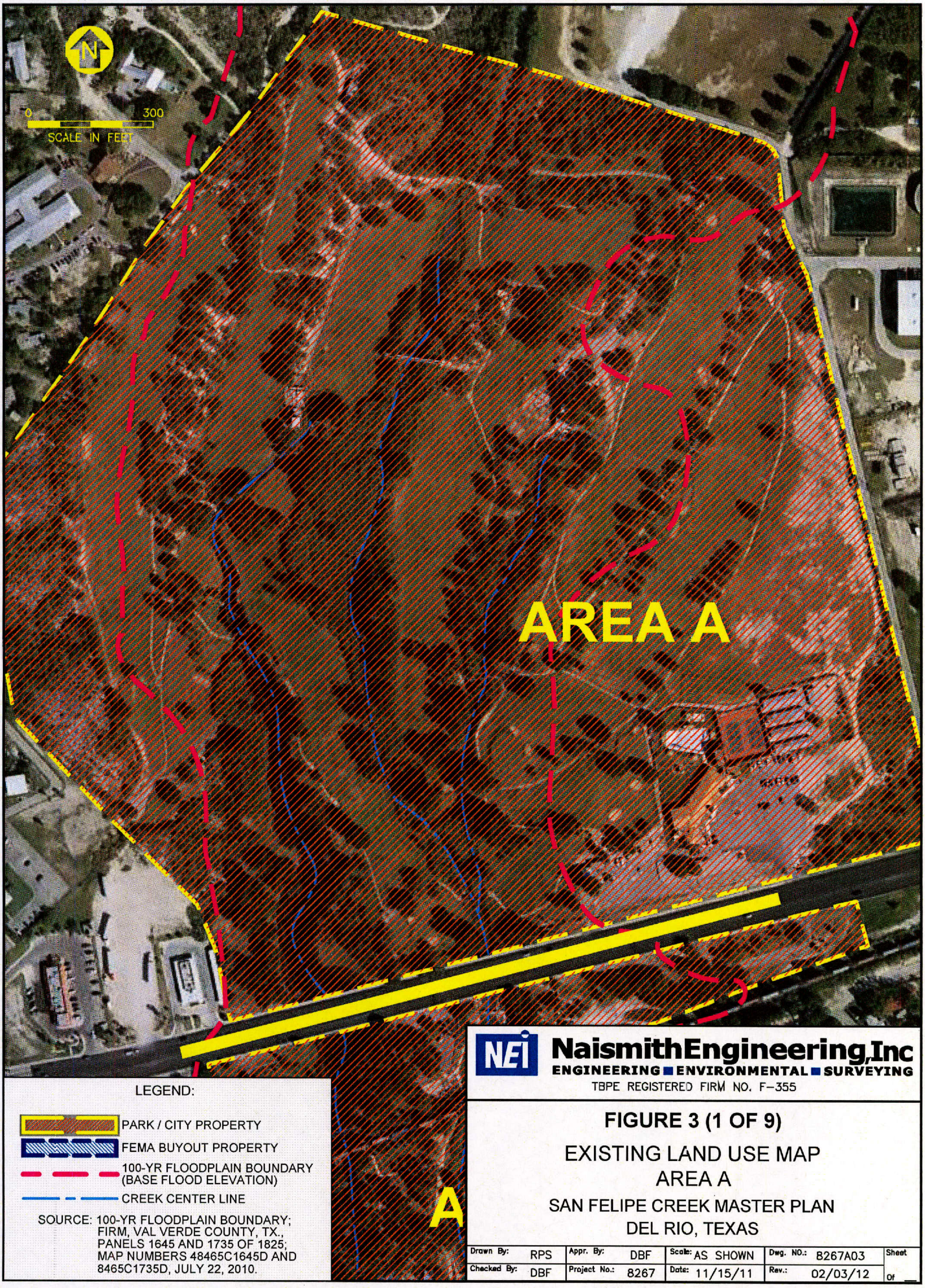

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FIGURE 3 (1 OF 9)

EXISTING LAND USE MAP
AREA A
SAN FELIPE CREEK MASTER PLAN
DEL RIO, TEXAS

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Checked By: DBF	Project No.: 8267	Date: 11/15/11	Rev.: 02/03/12	Of

LEGEND:

PARK / CITY PROPERTY

FEMA BUYOUT PROPERTY

100-YR FLOODPLAIN BOUNDARY (BASE FLOOD ELEVATION)

CREEK CENTER LINE

SOURCE: 100-YR FLOODPLAIN BOUNDARY; FIRM, VAL VERDE COUNTY, TX., PANELS 1645 AND 1735 OF 1825; MAP NUMBERS 48465C1645D AND 8465C1735D, JULY 22, 2010.

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FIGURE 3 (2 OF 9)

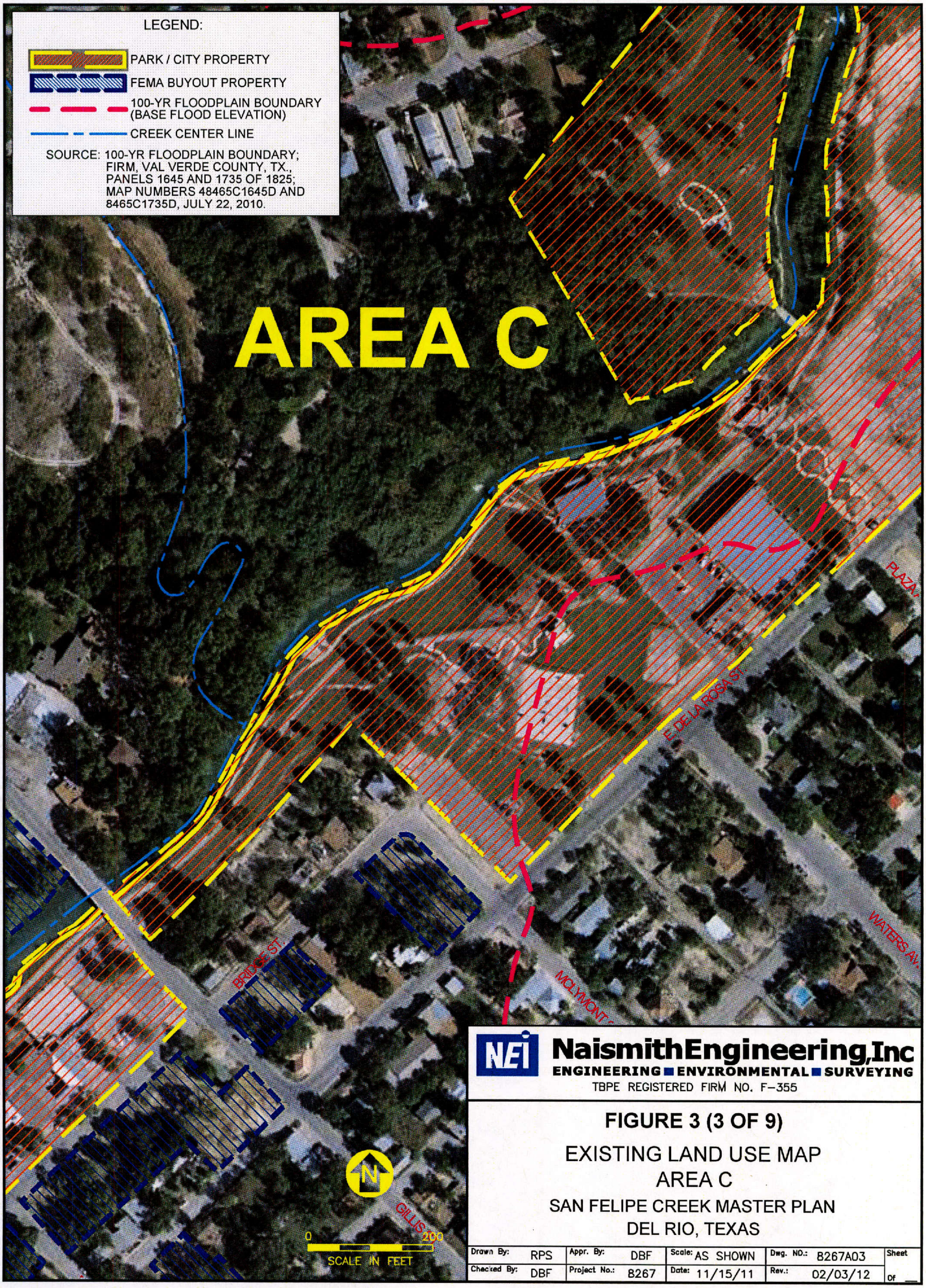
EXISTING LAND USE MAP

AREA B

SAN FELIPE CREEK MASTER PLAN

DEL RIO, TEXAS

Drawn By:	RPS	Appr. By:	DBF	Scale:	AS SHOWN	Dwg. NO.:	8267A03	Sheet			
Checked By:	DBF	Project No.:	8267	Date:	11/15/11	Rev.:	02/03/12	Of			



LEGEND:
PARK / CITY PROPERTY
FEMA BUYOUT PROPERTY
100-YR FLOODPLAIN BOUNDARY (BASE FLOOD ELEVATION)
CREEK CENTER LINE
SOURCE: 100-YR FLOODPLAIN BOUNDARY; FIRM, VAL VERDE COUNTY, TX., PANELS 1645 AND 1735 OF 1825; MAP NUMBERS 48465C1645D AND 8465C1735D, JULY 22, 2010.
AREA C
PLAZA
E. DE LA ROSA ST.
WATERS AV.
BRIDGE ST.
MCLYMONT
GILLIS
N
0
200
SCALE IN FEET
NaismithEngineering,Inc
ENGINEERING ■ ENVIRONMENTAL ■ SURVEYING
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FIGURE 3 (3 OF 9)
EXISTING LAND USE MAP
AREA C
SAN FELIPE CREEK MASTER PLAN
DEL RIO, TEXAS
Drawn By: RPS
Appr. By: DBF
Scale: AS SHOWN
Dwg. NO.: 8267A03
Sheet
Checked By: DBF
Project No.: 8267
Date: 11/15/11
Rev.: 02/03/12
Of

LEGEND:

PARK / CITY PROPERTY

FEMA BUYOUT PROPERTY

100-YR FLOODPLAIN BOUNDARY (BASE FLOOD ELEVATION)

CREEK CENTER LINE

SOURCE: 100-YR FLOODPLAIN BOUNDARY; FIRM, VAL VERDE COUNTY, TX., PANELS 1645 AND 1735 OF 1825; MAP NUMBERS 48465C1645D AND 8465C1735D, JULY 22, 2010.

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FIGURE 3 (4 OF 9)

EXISTING LAND USE MAP
AREA D

SAN FELIPE CREEK MASTER PLAN
DEL RIO, TEXAS

Drawn By: RPS	Appr. By: DBF	Scale: AS SHOWN	Dwg. NO.: 8267A03	Sheet
Checked By: DBF	Project No.: 8267	Date: 11/15/11	Rev.: 02/03/12	Of

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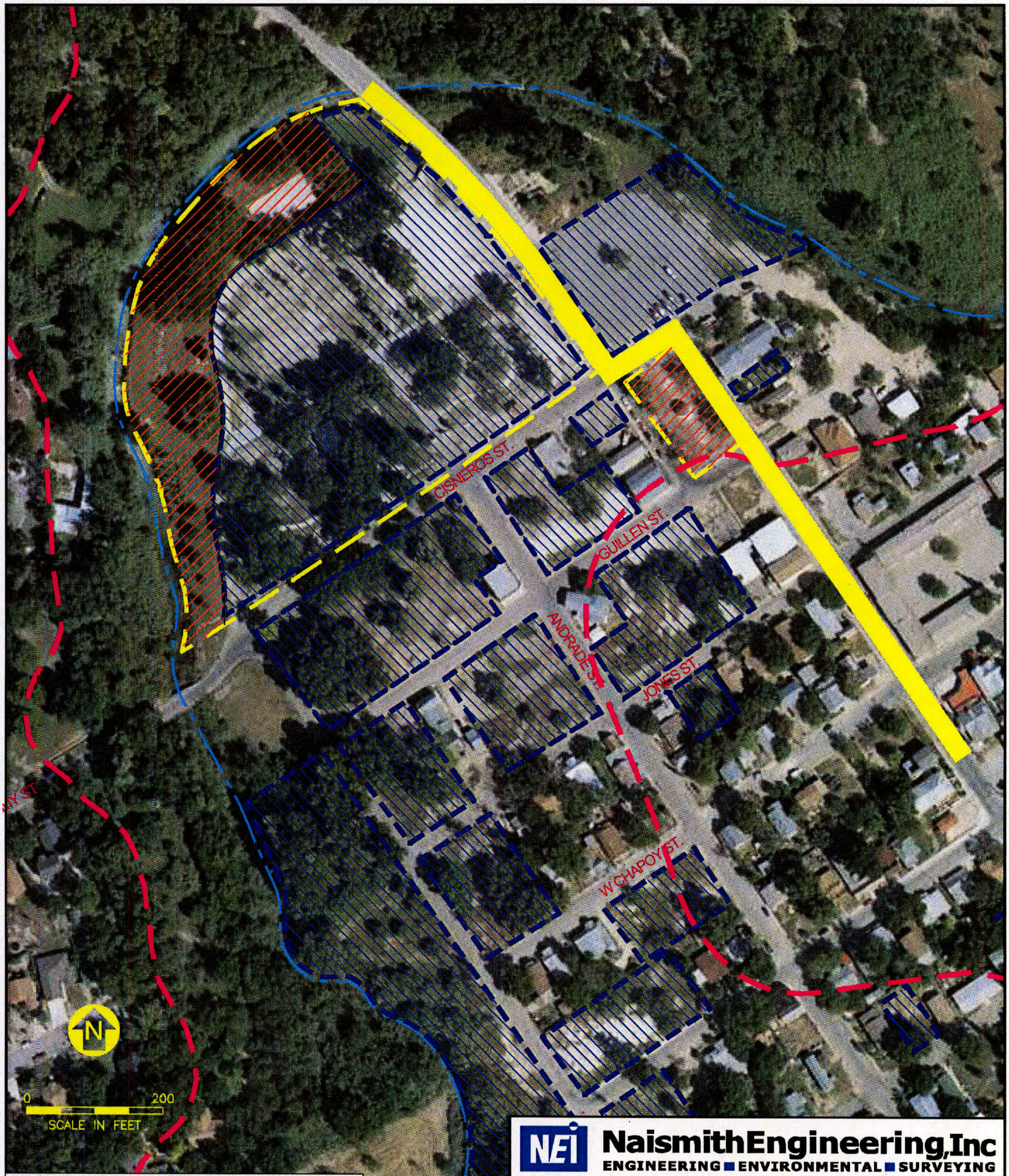
FIGURE 3 (5 OF 9)

EXISTING LAND USE MAP
AREA E

SAN FELIPE CREEK MASTER PLAN
DEL RIO, TEXAS

Drawn By: RPS	Appr. By: DBF	Scale: AS SHOWN	Dwg. NO.: 8267A03	Sheet
Checked By: DBF	Project No.: 8267	Date: 11/15/11	Rev.: 02/03/12	Of



LEGEND:

- PARK / CITY PROPERTY
- FEMA BUYOUT PROPERTY
- 100-YR FLOODPLAIN BOUNDARY (BASE FLOOD ELEVATION)
- CREEK CENTER LINE

SOURCE: 100-YR FLOODPLAIN BOUNDARY; FIRM, VAL VERDE COUNTY, TX., PANELS 1645 AND 1735 OF 1825; MAP NUMBERS 48465C1645D AND 8465C1735D, JULY 22, 2010.

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FIGURE 3 (6 OF 9)

EXISTING LAND USE MAP
AREA F (1 OF 3)
SAN FELIPE CREEK MASTER PLAN
DEL RIO, TEXAS

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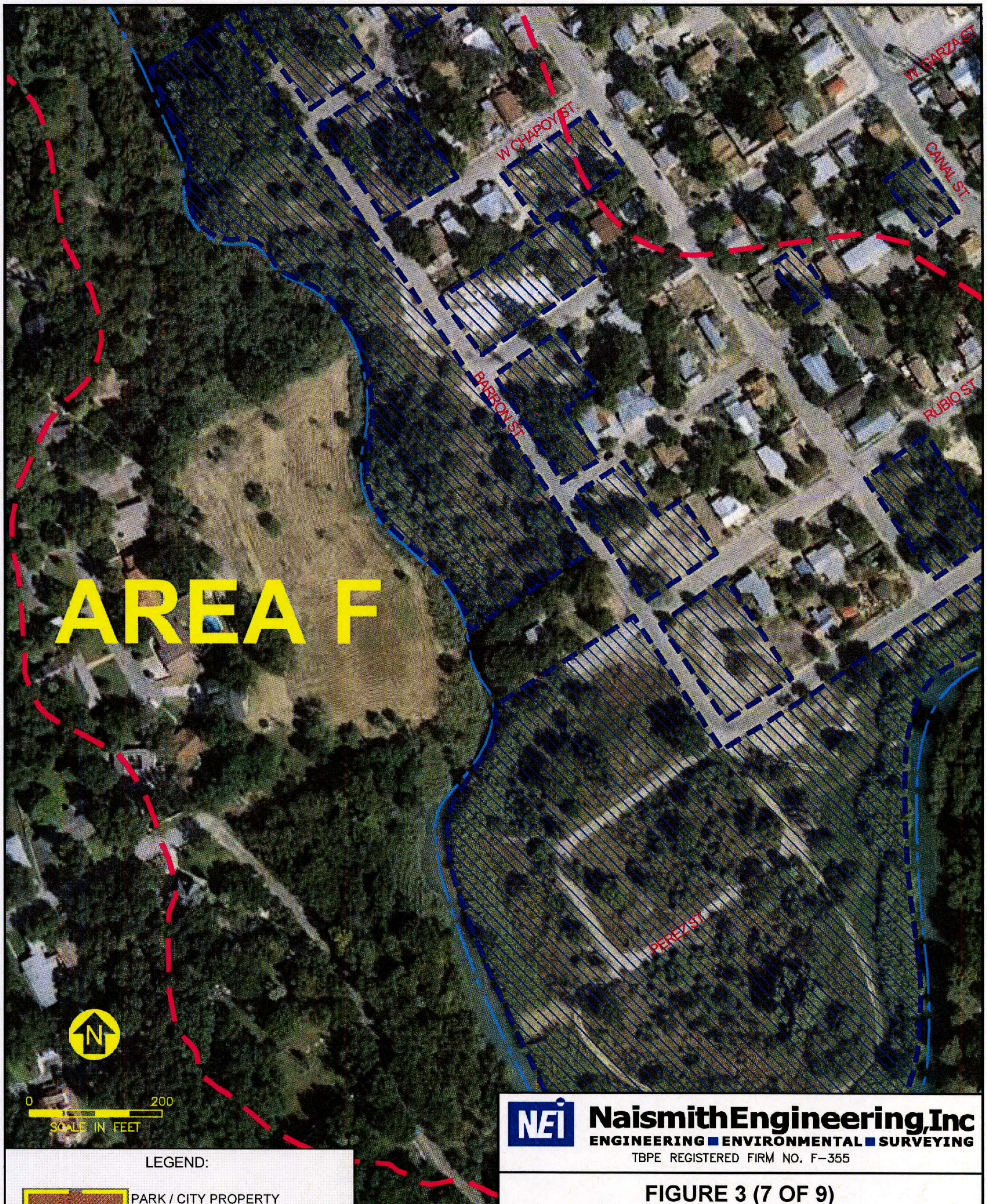
Checked By: DBF	Project No.: 8267	Date: 11/15/11	Rev.: 02/03/12	Of



LEGEND:

- PARK / CITY PROPERTY
- FEMA BUYOUT PROPERTY
- 100-YR FLOODPLAIN BOUNDARY (BASE FLOOD ELEVATION)
- CREEK CENTER LINE

SOURCE: 100-YR FLOODPLAIN BOUNDARY; FIRM, VAL VERDE COUNTY, TX., PANELS 1645 AND 1735 OF 1825; MAP NUMBERS 48465C1645D AND 8465C1735D, JULY 22, 2010.

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FIGURE 3 (7 OF 9)

EXISTING LAND USE MAP
AREA F (2 OF 3)
SAN FELIPE CREEK MASTER PLAN
DEL RIO, TEXAS

Drawn By:	RPS	Appr. By:	DBF	Scale:	AS SHOWN	Dwg. NO.:	8267A03	Sheet
Checked By:	DBF	Project No.:	8267	Date:	11/15/11	Rev.:	02/03/12	Of

LEGEND:

PARK / CITY PROPERTY

FEMA BUYOUT PROPERTY

100-YR FLOODPLAIN BOUNDARY (BASE FLOOD ELEVATION)

CREEK CENTER LINE

SOURCE: 100-YR FLOODPLAIN BOUNDARY; FIRM, VAL VERDE COUNTY, TX., PANELS 1645 AND 1735 OF 1825; MAP NUMBERS 48465C1645D AND 8465C1735D, JULY 22, 2010.

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FIGURE 3 (8 OF 9)

EXISTING LAND USE MAP
AREA F (3 OF 3)

SAN FELIPE CREEK MASTER PLAN
DEL RIO, TEXAS

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Checked By:	DBF	Project No.:	8267	Date: 11/15/11	Rev.:	02/03/12	Of	

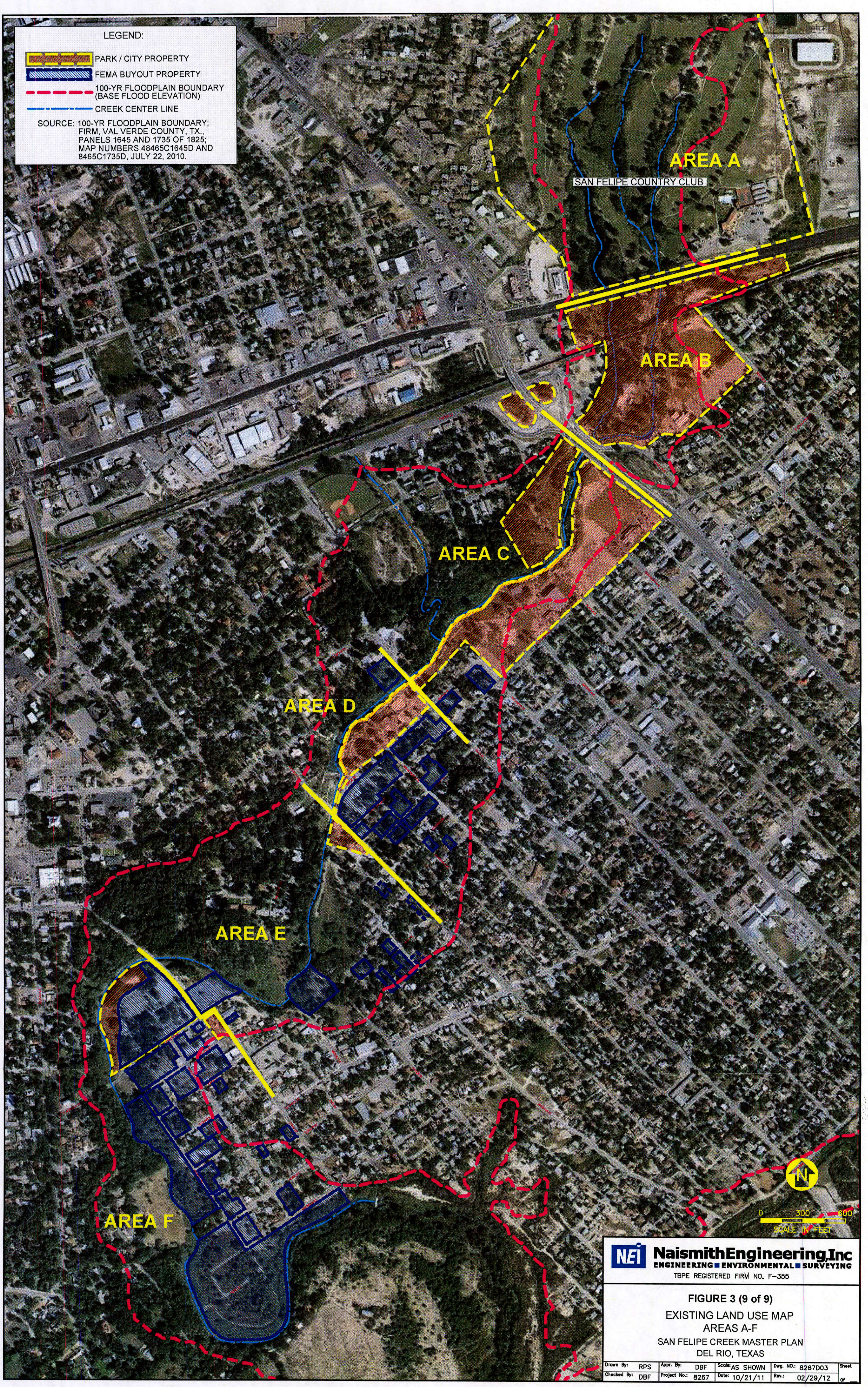

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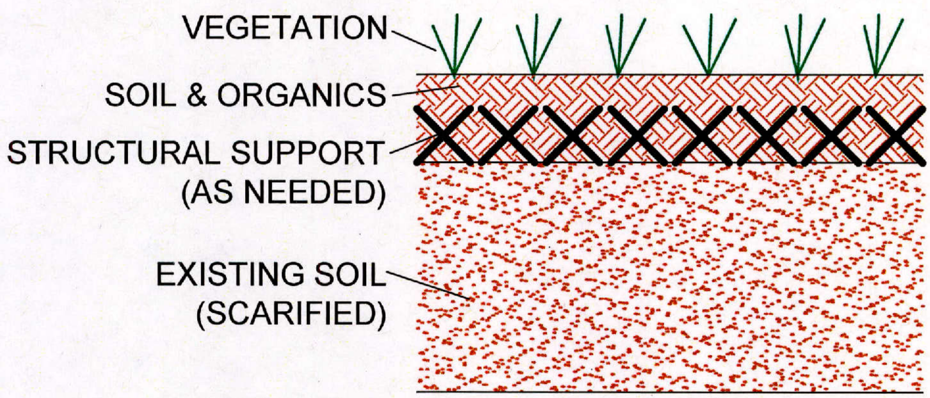
FIGURE 3 (9 of 9)

EXISTING LAND USE MAP
AREAS A-F
SAN FELIPE CREEK MASTER PLAN
DEL RIO, TEXAS

Drawn By:	RPS	Appr. By:	DBF	Scale:	AS SHOWN	Dwg. NO.:	8267D03	Sheet
Checked By:	DBF	Project No.:	8267	Date:	10/21/11	Rev.:	02/29/12	of

VEGETATION ENHANCEMENT



RECOMMENDED RIPARIAN AREA GRASSES (& SEDGES):

TALL:

- EASTERN GAMAGRASS (*Tripsacon dactyloides*)
- SWITCHGRASS (*Panicum virgatum*)
- EMORY SEDGE (*Carex emoryi*)
- SAWGRASS (*Cladium mariscus*)

SHORTER:

- SPIKERUSH (*Eleocharis sp.*)
- RICE CUTGRASS (*Leersia oryzoides*)
- APAREJOGRASS (*Muhlenbergia utilis*)
- TEAL LOVEGRASS (*Eragrostis hypnoides*)

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FIGURE 4
VEGETATION ENHANCEMENT SCHEMATIC
SAN FELIPE CREEK MASTER PLAN
DEL RIO, TEXAS

Drawn By: RPS-jbs	Appr. By:	DBF	Scale:	N.T.S.	Dwg. NO.:	8267A06	Sheet	
Checked By: DBF	Project No.:	8267	Date:	11/16/11	Rev.:	06/26/12	Of	

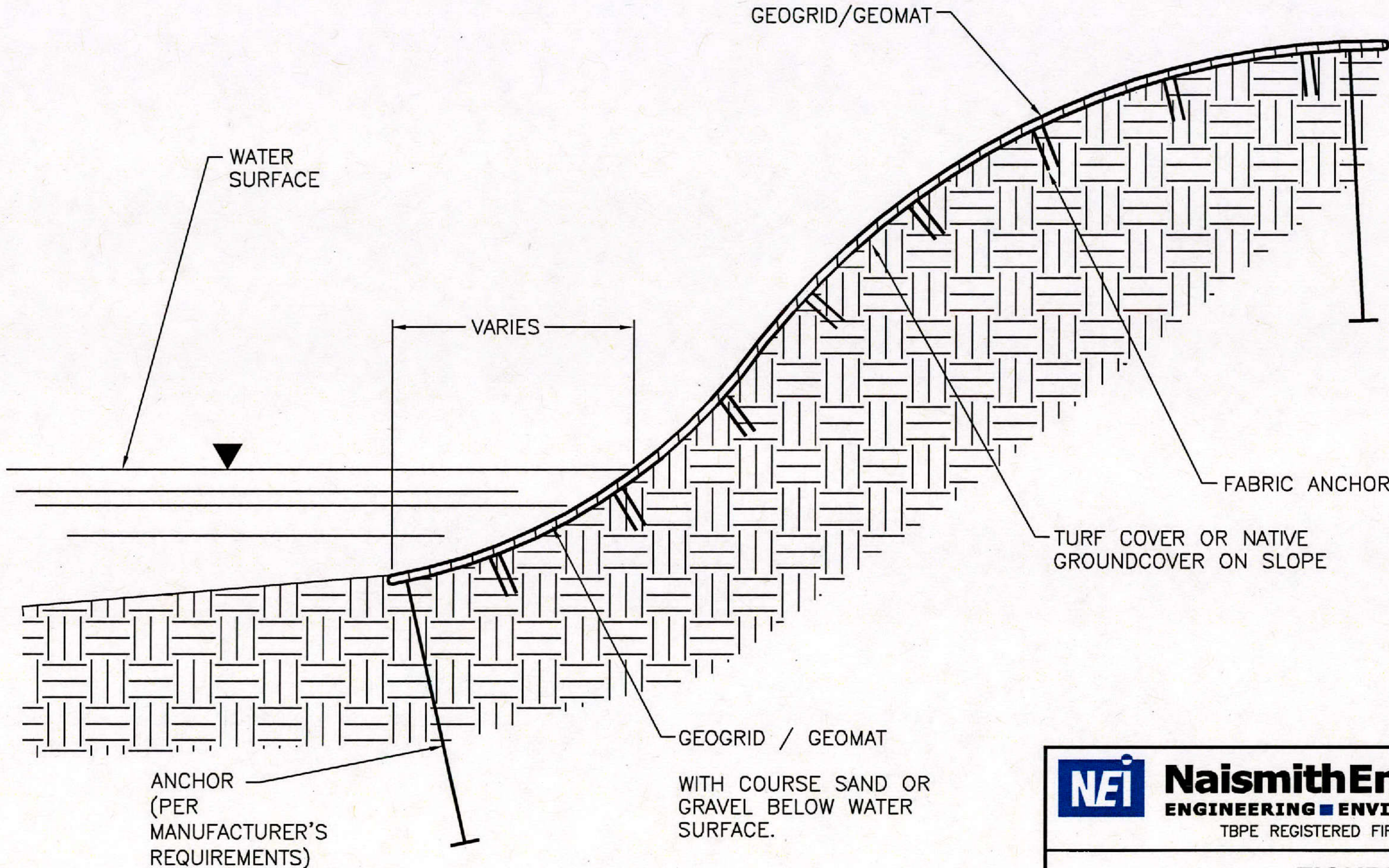

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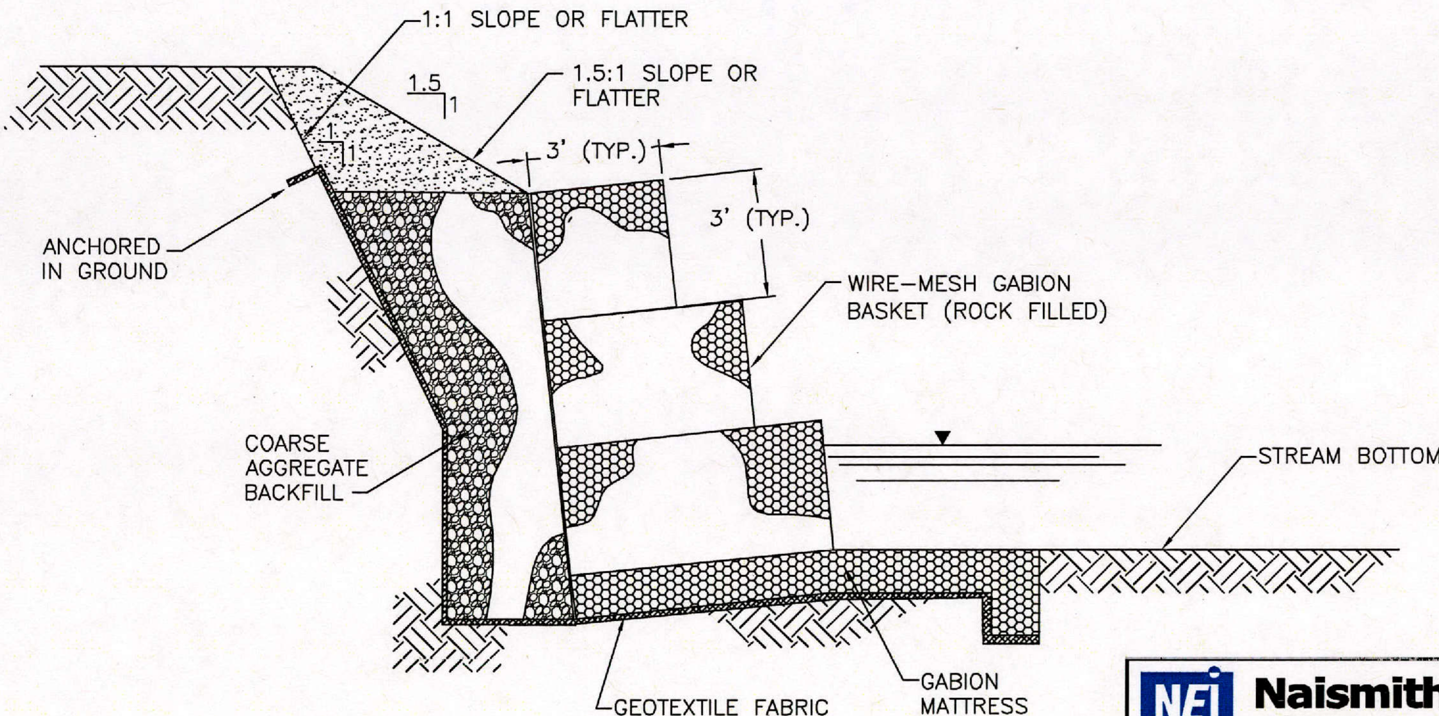
FIGURE 5

TYPICAL GEOGRID / GEOMAT
SOIL REINFORCEMENT SYSTEM DETAIL

SAN FELIPE CREEK MASTER PLAN
DEL RIO, TEXAS

Drawn By:	JBS	Appr. By:	DBF	Scale:	N.T.S.	Dwg. NO.:	A12	Sheet
Checked By:	DBF	Project No.:	8267	Date:	02/02/12	Rev.:		Of



NOTE: DETAIL BASED IN PART ON NRCS
STANDARD DETAIL IL-ENG-55 (MAR. 2010)

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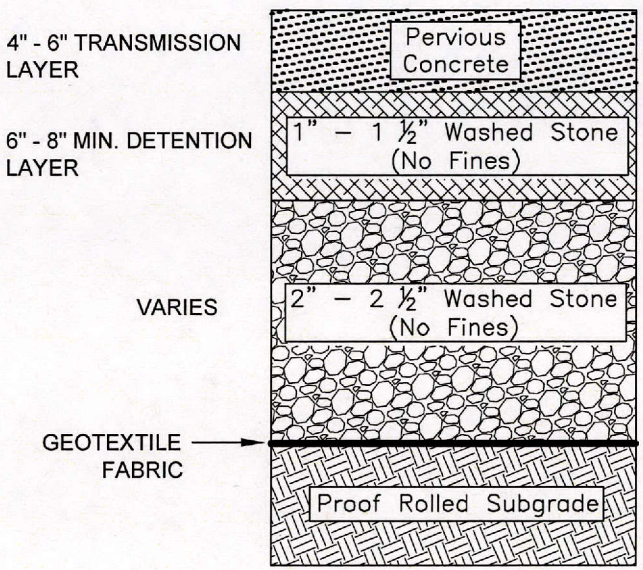
FIGURE 6

TYPICAL ROCK GABION BASKET
STREAM BANK STABILIZATION DETAIL

SAN FELIPE CREEK MASTER PLAN
DEL RIO, TEXAS

Drawn By: JBS	Appr. By: DBF	Scale: N.T.S.	Dwg. NO.: A12	Sheet
Checked By: DBF	Project No.: 8267	Date: 02/02/12	Rev.:	Of

PERVIOUS CONCRETE TYPICAL SECTION



GRAVEL PAVEMENT SYSTEM TYPICAL SECTION

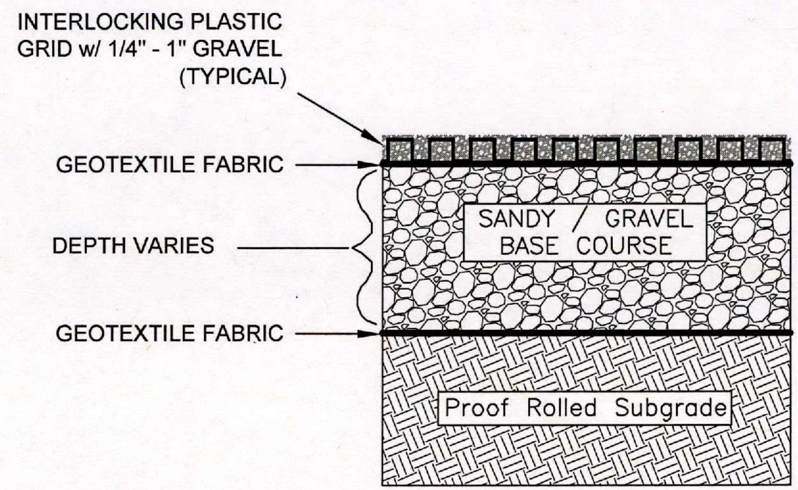


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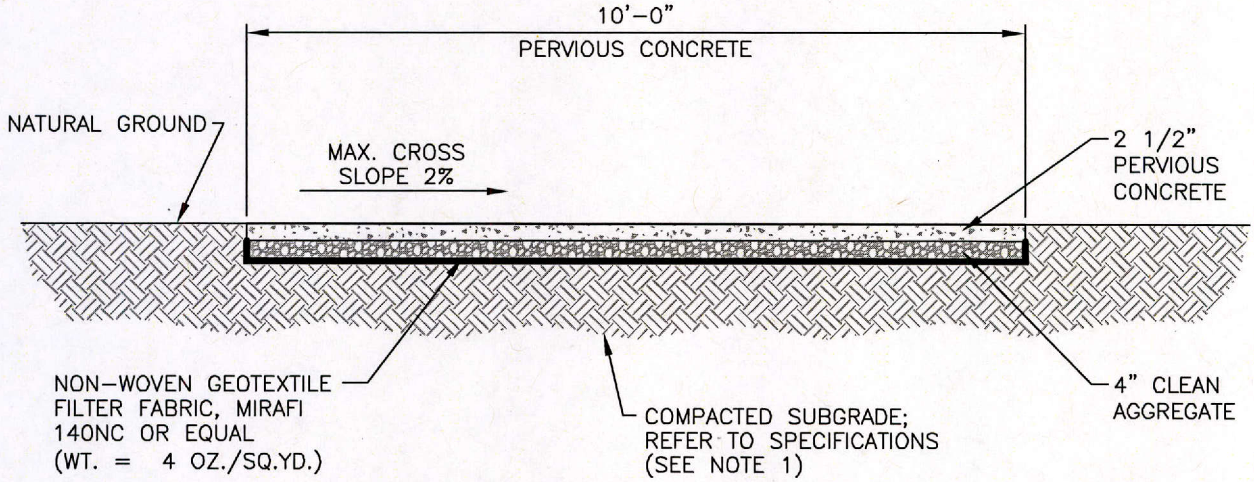
FIGURE 7
PERVIOUS PAVEMENT PARKING AREA
SECTION DETAIL
SAN FELIPE CREEK MASTER PLAN
DEL RIO, TEXAS

Drawn By: JBS		Appr. By: DBF		Scale: N.T.S.		Dwg. NO.: 8267A06		Sheet
Checked By: DBF		Project No.: 8267		Date: 11/16/11		Rev.: 06/25/12		of



PERVIOUS CONCRETE HIKE & BIKE TRAIL

(1) **TYPICAL SECTION**

NOT TO SCALE

NOTE:

1. ROLL SUBGRADE TO IDENTIFY WET OR SOFT AREAS. ELIMINATE WET/SOFT AREAS BY DIGGING OUT AREA AND REPLACING WITH SUITABLE SOIL.

2. POROUS CONCRETE MEETING THE PROJECT SPECIFICATIONS WILL NOT REQUIRE REINFORCEMENT.

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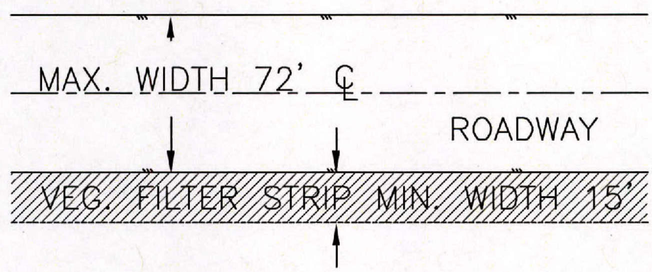
FIGURE 8

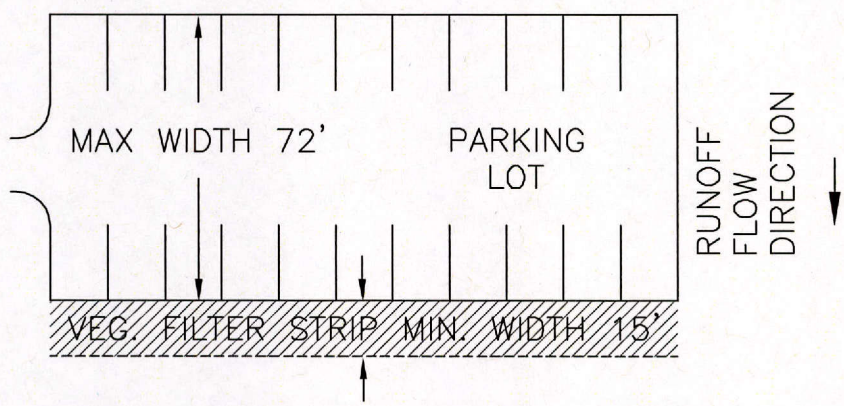
PERVIOUS PAVEMENT HIKE & BIKE TRAIL SECTION DETAIL

SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

Drawn By:	RPS	Appr. By:	DBF	Scale:	N.T.S.	Dwg. NO.:	8267A10	Sheet	
Checked By:	DBF	Project No.:	8267	Date:	12/06/11	Rev.:	02/08/12	Of	



FILTER STRIP ALONG ROADWAY



CONFIGURATION OF FILTER STRIP
ADJACENT TO PARKING LOT

EXAMPLES BASED ON FIGURES 3-21 & 3-22 FROM TCEQ'S "COMPLYING WITH THE EDWARDS AQUIFER RULES - TECHNICAL GUIDANCE ON BEST MANAGEMENT PRACTICES" (RG-38, JULY 2005)

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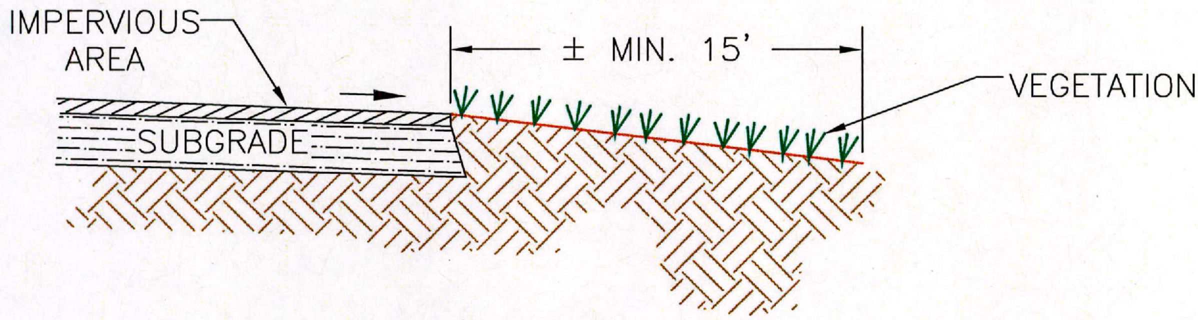
FIGURE 9

TYPICAL VEGETATIVE FILTER STRIP
LAYOUT DETAILS

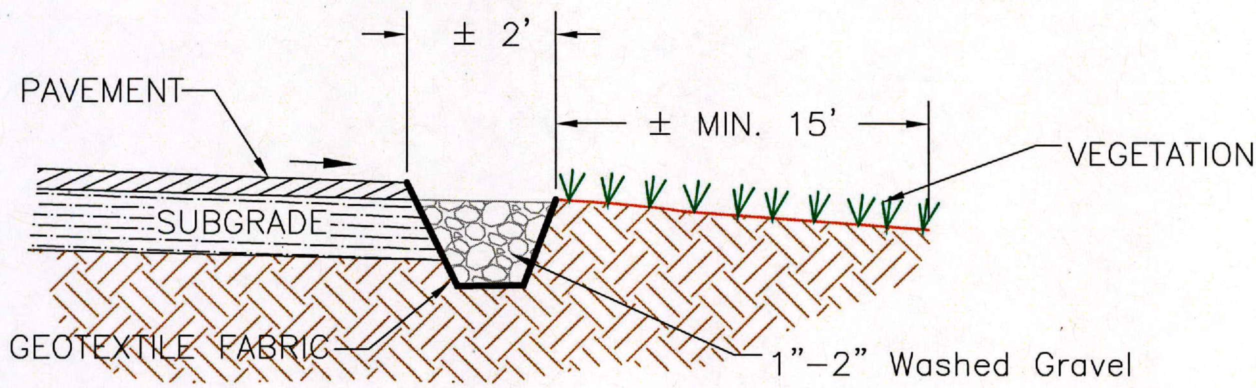
SAN FELIPE CREEK MASTER PLAN
DEL RIO, TEXAS

Drawn By:	JBS	Appr. By:	DBF	Scale:	N.T.S.	Dwg. NO.:	A06	Sheet		
Checked By:	DBF	Project No.:	8267	Date:	11/16/11	Rev.:		Of		

VEGETATIVE FILTER STRIP



ALTERNATE 1



ALTERNATE 2

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FIGURE 10
VEGETATIVE FILTER STRIP SCHEMATIC
SAN FELIPE CREEK MASTER PLAN
DEL RIO, TEXAS

Drawn By:	JBS	Appr. By:	DBF	Scale:	N.T.S.	Dwg. NO.:	A06	Sheet
Checked By:	DBF	Project No.:	8267	Date:	11/16/11	Rev.:		Of ___

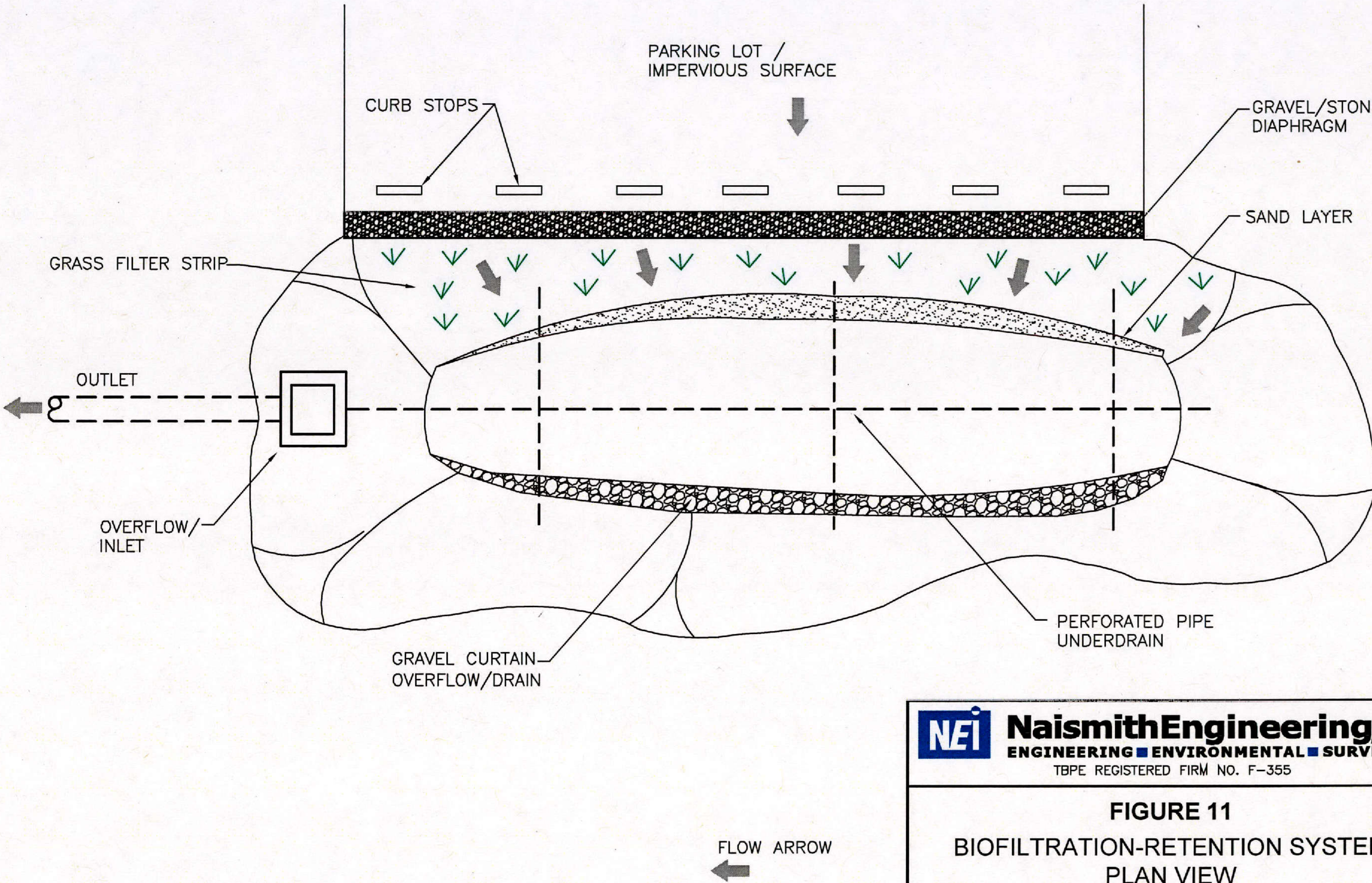

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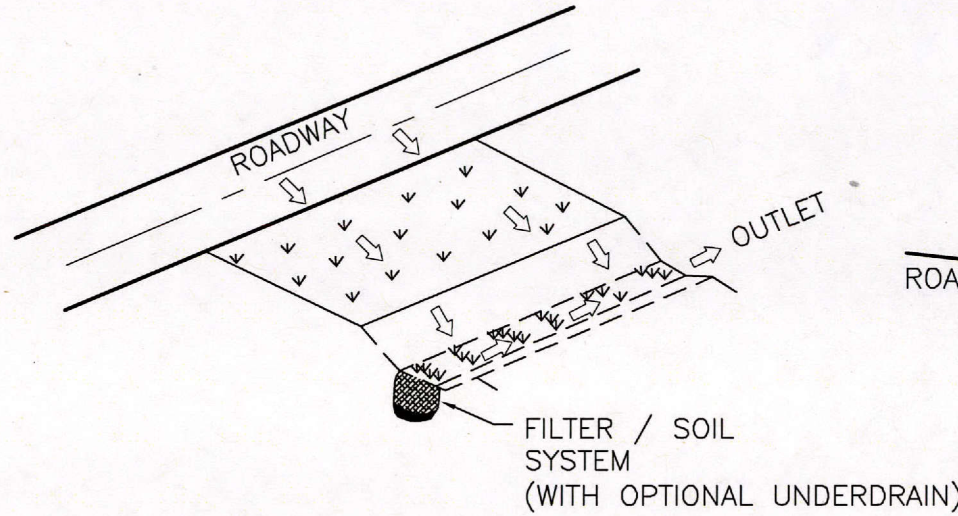
FIGURE 11

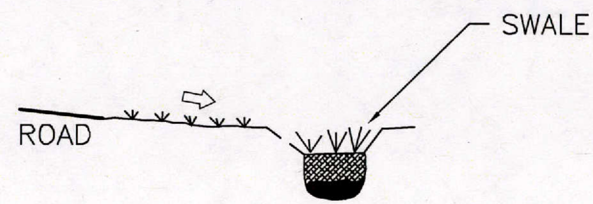
BIOFILTRATION-RETENTION SYSTEM
PLAN VIEW

SAN FELIPE CREEK MASTER PLAN
DEL RIO, TEXAS

Drawn By: JBS	Appr. By: DBF	Scale: N.T.S.	Dwg. NO.: A13	Sheet
Checked By: DBF	Project No.: 8267	Date: 02/03/12	Rev.:	Of



BIOFILTRATION SCHEMATIC VIEW



CROSS-SECTION

BIOFILTRATION SWALE

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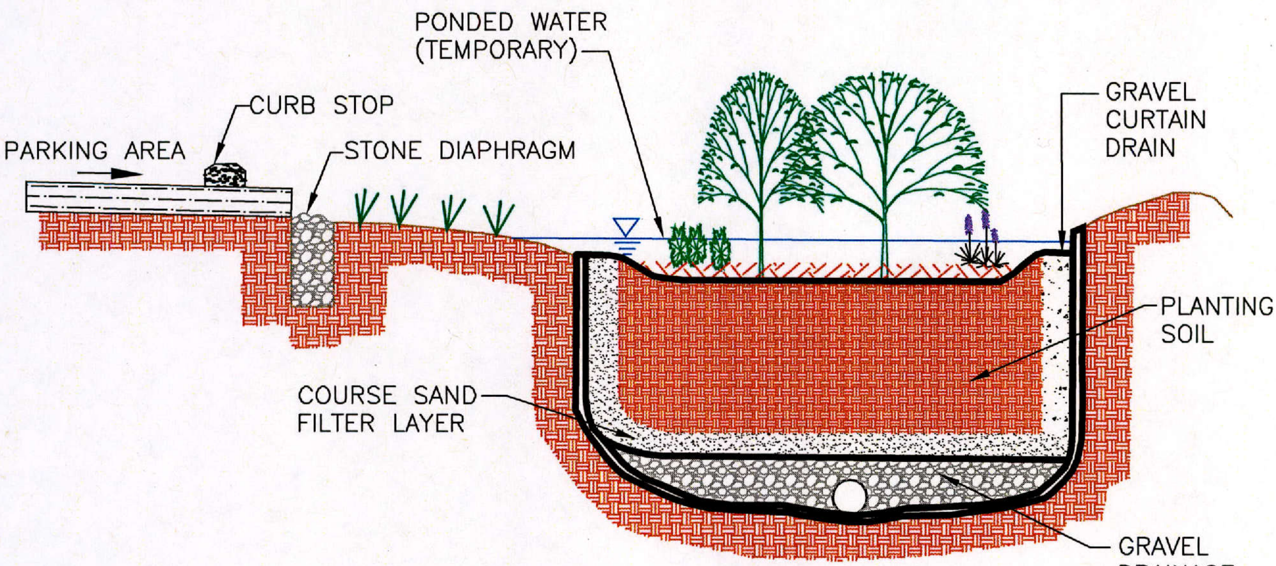
FIGURE 12

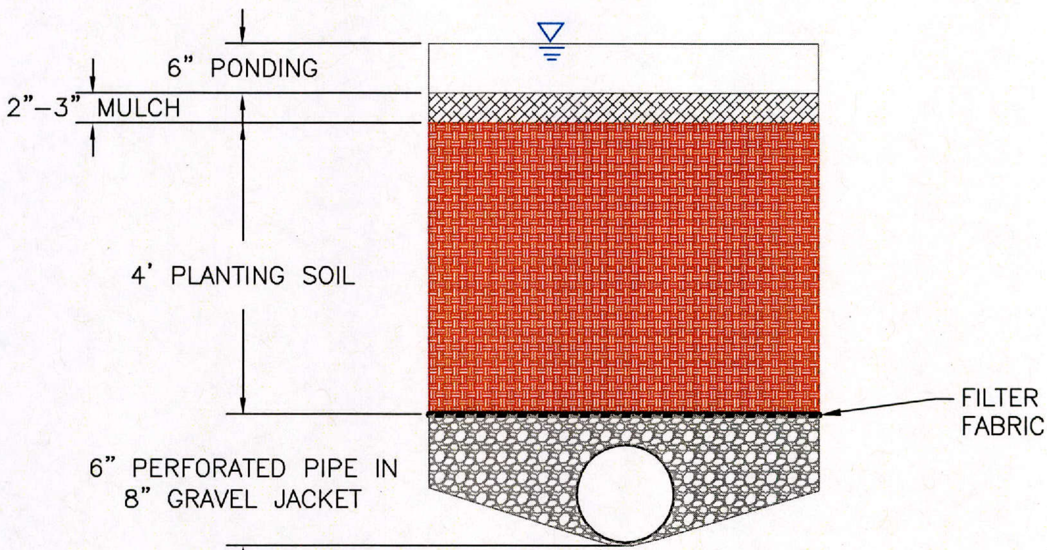
BIOFILTRATION SWALE SCHEMATIC DETAIL

SAN FELIPE CREEK MASTER PLAN
DEL RIO, TEXAS

Drawn By: JBS		Appr. By: DBF		Scale: N.T.S.		Dwg. NO.: A08		Sheet
Checked By: DBF		Project No.: 8267		Date: 11/28/11		Rev.:		Of



PROFILE



TYPICAL SECTION

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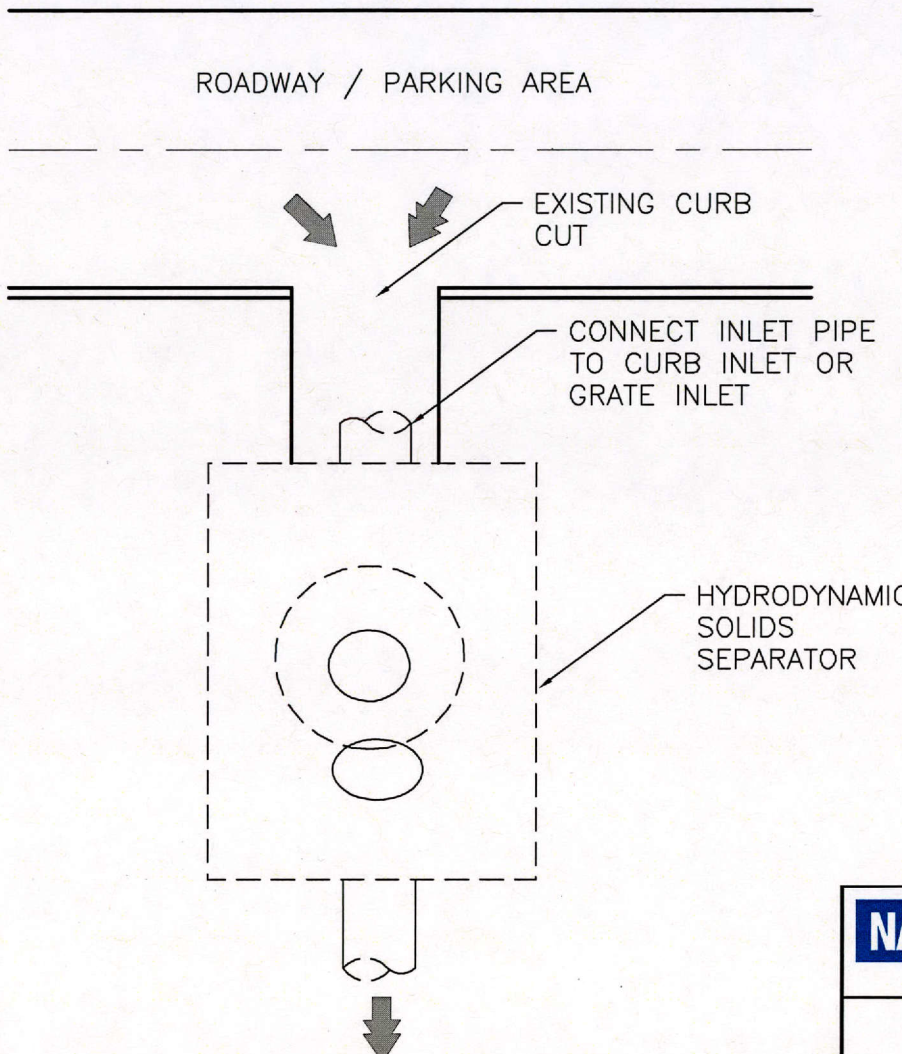
FIGURE 13

BIORETENTION / BIOFILTRATION
CROSS-SECTION DETAIL
SAN FELIPE CREEK MASTER PLAN
DEL RIO, TEXAS

Drawn By: JBS	Appr. By: DBF	Scale: N.T.S.	Dwg. NO.: A06	Sheet
Checked By: DBF	Project No.: 8267	Date: 11/16/11	Rev.:	Of



HYDRODYNAMIC SEPARATOR
SCHEMATIC PLANVIEW
(TYP.)

STORMWATER FLOW

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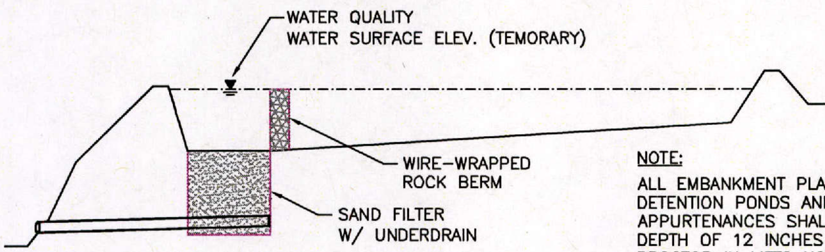
FIGURE 14

HYDRODYNAMIC SEPARATOR UNIT
TYPICAL SCHEMATIC DETAIL
SAN FELIPE CREEK MASTER PLAN
DEL RIO, TEXAS

Drawn By: JBS	Appr. By: DBF	Scale: N.T.S.	Dwg. NO.: A08	Sheet
Checked By: DBF	Project No.: 8267	Date: 11/28/11	Rev.:	Of

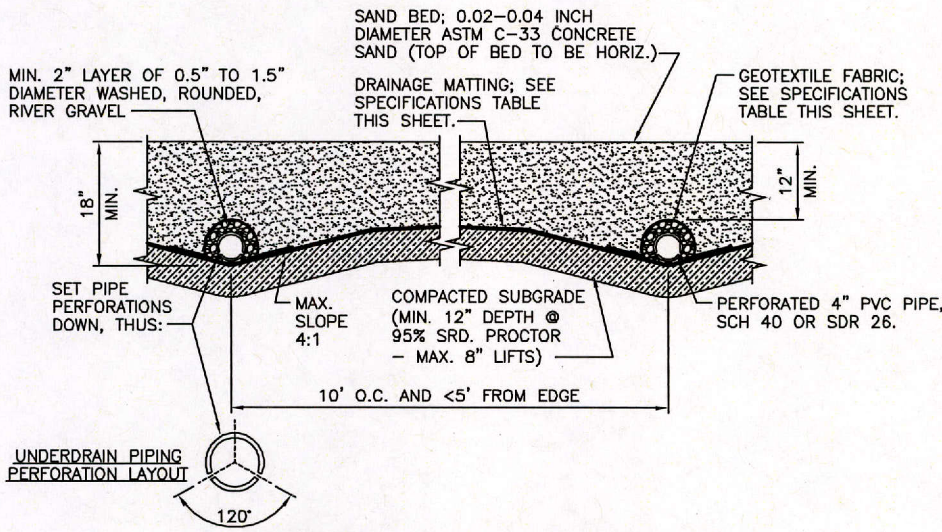


NOTE:

ALL EMBANKMENT PLACED FOR THE WATER QUALITY / DETENTION PONDS AND ITS ASSOCIATED APPURTENANCES SHALL BE MACHINE COMPACTED TO A DEPTH OF 12 INCHES AT A MINIMUM 95% STD. PROCTOR IN LIFTS NOT TO EXCEED 8 INCHES.

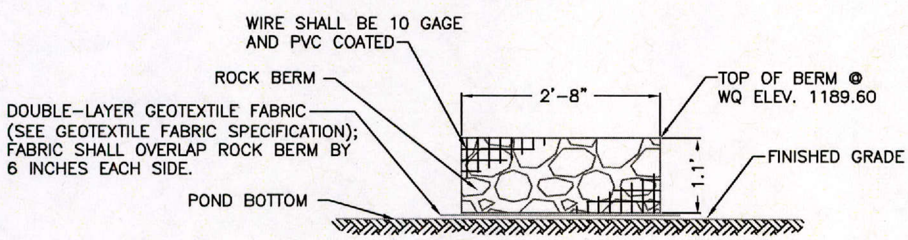
WATER QUALITY POND (TYPICAL CROSS-SECTION)

NOT TO SCALE



SAND FILTER BED PROFILE

NOT TO SCALE



ROCK BERM

NOT TO SCALE

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FIGURE 15

WATER QUALITY POND DETAILS

SAN FELIPE CREEK MASTER PLAN
DEL RIO, TEXAS

Drawn By: RPS	Appr. By:	DBF	Scale:	N.T.S.	Dwg. NO.:	8267A07	Sheet	
Checked By: DBF	Project No.:	8267	Date:	11/16/11	Rev.:	02/08/12	Of	

NOTES:

1. A DIVERSE MIXTURE OF GRASSES, SHRUBS, PLANTS AND TREES IS MOST DESIRABLE.

2. MINIMIZE IMPROVEMENTS MADE WITHIN THE RIPARIAN ZONE.

3. MINIMIZE THE USE OF IMPERVIOUS SURFACES WITHIN THE RIPARIAN ZONE.

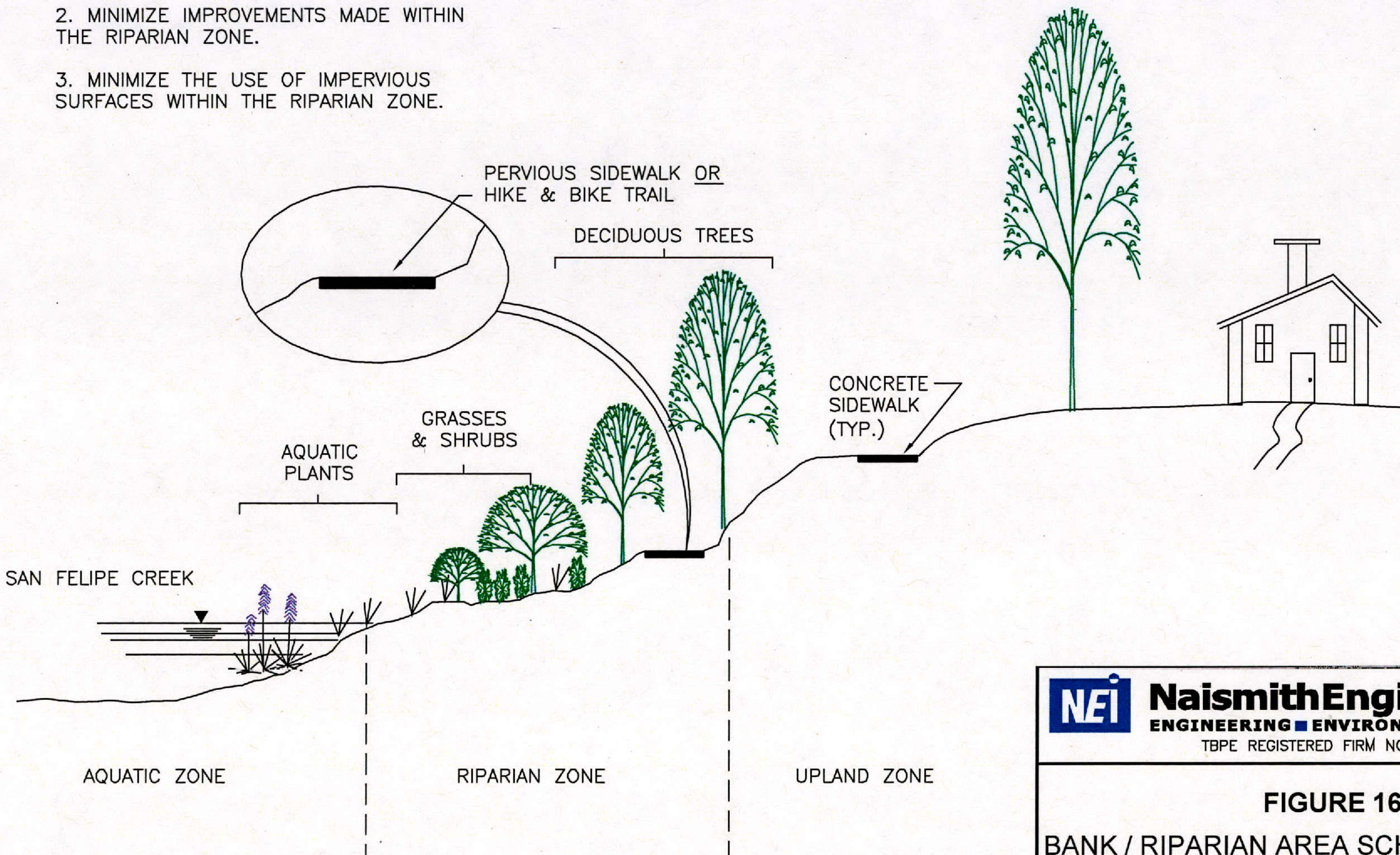

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FIGURE 16

BANK / RIPARIAN AREA SCHEMATIC DETAIL

SAN FELIPE CREEK MASTER PLAN
DEL RIO, TEXAS

Drawn By: JBS	Appr. By: DBF	Scale: N.T.S.	Dwg. NO.: A12	Sheet
Checked By: DBF	Project No.: 8267	Date: 02/08/12	Rev.:	Of

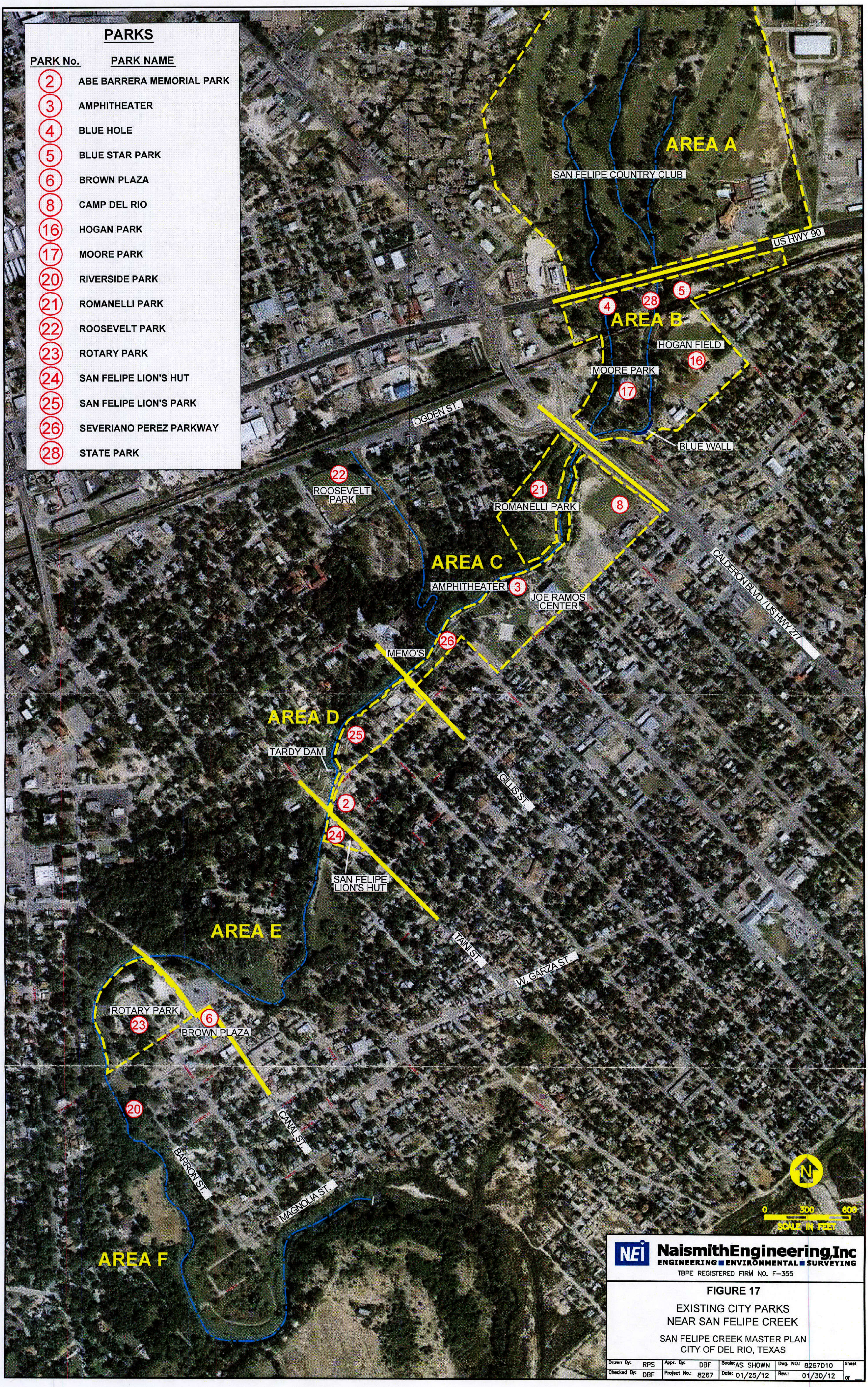
PARKS
PARK No.
PARK NAME
2 ABE BARRERA MEMORIAL PARK
3 AMPHITHEATER
4 BLUE HOLE
5 BLUE STAR PARK
6 BROWN PLAZA
8 CAMP DEL RIO
16 HOGAN PARK
17 MOORE PARK
20 RIVERSIDE PARK
21 ROMANELLI PARK
22 ROOSEVELT PARK
23 ROTARY PARK
24 SAN FELIPE LION'S HUT
25 SAN FELIPE LION'S PARK
26 SEVERIANO PEREZ PARKWAY
28 STATE PARK
AREA A
SAN FELIPE COUNTRY CLUB
US HWY 90
AREA B
HOGAN FIELD
MOORE PARK
BLUE WALL
OGDEN ST.
ROOSEVELT PARK
ROMANELLI PARK
AREA C
AMPHITHEATER
JOE RAMOS CENTER
CALDERON BLVD / US HWY 277
MEMO'S
AREA D
TARDY DAM
GILLIS ST.
SAN FELIPE LION'S HUT
AREA E
TANI ST.
W. GARZA ST.
ROTARY PARK
BROWN PLAZA
CANAL ST.
BARRON ST.
MAGNOLIA ST.
AREA F
0
300
600
SCALE IN FEET
NEI
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FIGURE 17
EXISTING CITY PARKS
NEAR SAN FELIPE CREEK
SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS
Drawn By: RPS
Checked By: DBF
Appr. By: DBF
Project No.: 8267
Scale: AS SHOWN
Date: 01/25/12
Dwg. NO.: 8267D10
Rev.: 01/30/12
Sheet
of

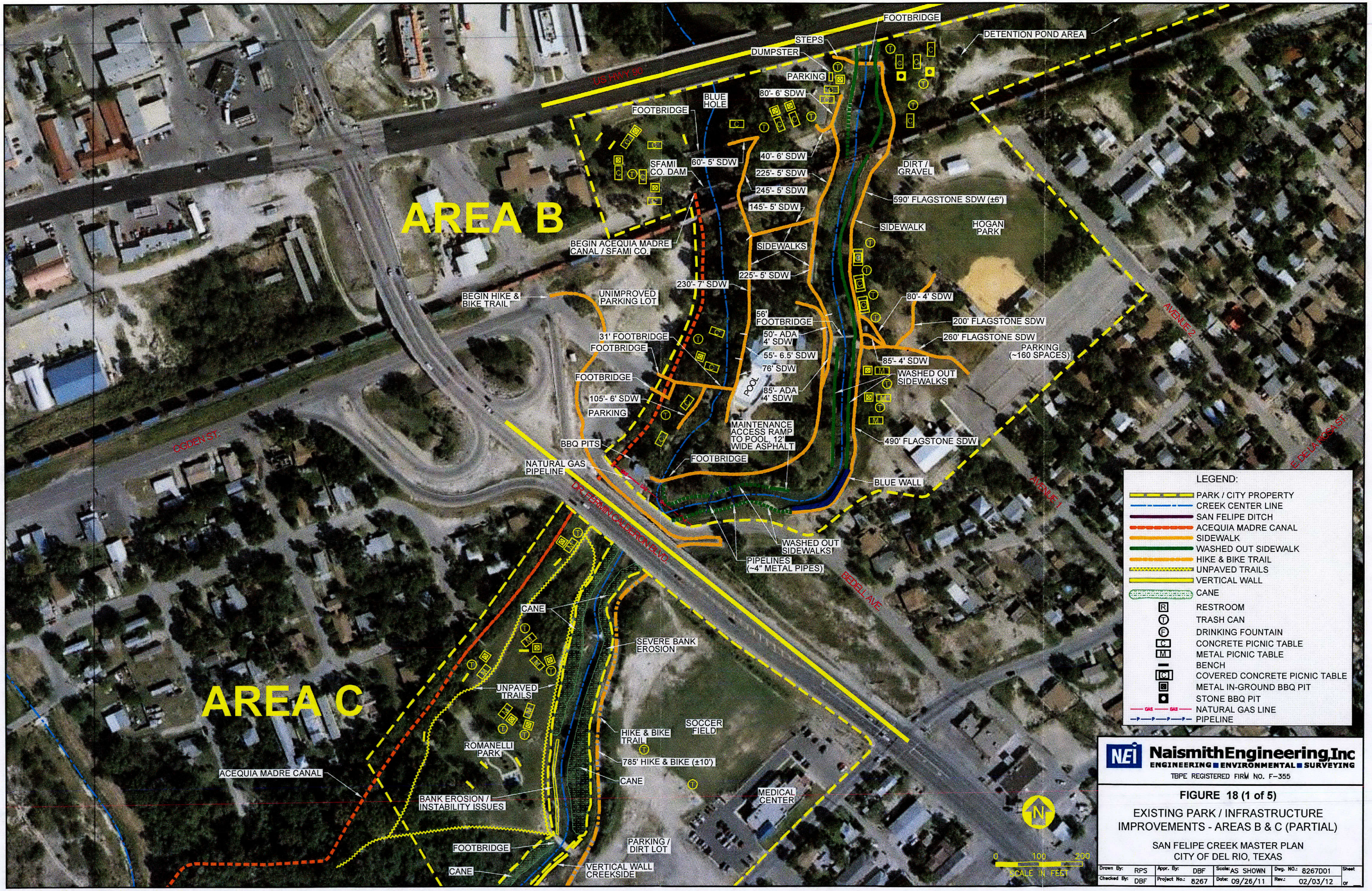

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FIGURE 18 (1 of 5)

EXISTING PARK / INFRASTRUCTURE IMPROVEMENTS - AREAS B & C (PARTIAL)

SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

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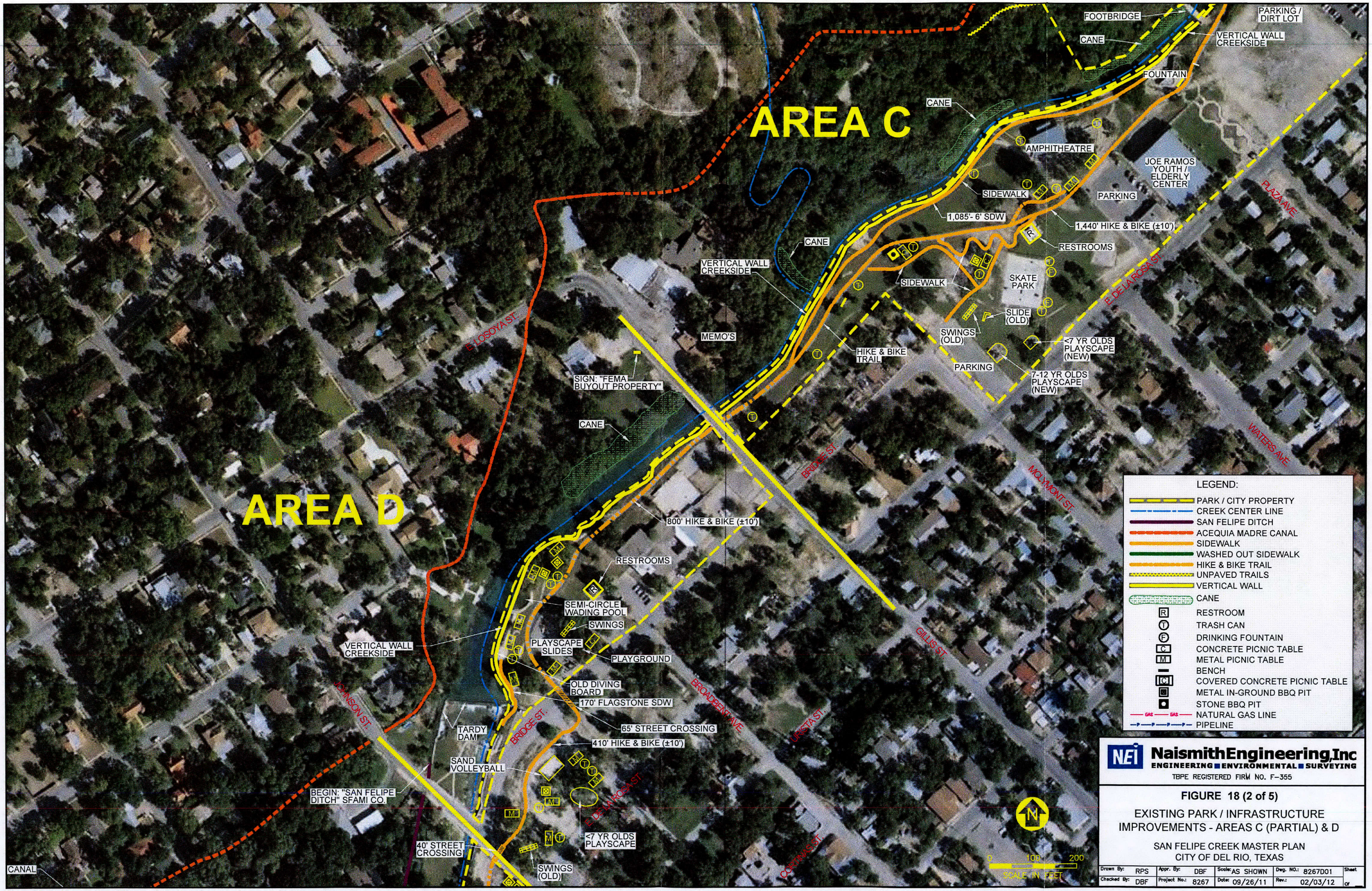
Checked By: DBF	Project No.: 8267	Date: 09/26/11	Rev.: 02/03/12	of


AREA C
AREA D
FOOTBRIDGE
PARKING / DIRT LOT
CANE
VERTICAL WALL CREEKSIDE
FOUNTAIN
CANE
AMPHITHEATRE
JOE RAMOS YOUTH / ELDERLY CENTER
PARKING
SIDEWALK
1,085'- 6' SDW
1,440' HIKE & BIKE (±10')
RESTROOMS
CANE
VERTICAL WALL CREEKSIDE
SIDEWALK
SKATE PARK
SLIDE (OLD)
SWINGS (OLD)
<7 YR OLDS PLAYSCAPE (NEW)
7-12 YR OLDS PLAYSCAPE (NEW)
PARKING
HIKE & BIKE TRAIL
MEMO'S
SIGN: "FEMA BUYOUT PROPERTY"
CANE
E. LOSOYA ST.
E. DE LA ROSA ST.
PLAZA AVE.
WATERS AVE.
MCLYMONT ST.
BRIDGE ST.
800' HIKE & BIKE (±10')
RESTROOMS
SEMI-CIRCLE WADING POOL
SWINGS
PLAYSCAPE SLIDES
PLAYGROUND
VERTICAL WALL CREEKSIDE
OLD DIVING BOARD
170' FLAGSTONE SDW
65' STREET CROSSING
410' HIKE & BIKE (±10')
TARDY DAM
SAND VOLLEYBALL
BEGIN: "SAN FELIPE DITCH" SFAMI CO.
JOHNSON ST.
BROADBENT AVE.
GILLIS ST.
CANAL
40' STREET CROSSING
<7 YR OLDS PLAYSCAPE
SWINGS (OLD)
LEGEND:
PARK / CITY PROPERTY
CREEK CENTER LINE
SAN FELIPE DITCH
ACEQUIA MADRE CANAL
SIDEWALK
WASHED OUT SIDEWALK
HIKE & BIKE TRAIL
UNPAVED TRAILS
VERTICAL WALL
CANE
RESTROOM
TRASH CAN
DRINKING FOUNTAIN
CONCRETE PICNIC TABLE
METAL PICNIC TABLE
BENCH
COVERED CONCRETE PICNIC TABLE
METAL IN-GROUND BBQ PIT
STONE BBQ PIT
NATURAL GAS LINE
PIPELINE
0 100 200
SCALE IN FEET
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TBPE REGISTERED FIRM NO. F-355
FIGURE 18 (2 of 5)
EXISTING PARK / INFRASTRUCTURE IMPROVEMENTS - AREAS C (PARTIAL) & D
SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS
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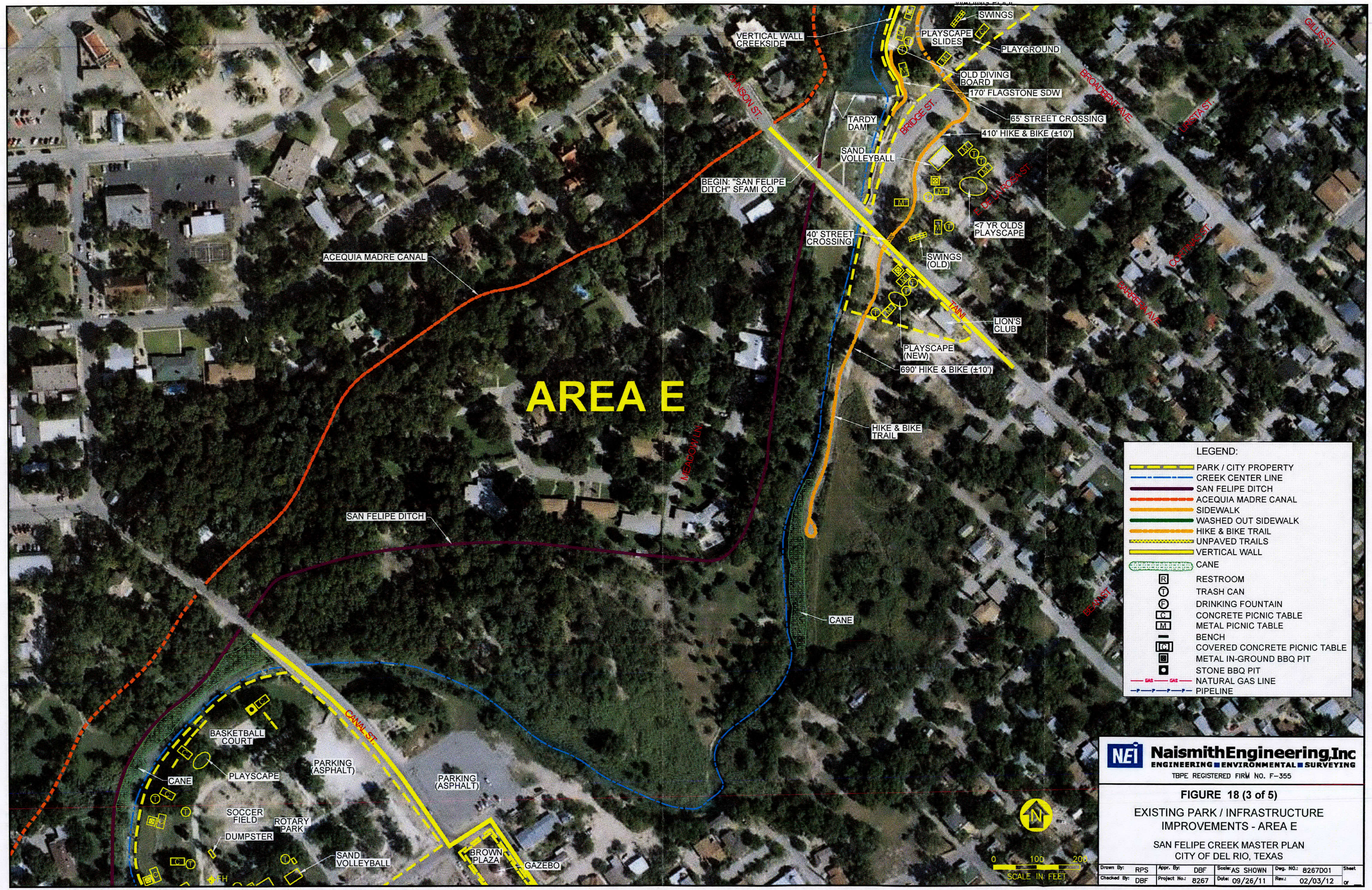
Appr. By: DBF
Scale: AS SHOWN
Dwg. NO.: 8267D01
Sheet
Checked By: DBF
Project No.: 8267
Date: 09/26/11
Rev.: 02/03/12
of


AREA E
VERTICAL WALL CREEKSIDE
SWINGS
PLAYSCAPE SLIDES
PLAYGROUND
OLD DIVING BOARD
170' FLAGSTONE SDW
65' STREET CROSSING
410' HIKE & BIKE (±10')
TARDY DAM
SAND VOLLEYBALL
BEGIN: "SAN FELIPE DITCH" SFAMI CO.
40' STREET CROSSING
SWINGS (OLD)
<7 YR OLDS PLAYSCAPE
LION'S CLUB
PLAYSCAPE (NEW)
690' HIKE & BIKE (±10')
HIKE & BIKE TRAIL
ACEQUIA MADRE CANAL
SAN FELIPE DITCH
CANE
JOHNSON ST.
BRIDGE ST.
BROADBENT AVE.
E. DE LA ROSA ST.
CANAL ST.
BASKETBALL COURT
PLAYSCAPE
CANE
SOCCER FIELD
ROTARY PARK
DUMPSTER
PARKING (ASPHALT)
PARKING (ASPHALT)
SAND VOLLEYBALL
BROWN PLAZA
GAZEBO
FH
LEGEND:
PARK / CITY PROPERTY
CREEK CENTER LINE
SAN FELIPE DITCH
ACEQUIA MADRE CANAL
SIDEWALK
WASHED OUT SIDEWALK
HIKE & BIKE TRAIL
UNPAVED TRAILS
VERTICAL WALL
CANE
RESTROOM
TRASH CAN
DRINKING FOUNTAIN
CONCRETE PICNIC TABLE
METAL PICNIC TABLE
BENCH
COVERED CONCRETE PICNIC TABLE
METAL IN-GROUND BBQ PIT
STONE BBQ PIT
NATURAL GAS LINE
PIPELINE
0 100 200
SCALE IN FEET
NaismithEngineering,Inc
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TBPE REGISTERED FIRM NO. F-355
FIGURE 18 (3 of 5)
EXISTING PARK / INFRASTRUCTURE IMPROVEMENTS - AREA E
SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS
Drawn By: RPS
Appr. By: DBF
Scale: AS SHOWN
Dwg. NO.: 8267D01
Sheet
Checked By: DBF
Project No.: 8267
Date: 09/26/11
Rev.: 02/03/12
of

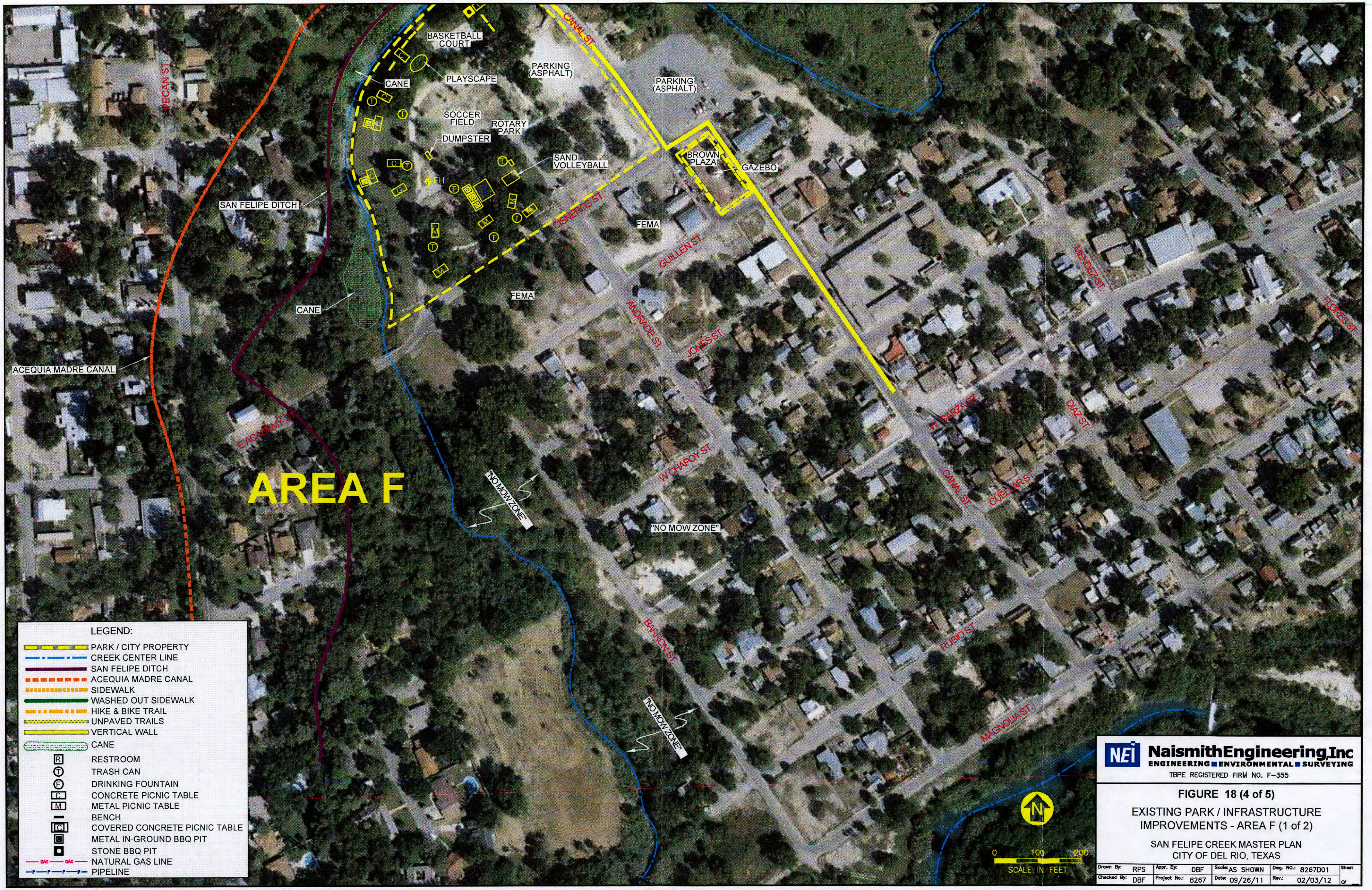
BASKETBALL COURT
PLAYSCAPE
CANE
PARKING (ASPHALT)
PARKING (ASPHALT)
SOCCER FIELD
ROTARY PARK
DUMPSTER
SAND VOLLEYBALL
BROWN PLAZA
GAZEBO
CANAL ST.
PECAN ST.
SAN FELIPE DITCH
CISNEROS ST.
FEMA
GUILLEN ST.
CANE
FEMA
ANDRADE ST.
JONES ST.
ACEQUIA MADRE CANAL
E. ACADEMY ST.
AREA F
"NO MOW ZONE"
W. CHAPOY ST.
"NO MOW ZONE"
MENDEZ ST.
FLORES ST.
GARZA ST.
DIAZ ST.
CANAL ST.
CUELLAR ST.
RUBIO ST.
BARRON ST.
"NO MOW ZONE"
MAGNOLIA ST.
LEGEND:
PARK / CITY PROPERTY
CREEK CENTER LINE
SAN FELIPE DITCH
ACEQUIA MADRE CANAL
SIDEWALK
WASHED OUT SIDEWALK
HIKE & BIKE TRAIL
UNPAVED TRAILS
VERTICAL WALL
CANE
RESTROOM
TRASH CAN
DRINKING FOUNTAIN
CONCRETE PICNIC TABLE
METAL PICNIC TABLE
BENCH
COVERED CONCRETE PICNIC TABLE
METAL IN-GROUND BBQ PIT
STONE BBQ PIT
NATURAL GAS LINE
PIPELINE
0 100 200
SCALE IN FEET
N
NEI NaismithEngineering,Inc
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FIGURE 18 (4 of 5)
EXISTING PARK / INFRASTRUCTURE IMPROVEMENTS - AREA F (1 of 2)
SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS
Drawn By: RPS Appr. By: DBF Scale: AS SHOWN Dwg. NO.: 8267D01
Checked By: DBF Project No.: 8267 Date: 09/26/11 Rev.: 02/03/12

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FIGURE 18 (5 of 5)

EXISTING PARK / INFRASTRUCTURE
IMPROVEMENTS - AREA F (2 of 2)

SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

Drawn By: RPS	Appr. By: DBF	Scale: AS SHOWN	Dwg. NO.: 8267D01	Sheet
Checked By: DBF	Project No.: 8267	Date: 09/26/11	Rev.: 02/03/12	of

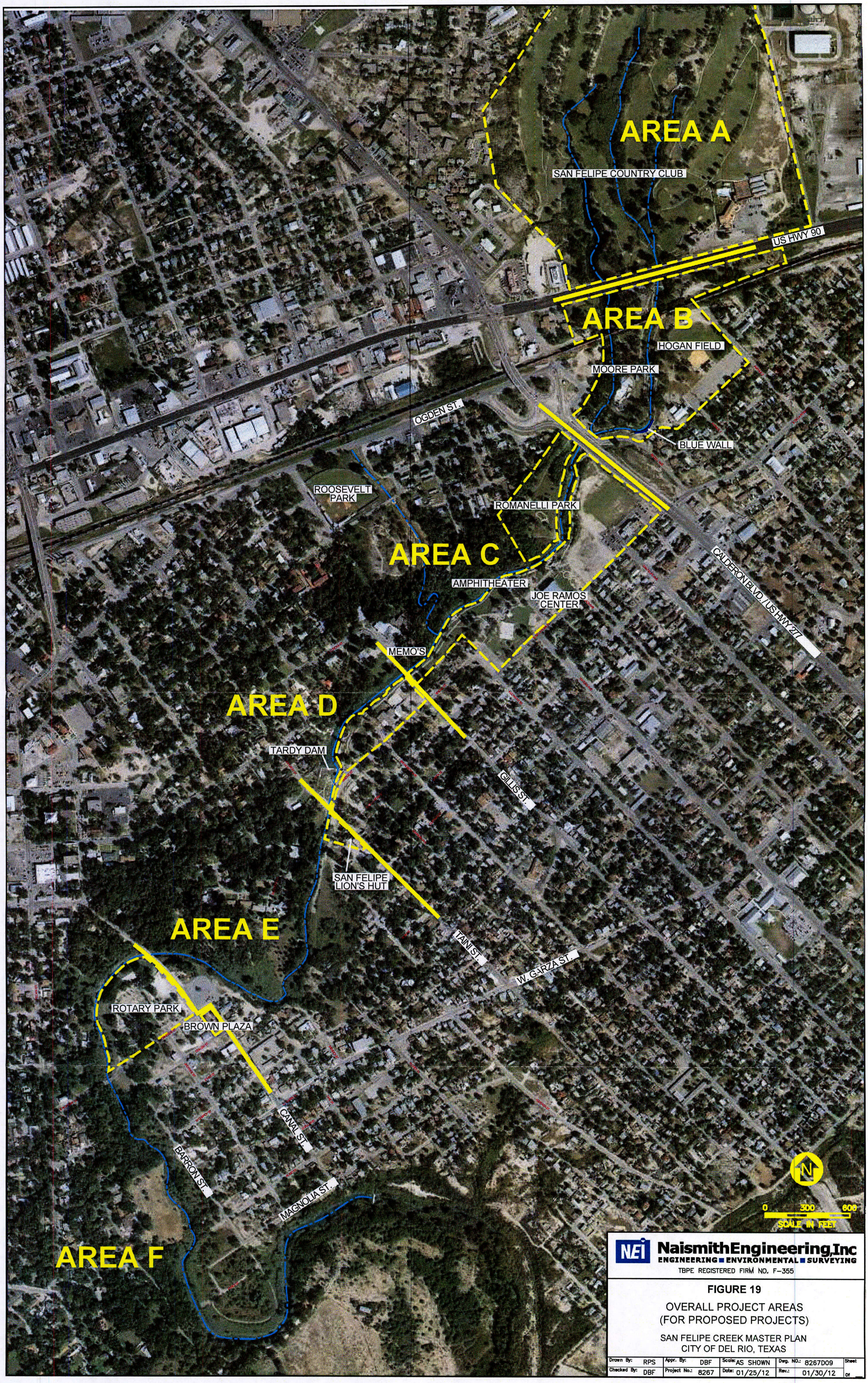
AREA A
SAN FELIPE COUNTRY CLUB
US HWY 90
AREA B
HOGAN FIELD
MOORE PARK
BLUE WALL
OGDEN ST.
ROOSEVELT PARK
ROMANELLI PARK
AREA C
AMPHITHEATER
JOE RAMOS CENTER
CALDERON BLVD./US HWY 277
MEMO'S
AREA D
TARDY DAM
GILLIS ST.
SAN FELIPE LION'S HUT
AREA E
TAINI ST.
W. GARZA ST.
ROTARY PARK
BROWN PLAZA
CANAL ST.
BARRON ST.
MAGNOLIA ST.
AREA F
0 300 600
SCALE IN FEET
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FIGURE 19
OVERALL PROJECT AREAS
(FOR PROPOSED PROJECTS)
SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS
Drawn By: RPS
Appr. By: DBF
Scale: AS SHOWN
Dwg. NO.: 8267D09
Checked By: DBF
Project No.: 8267
Date: 01/25/12
Rev.: 01/30/12
Sheet of

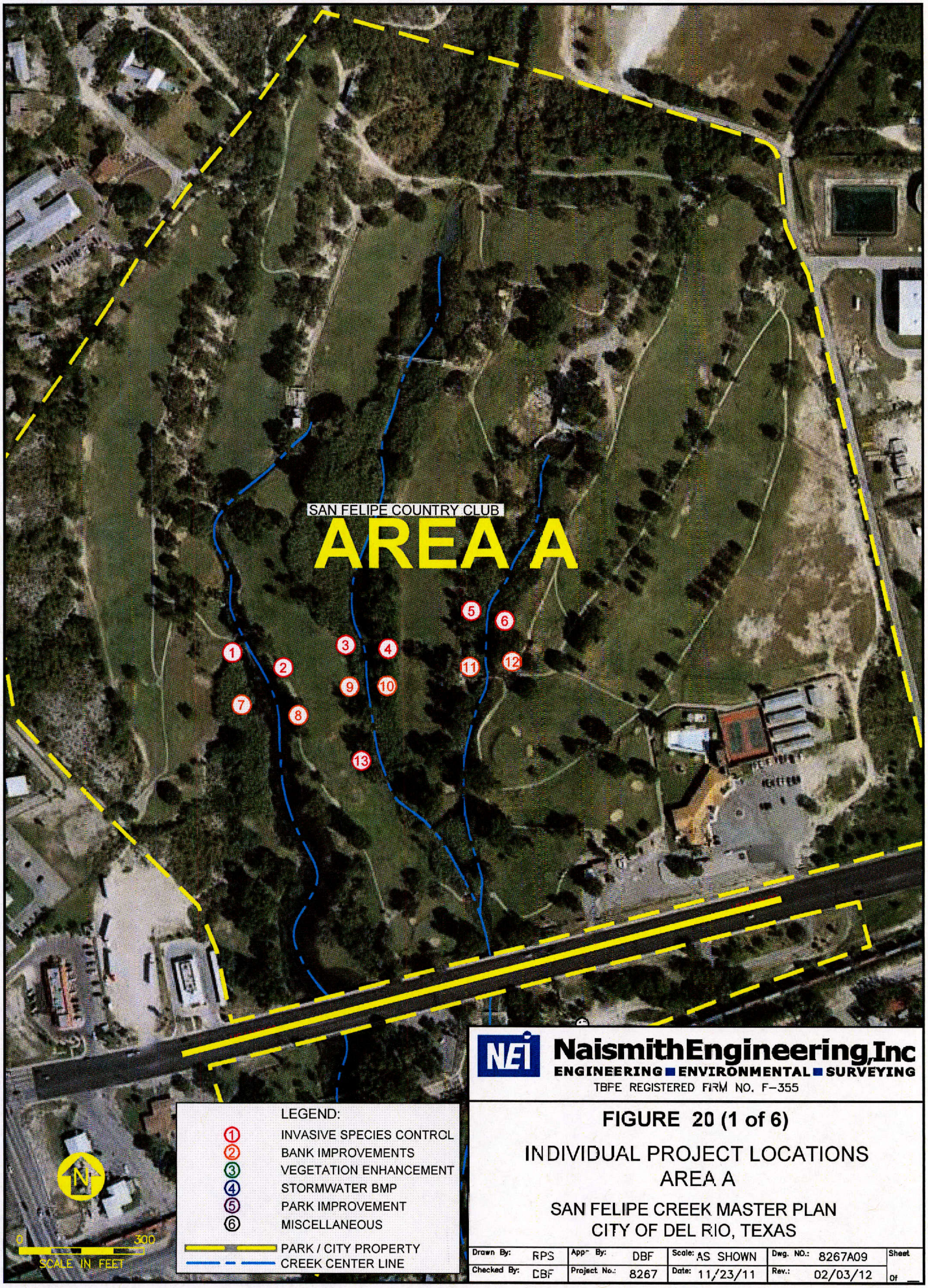

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FIGURE 20 (1 of 6)

INDIVIDUAL PROJECT LOCATIONS
AREA A

SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

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Checked By: DBF	Project No.: 8267	Date: 11/23/11	Rev.: 02/03/12	Of

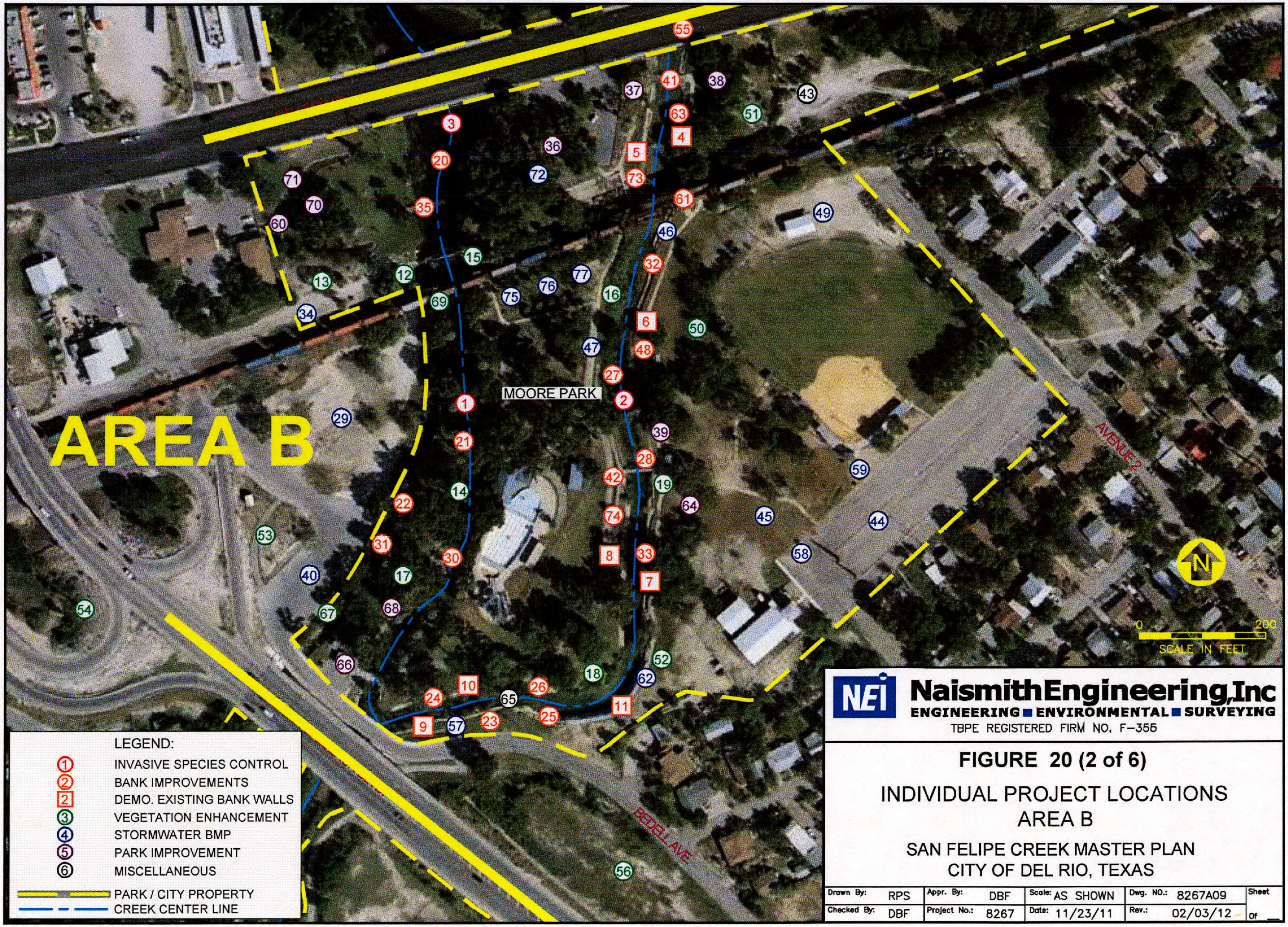

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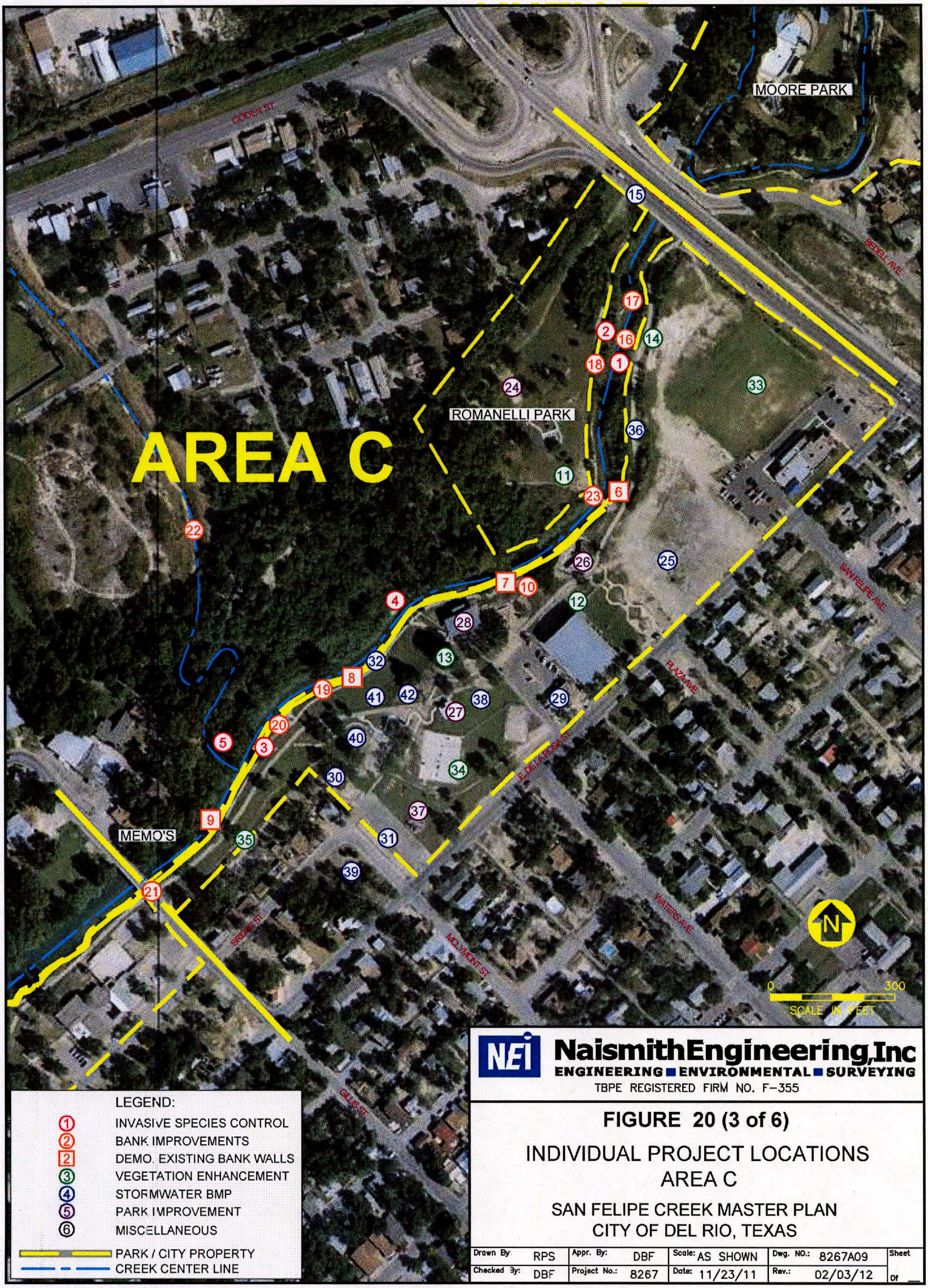
FIGURE 20 (2 of 6)

INDIVIDUAL PROJECT LOCATIONS
AREA B

SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

Drawn By:	RPS	Appr. By:	DBF	Scale: AS SHOWN	Dwg. No.:	8267A09	Sheet	
Checked By:	DBF	Project No.:	8267	Date: 11/23/11	Rev.:	02/03/12	Of	



LEGEND:

- 1 INVASIVE SPECIES CONTROL
- 2 BANK IMPROVEMENTS
- 2 DEMO. EXISTING BANK WALLS
- 3 VEGETATION ENHANCEMENT
- 4 STORMWATER BMP
- 5 PARK IMPROVEMENT
- 6 MISCELLANEOUS
- PARK / CITY PROPERTY
- CREEK CENTER LINE

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FIGURE 20 (3 of 6)

INDIVIDUAL PROJECT LOCATIONS
AREA C

SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

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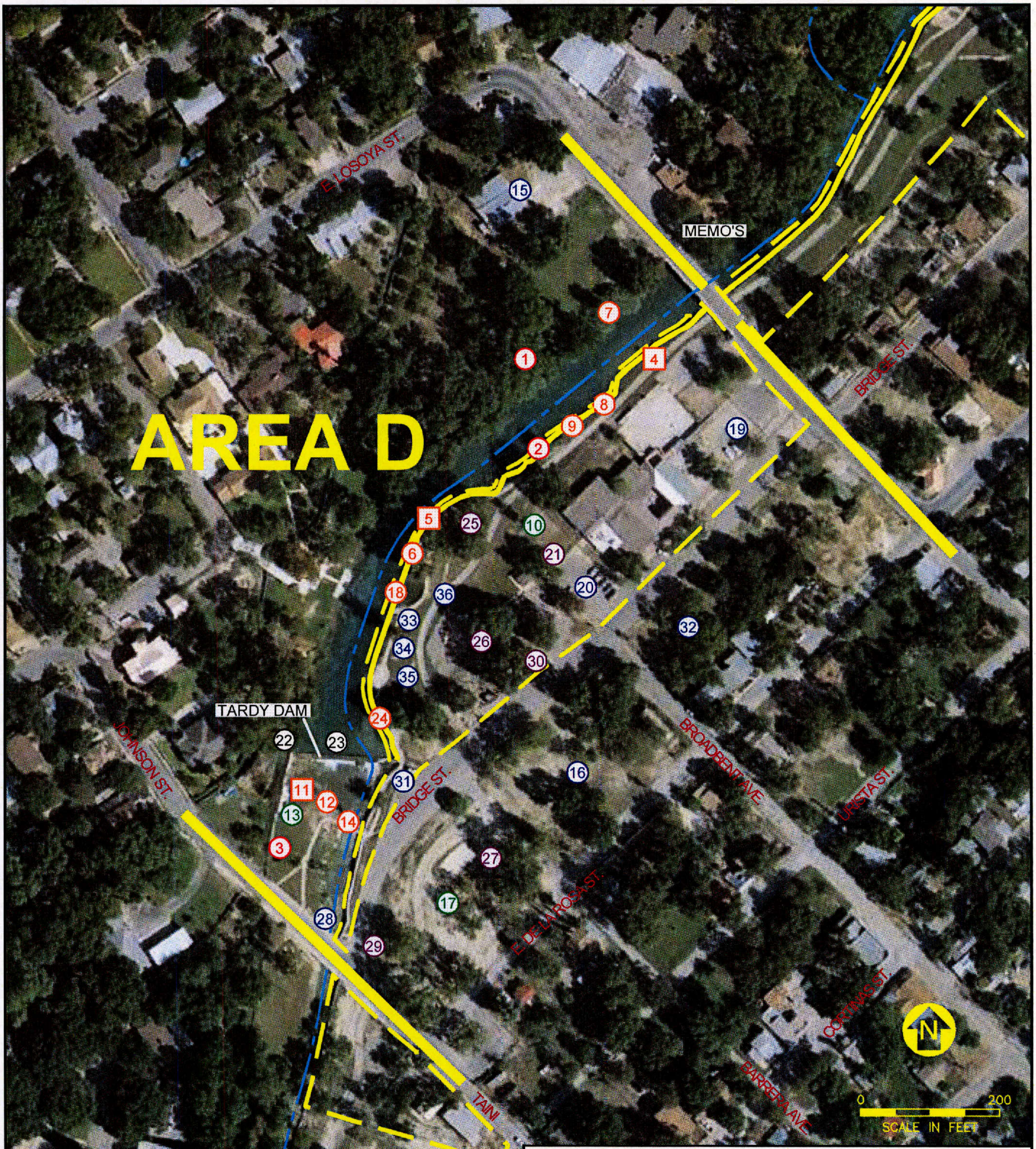
Checked By: DBF	Project No.: 8267	Date: 11/23/11	Rev.: 02/03/12	Of



LEGEND:

- 1 INVASIVE SPECIES CONTROL
- 2 BANK IMPROVEMENTS
- 2 DEMO. EXISTING BANK WALLS
- 3 VEGETATION ENHANCEMENT
- 4 STORMWATER BMP
- 5 PARK IMPROVEMENT
- 6 MISCELLANEOUS
- PARK / CITY PROPERTY
- CREEK CENTER LINE

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FIGURE 20 (4 of 6)

INDIVIDUAL PROJECT LOCATIONS
AREA D

SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

Drawn By: RPS	Appr. By: DBF	Scale: AS SHOWN	Dwg. No.: 8267A09	Sheet
Checked By: DEF	Project No.: 8267	Date: 11/23/11	Rev.: 02/03/12	Of

FIGURE 20 (5 of 6)

INDIVIDUAL PROJECT LOCATIONS
AREA E

SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

Drawn By: RPS	Appr. By:	DBF	Scale:	AS SHOWN	Dwg. NO.:	8267A09	Sheet	
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FIGURE 20 (6 of 6)

INDIVIDUAL PROJECT LOCATIONS
AREA F

SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

Drawn By:	RFS	Appr. By:	DBF	Scale:	AS SHOWN	Dwg. NO.:	8267A09	Sheet	
Checked By:	DBF	Project No.:	8267	Date:	11/23/11	Rev.:	02/29/12	Of	


LEGEND:
RECONSTRUCT EXISTING WALLS (PROVIDE CONTINUOUS CREEK ACCESS)
RECONSTRUCT EXISTING WALLS (PROVIDE FOCUSED CREEK ACCESS)
REMOVE EXISTING WALLS AND ESTABLISH RIPARIAN AREA (PROVIDE FOCUSED CREEK ACCESS) *
IMPROVE / ESTABLISH RIPARIAN AREA (PROVIDE FOCUSED CREEK ACCESS) *
IMPROVE / ESTABLISH RIPARIAN AREA (NO IMPROVED CREEK ACCESS) *
EXISTING WALLS (LEAVE IN PLACE)
FOCUSED ACCESS POINTS
* - RIPARIAN AREAS SHOULD BE ACTIVILY MANAGED IN ACCORDANCE WITH THE GUIDANCE OUTLINED IN THE FACT SHEET DEVELOPED FOR THE "VEGETATION MANAGEMENT AREAS ALONG SAN FELIPE CREEK" (APPENDIX N OF SAN FELIPE CREEK MASTER PLAN).
AREA A
$195,000
US HWY 90
AREA B
$3,094,000
MOORE PARK
REPLACE BLUE WALL
ROMANELLI PARK
AREA C
$2,343,000
MEMO'S
AREA D
$757,000
TARDY DAM
AREA E
$441,000
ROTARY PARK
BROWN PLAZA
TOTAL = $7,220,000
BARRON ST.
MAGNOLIA ST.
AREA F
$390,000
N
0 300 600
SCALE IN FEET
NOTE:
UNLESS INDICATED, COSTS SHOWN DO NOT INCLUDE BRIDGE REPLACEMENTS FOCUSED ACCESS FEATURES, OR KAYAK PUT IN / TAKE OUT IMPROVEMENTS.
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FIGURE 21 (1 of 8)
PROPOSED PROJECTS
BANK IMPROVEMENTS
SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS
Drawn By: RPS–jbs
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Scale: AS SHOWN
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Date: 10/21/11
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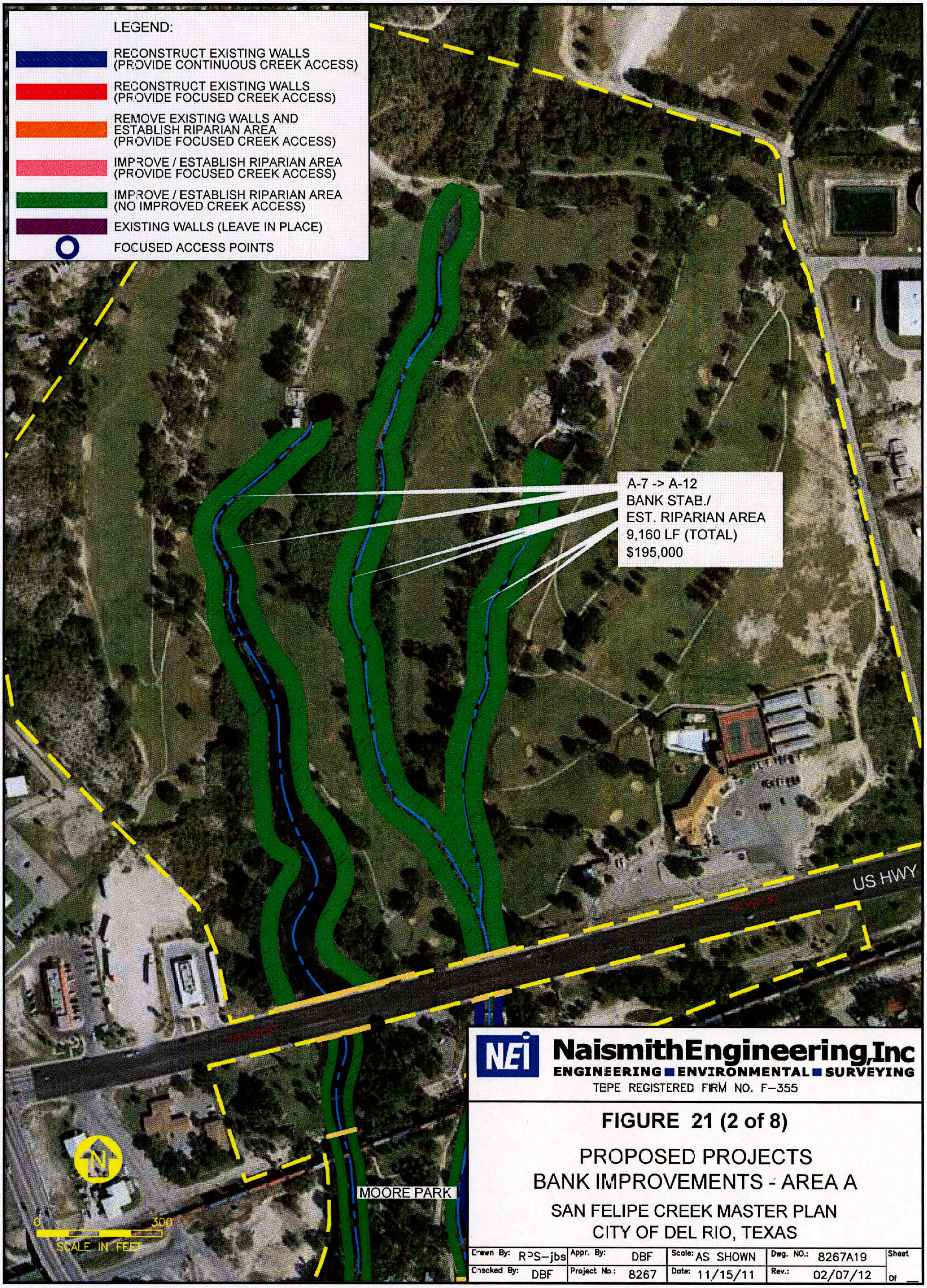

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FIGURE 21 (2 of 8)

PROPOSED PROJECTS
BANK IMPROVEMENTS - AREA A

SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

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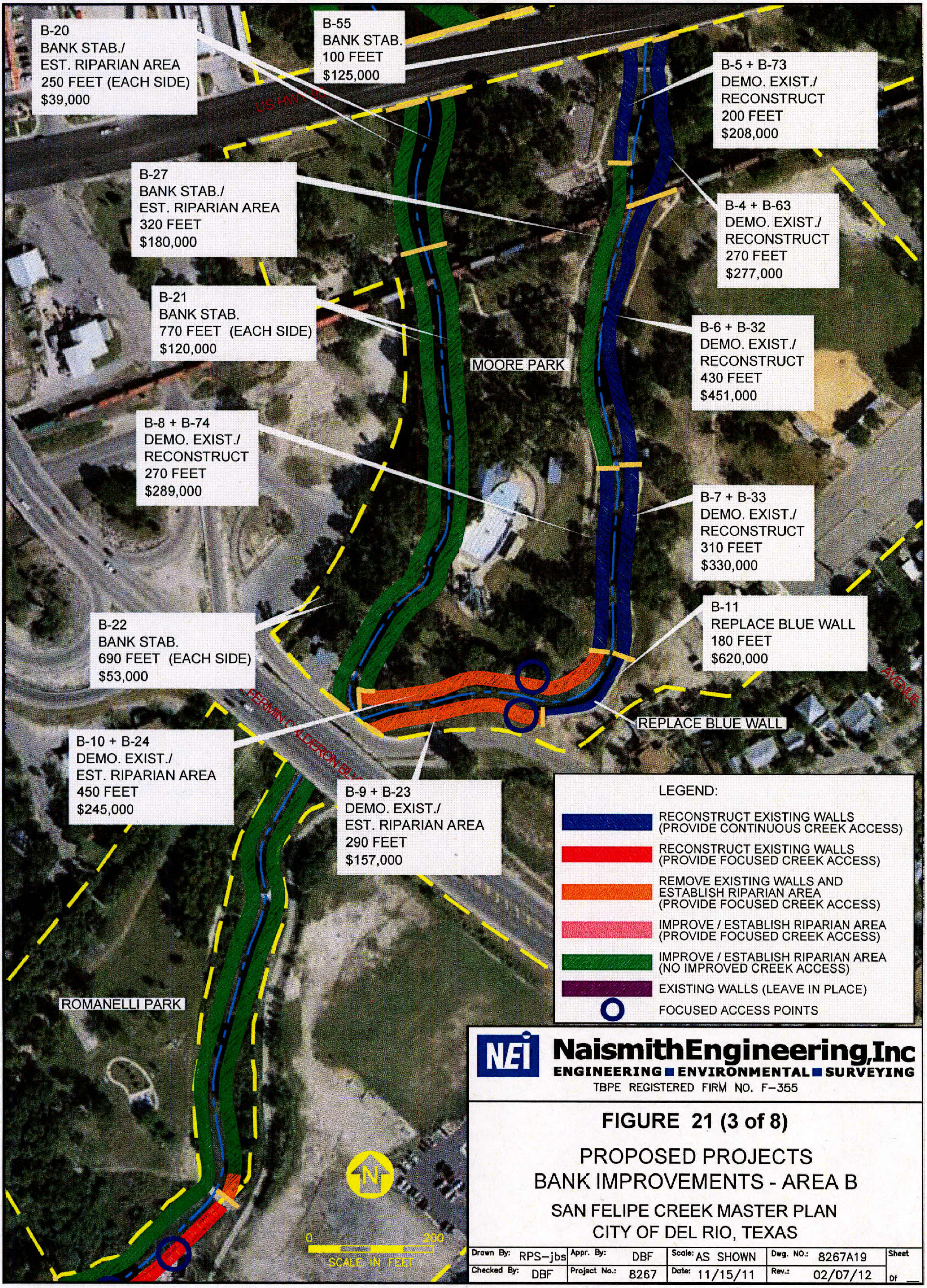
B-20
BANK STAB./
EST. RIPARIAN AREA
250 FEET (EACH SIDE)
$39,000
B-55
BANK STAB.
100 FEET
$125,000
US HWY 90
B-5 + B-73
DEMO. EXIST./
RECONSTRUCT
200 FEET
$208,000
B-27
BANK STAB./
EST. RIPARIAN AREA
320 FEET
$180,000
B-4 + B-63
DEMO. EXIST./
RECONSTRUCT
270 FEET
$277,000
B-21
BANK STAB.
770 FEET (EACH SIDE)
$120,000
B-6 + B-32
DEMO. EXIST./
RECONSTRUCT
430 FEET
$451,000
MOORE PARK
B-8 + B-74
DEMO. EXIST./
RECONSTRUCT
270 FEET
$289,000
B-7 + B-33
DEMO. EXIST./
RECONSTRUCT
310 FEET
$330,000
B-22
BANK STAB.
690 FEET (EACH SIDE)
$53,000
B-11
REPLACE BLUE WALL
180 FEET
$620,000
AVENUE
FERMIN CALDERON BLVD
REPLACE BLUE WALL
B-10 + B-24
DEMO. EXIST./
EST. RIPARIAN AREA
450 FEET
$245,000
B-9 + B-23
DEMO. EXIST./
EST. RIPARIAN AREA
290 FEET
$157,000
LEGEND:
RECONSTRUCT EXISTING WALLS (PROVIDE CONTINUOUS CREEK ACCESS)
RECONSTRUCT EXISTING WALLS (PROVIDE FOCUSED CREEK ACCESS)
REMOVE EXISTING WALLS AND ESTABLISH RIPARIAN AREA (PROVIDE FOCUSED CREEK ACCESS)
IMPROVE / ESTABLISH RIPARIAN AREA (PROVIDE FOCUSED CREEK ACCESS)
IMPROVE / ESTABLISH RIPARIAN AREA (NO IMPROVED CREEK ACCESS)
EXISTING WALLS (LEAVE IN PLACE)
FOCUSED ACCESS POINTS
ROMANELLI PARK
N
0
200
SCALE IN FEET
NEI
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FIGURE 21 (3 of 8)
PROPOSED PROJECTS
BANK IMPROVEMENTS - AREA B
SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS
Drawn By: RPS–jbs
Appr. By: DBF
Scale: AS SHOWN
Dwg. NO.: 8267A19
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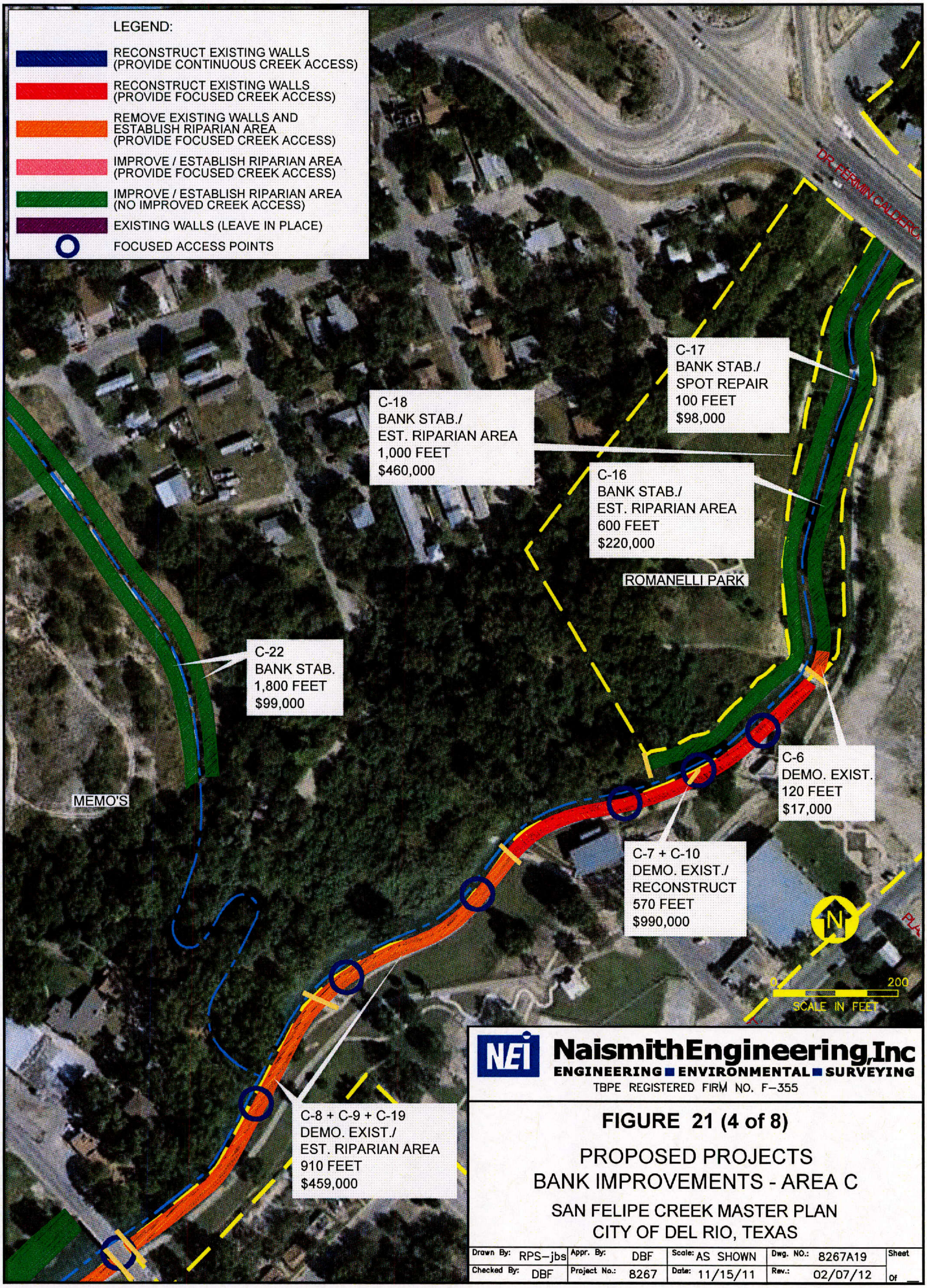
Checked By: DBF
Project No.: 8267
Date: 11/15/11
Rev.: 02/07/12
Of



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TBPE REGISTERED FIRM NO. F-355

FIGURE 21 (4 of 8)

PROPOSED PROJECTS
BANK IMPROVEMENTS - AREA C

SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

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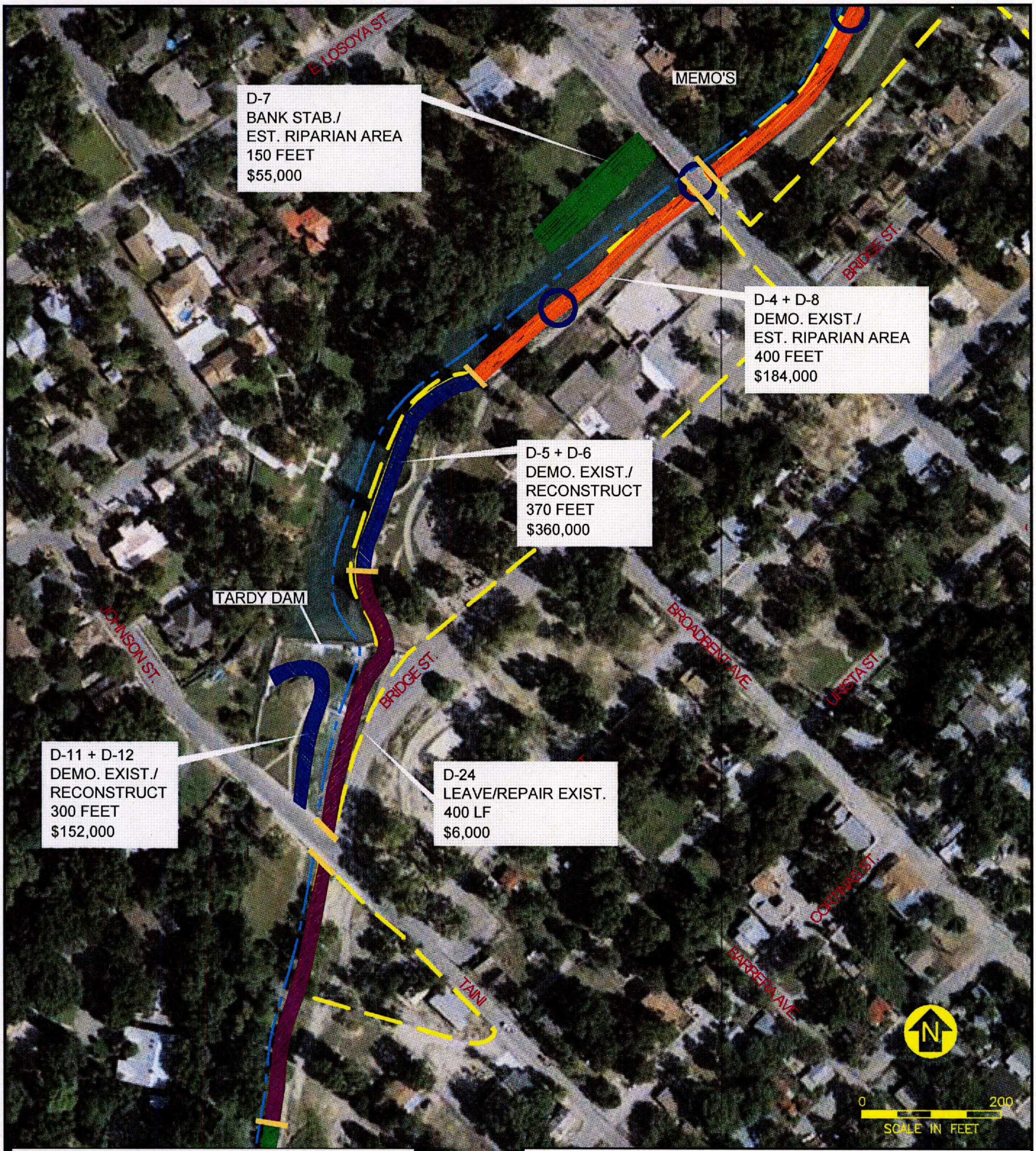

LEGEND:

- RECONSTRUCT EXISTING WALLS (PROVIDE CONTINUOUS CREEK ACCESS)
- RECONSTRUCT EXISTING WALLS (PROVIDE FOCUSED CREEK ACCESS)
- REMOVE EXISTING WALLS AND ESTABLISH RIPARIAN AREA (PROVIDE FOCUSED CREEK ACCESS)
- IMPROVE / ESTABLISH RIPARIAN AREA (PROVIDE FOCUSED CREEK ACCESS)
- IMPROVE / ESTABLISH RIPARIAN AREA (NO IMPROVED CREEK ACCESS)
- EXISTING WALLS (LEAVE IN PLACE)
- FOCUSED ACCESS POINTS

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TBPE REGISTERED FIRM NO. F-355

FIGURE 21 (5 of 8)

PROPOSED PROJECTS
BANK IMPROVEMENTS - AREA D

SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

Drawn By: RPS-jbs	Appr. By: DBF	Scale: AS SHOWN	Dwg. NO.: 8267A19	Sheet
Checked By: DBF	Project No.: 8267	Date: 11/15/11	Rev.: 02/07/12	of

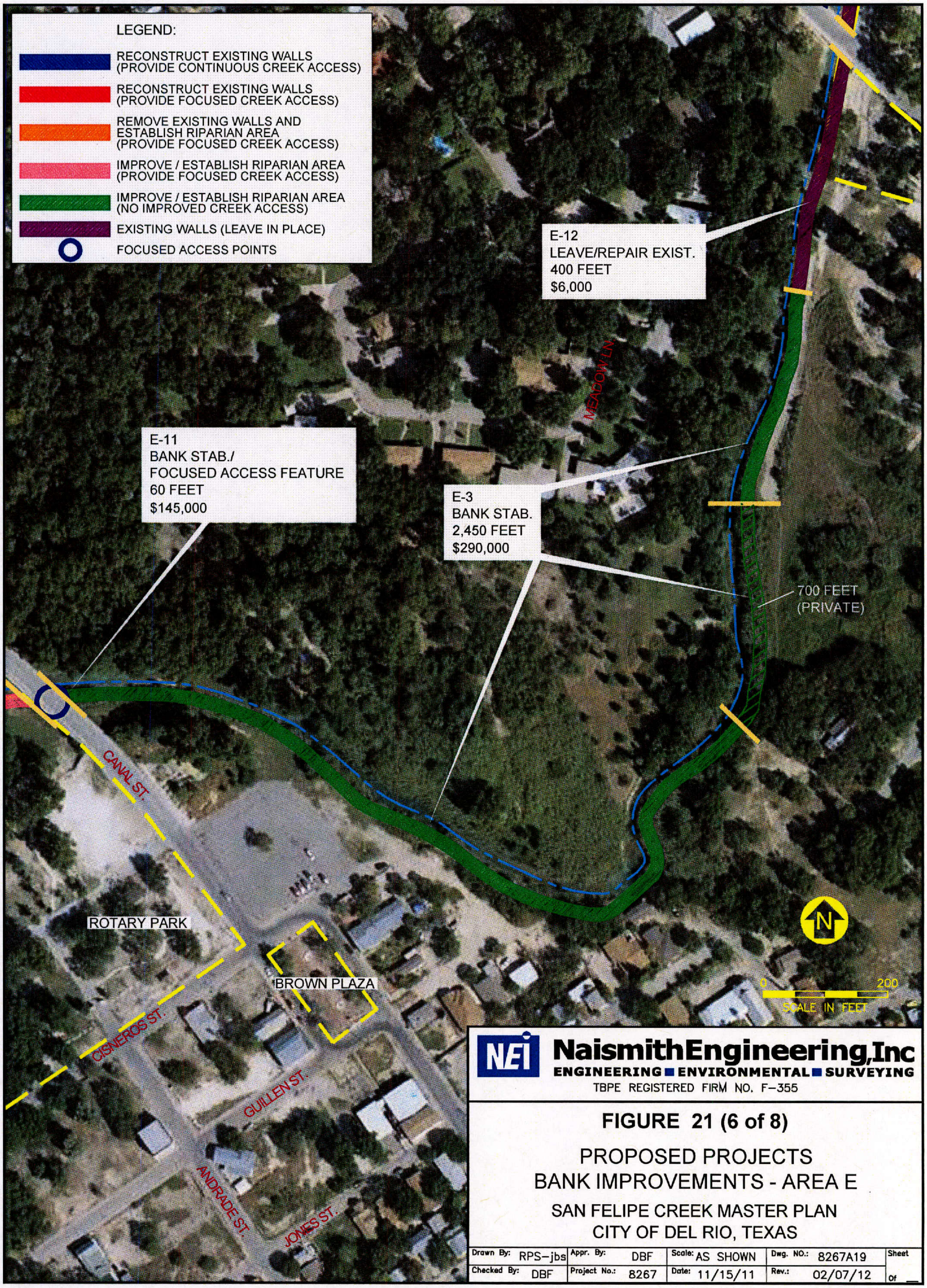

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FIGURE 21 (6 of 8)

PROPOSED PROJECTS
BANK IMPROVEMENTS - AREA E

SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

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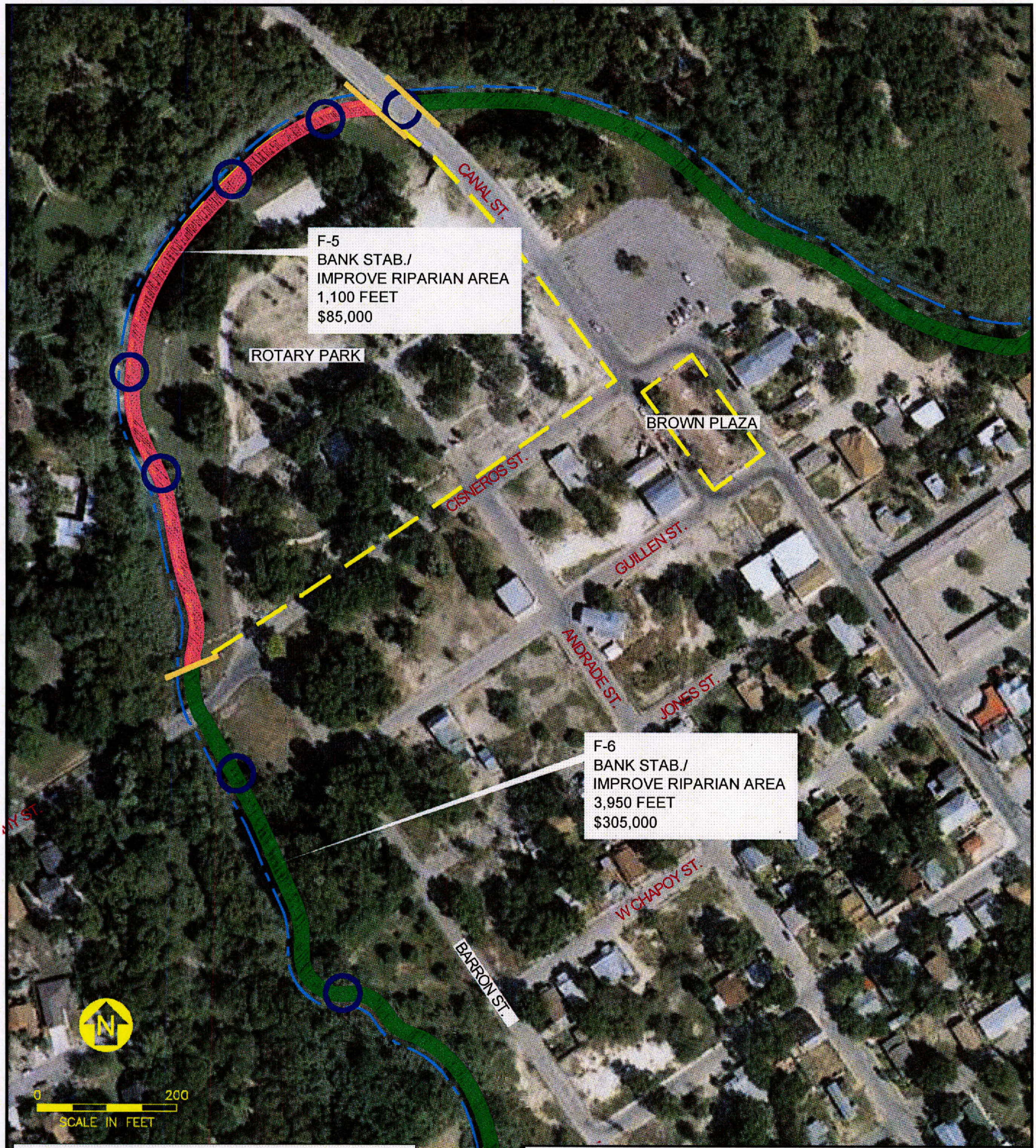
Checked By: DBF	Project No.: 8267	Date: 11/15/11	Rev.: 02/07/12	of



LEGEND:

- RECONSTRUCT EXISTING WALLS (PROVIDE CONTINUOUS CREEK ACCESS)
- RECONSTRUCT EXISTING WALLS (PROVIDE FOCUSED CREEK ACCESS)
- REMOVE EXISTING WALLS AND ESTABLISH RIPARIAN AREA (PROVIDE FOCUSED CREEK ACCESS)
- IMPROVE / ESTABLISH RIPARIAN AREA (PROVIDE FOCUSED CREEK ACCESS)
- IMPROVE / ESTABLISH RIPARIAN AREA (NO IMPROVED CREEK ACCESS)
- EXISTING WALLS (LEAVE IN PLACE)
- FOCUSED ACCESS POINTS

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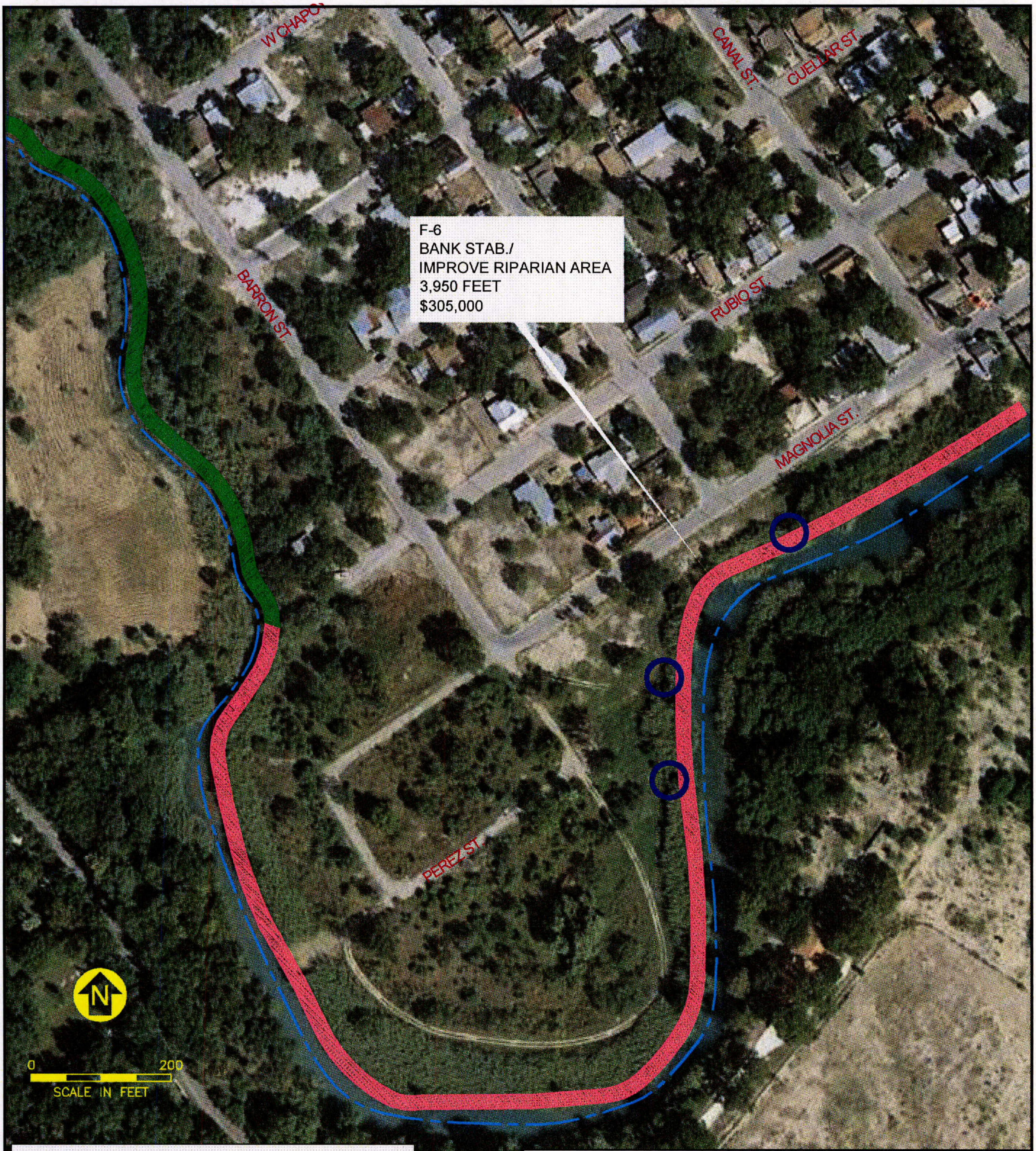
TBPE REGISTERED FIRM NO. F-355

FIGURE 21 (7 of 8)

PROPOSED PROJECTS
BANK IMPROVEMENTS - AREA F (1 of 2)

SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

Drawn By:	RPS–jbs	Appr. By:	DBF	Scale:	AS SHOWN	Dwg. NO.:	8267A19	Sheet
Checked By:	DBF	Project No.:	8267	Date:	11/15/11	Rev.:	02/07/12	Of



LEGEND:

- RECONSTRUCT EXISTING WALLS (PROVIDE CONTINUOUS CREEK ACCESS)
- RECONSTRUCT EXISTING WALLS (PROVIDE FOCUSED CREEK ACCESS)
- REMOVE EXISTING WALLS AND ESTABLISH RIPARIAN AREA (PROVIDE FOCUSED CREEK ACCESS)
- IMPROVE / ESTABLISH RIPARIAN AREA (PROVIDE FOCUSED CREEK ACCESS)
- IMPROVE / ESTABLISH RIPARIAN AREA (NO IMPROVED CREEK ACCESS)
- EXISTING WALLS (LEAVE IN PLACE)
- FOCUSED ACCESS POINTS

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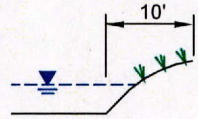
FIGURE 21 (8 of 8)

PROPOSED PROJECTS
BANK IMPROVEMENTS - AREA F (2 of 2)

SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

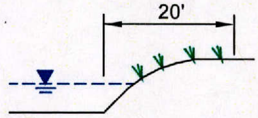
Drawn By:	RPS–jbs	Appr. By:	DBF	Scale:	AS SHOWN	Dwg. NO.:	8267A19	Sheet			
Checked By:	DBF	Project No.:	8267	Date:	11/15/11	Rev.:	02/07/12	Of			

VEGETATION I10



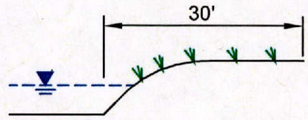
$23 / LF
+ $ 3 / LF (GEOGRID)
$26 / LF

VEGETATION I20



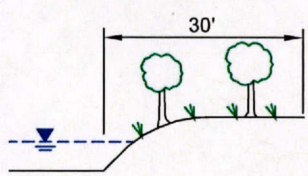
$45 / LF
+ $ 6 / LF (GEOGRID)
$51 / LF

VEGETATION I30



$65 / LF
+ $10 / LF (GEOGRID)
$75 / LF

VEGETATION II



$80 / LF
+ $10 / LF (GEOGRID)
$90 / LF

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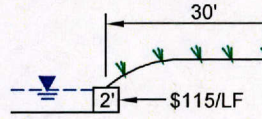
FIGURE 22 (1 of 5)

SAN FELIPE CREEK
PROPOSED
BANK IMPROVEMENT SCHEMATICS
CITY OF DEL RIO, TEXAS

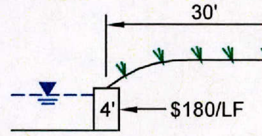
Drawn By: RPS	Appr. By:	DBF	Scale:	NTS	Dwg. NO.:	8267A11	Sheet	
Checked By: DBF	Project No.:	8267	Date:	02/08/12	Rev.:	02/08/12	Of	

VEGETATION I30 + 2' ROCK GABION



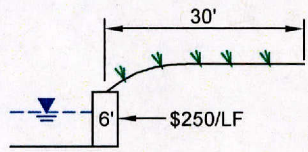
	$ 65 / LF
+	$115 / LF
	$180 / LF
	$ 10 / LF (GEOGRID)
+	$ 15 / LF (TREES)
	$205 / LF

VEGETATION I30 + 4' ROCK GABION



	$ 65 / LF
+	$180 / LF
	$245 / LF
	$ 10 / LF (GEOGRID)
+	$ 15 / LF (TREES)
	$270 / LF

VEGETATION I30 + 6' ROCK GABION



	$ 65 / LF
+	$250 / LF
	$315 / LF
	$ 10 / LF (GEOGRID)
+	$ 15 / LF (TREES)
	$340 / LF

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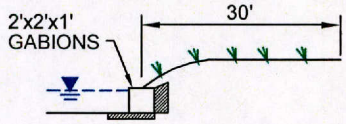
FIGURE 22 (2 of 5)

SAN FELIPE CREEK
PROPOSED
BANK IMPROVEMENT SCHEMATICS
CITY OF DEL RIO, TEXAS

Drawn By: RPS	Appr. By: DBF	Scale: NTS	Dwg. NO.: 8267A11	Sheet
Checked By: DBF	Project No.: 8267	Date: 02/08/12	Rev.: 02/08/12	Of

BANK IMPROVEMENTS - STONE I + VEGETATION I30

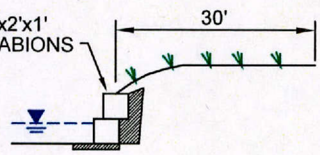


$ 65 / LF (VEG. I30)
$ 40 / LF (GABION MATRESS)
$ 20 / LF (ROCK)
+ $ 40 / LF (GABIONS)

$165 / LF
+ $ 15 / LF (EXCAVATION)

$180 / LF

BANK IMPROVEMENTS - STONE II + VEGETATION I30

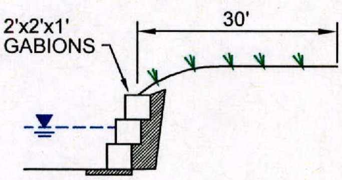


$ 65 / LF (VEG. I30)
$ 40 / LF (GABION MATRESS)
$ 40 / LF (ROCK)
+ $ 80 / LF (GABIONS)

$225 / LF
+ $ 20 / LF (EXCAVATION)

$245 / LF

BANK IMPROVEMENTS - STONE III + VEGETATION I30



$ 65 / LF (VEG. I30)
$ 40 / LF (GABION MATRESS)
$ 60 / LF (ROCK)
+ $120 / LF (GABIONS)

$285 / LF
+ $ 30 / LF (EXCAVATION)

$315 / LF

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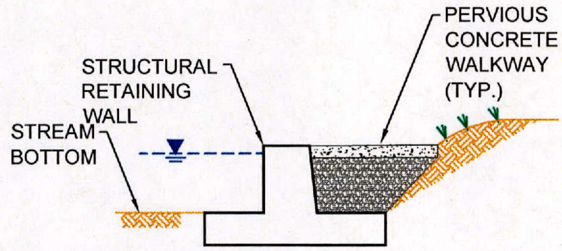
FIGURE 22 (3 of 5)

SAN FELIPE CREEK
PROPOSED
BANK IMPROVEMENT SCHEMATICS
CITY OF DEL RIO, TEXAS

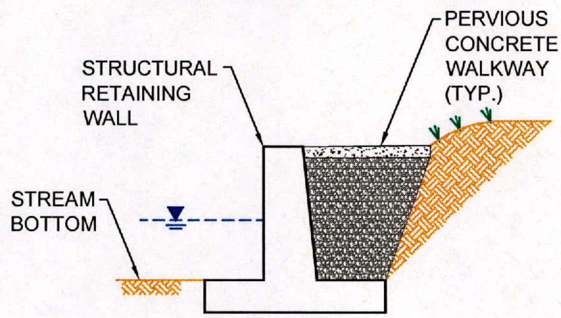
Drawn By: RPS	Appr. By: DBF	Scale: NTS	Dwg. NO.: 8267A11	Sheet
Checked By: DBF	Project No.: 8267	Date: 02/08/12	Rev.: 02/08/12	Of

STRUCTURAL WALL I - 0' TO 2'



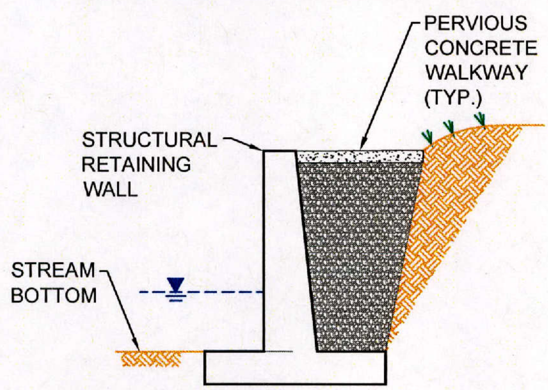
$120 / LF

STRUCTURAL WALL II - 2' TO 4'



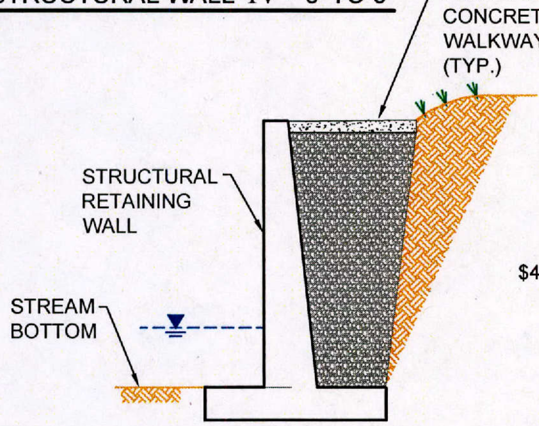
$240 / LF

STRUCTURAL WALL III - 4' TO 6'



$360 / LF

STRUCTURAL WALL IV - 6' TO 8'



$480 / LF

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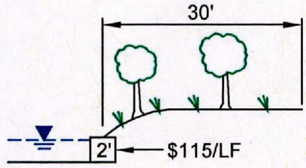
FIGURE 22 (4 of 5)

SAN FELIPE CREEK
PROPOSED
BANK IMPROVEMENT SCHEMATICS
CITY OF DEL RIO, TEXAS

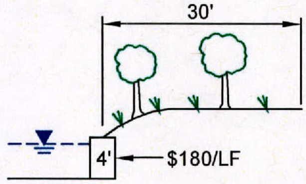
Drawn By: RPS	Appr. By: DBF	Scale: NTS	Dwg. NO.: 8267A11	Sheet
Checked By: DBF	Project No.: 8267	Date: 02/08/12	Rev.: 02/08/12	Of

VEGETATION II + 2' ROCK GABION



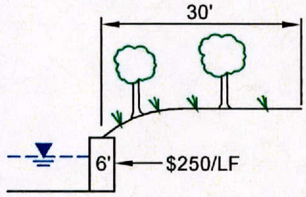
$ 80 / LF
+ $115 / LF
$195 / LF
$ 10 / LF (GEOGRID)
+ $ 15 / LF (TREES)
$220 / LF

VEGETATION II + 4' ROCK GABION



$ 80 / LF
+ $180 / LF
$260 / LF
$ 10 / LF (GEOGRID)
+ $ 15 / LF (TREES)
$285 / LF

VEGETATION II + 6' ROCK GABION



$ 80 / LF
+ $250 / LF
$330 / LF
$ 10 / LF (GEOGRID)
+ $ 15 / LF (TREES)
$355 / LF

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FIGURE 22 (5 of 5)

SAN FELIPE CREEK
PROPOSED
BANK IMPROVEMENT SCHEMATICS
CITY OF DEL RIO, TEXAS

Drawn By:	RPS	Appr. By:	DBF	Scale:	NTS	Dwg. NO.:	8267A11	Sheet	
Checked By:	DBF	Project No.:	8267	Date:	02/08/12	Rev.:	02/08/12	Of	

LEGEND

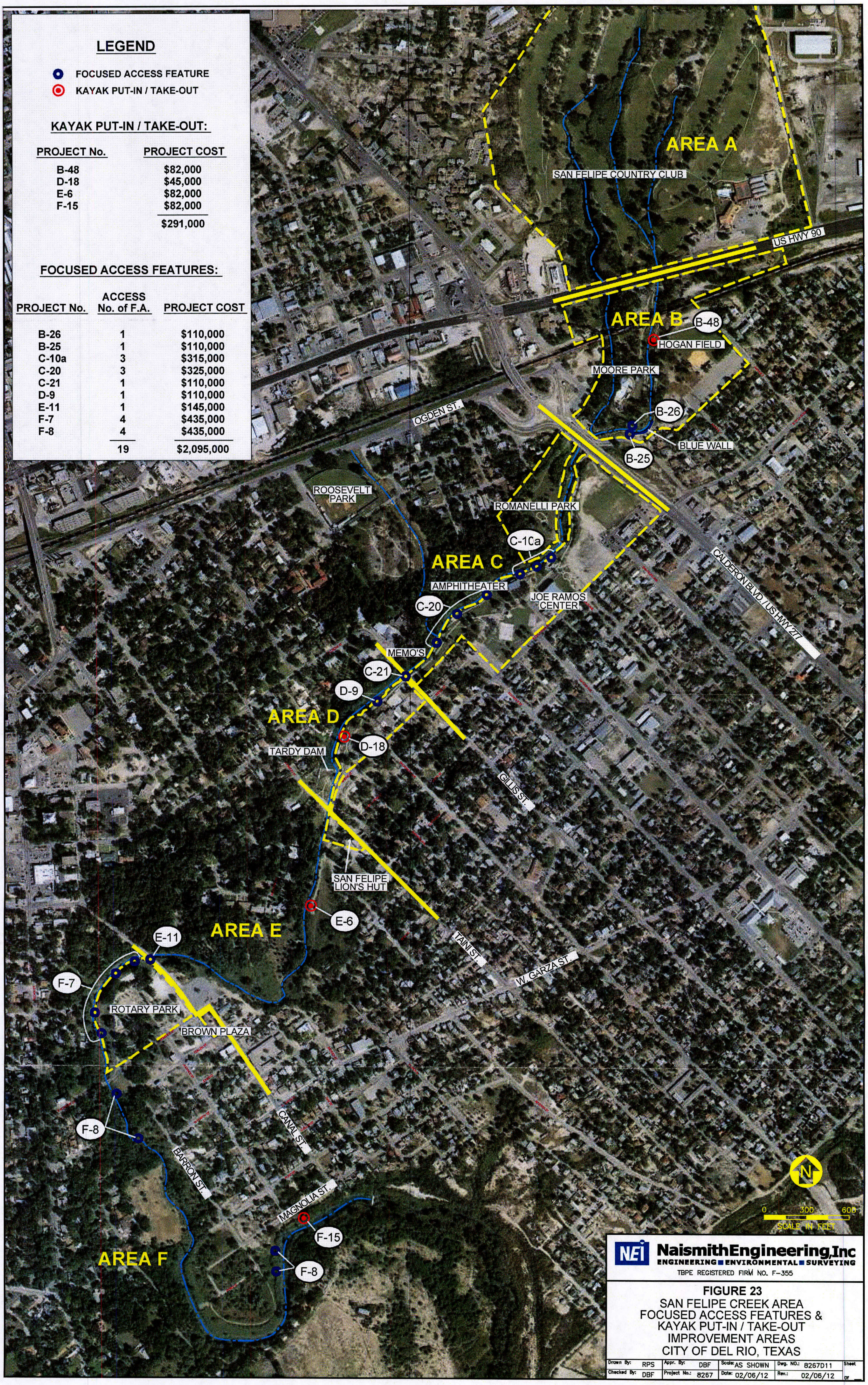
- FOCUSED ACCESS FEATURE
- KAYAK PUT-IN / TAKE-OUT

KAYAK PUT-IN / TAKE-OUT:

PROJECT No.	PROJECT COST
B-48	$82,000
D-18	$45,000
E-6	$82,000
F-15	$82,000
	$291,000

FOCUSED ACCESS FEATURES:

PROJECT No.	ACCESS No. of F.A.	PROJECT COST
B-26	1	$110,000
B-25	1	$110,000
C-10a	3	$315,000
C-20	3	$325,000
C-21	1	$110,000
D-9	1	$110,000
E-11	1	$145,000
F-7	4	$435,000
F-8	4	$435,000
	19	$2,095,000



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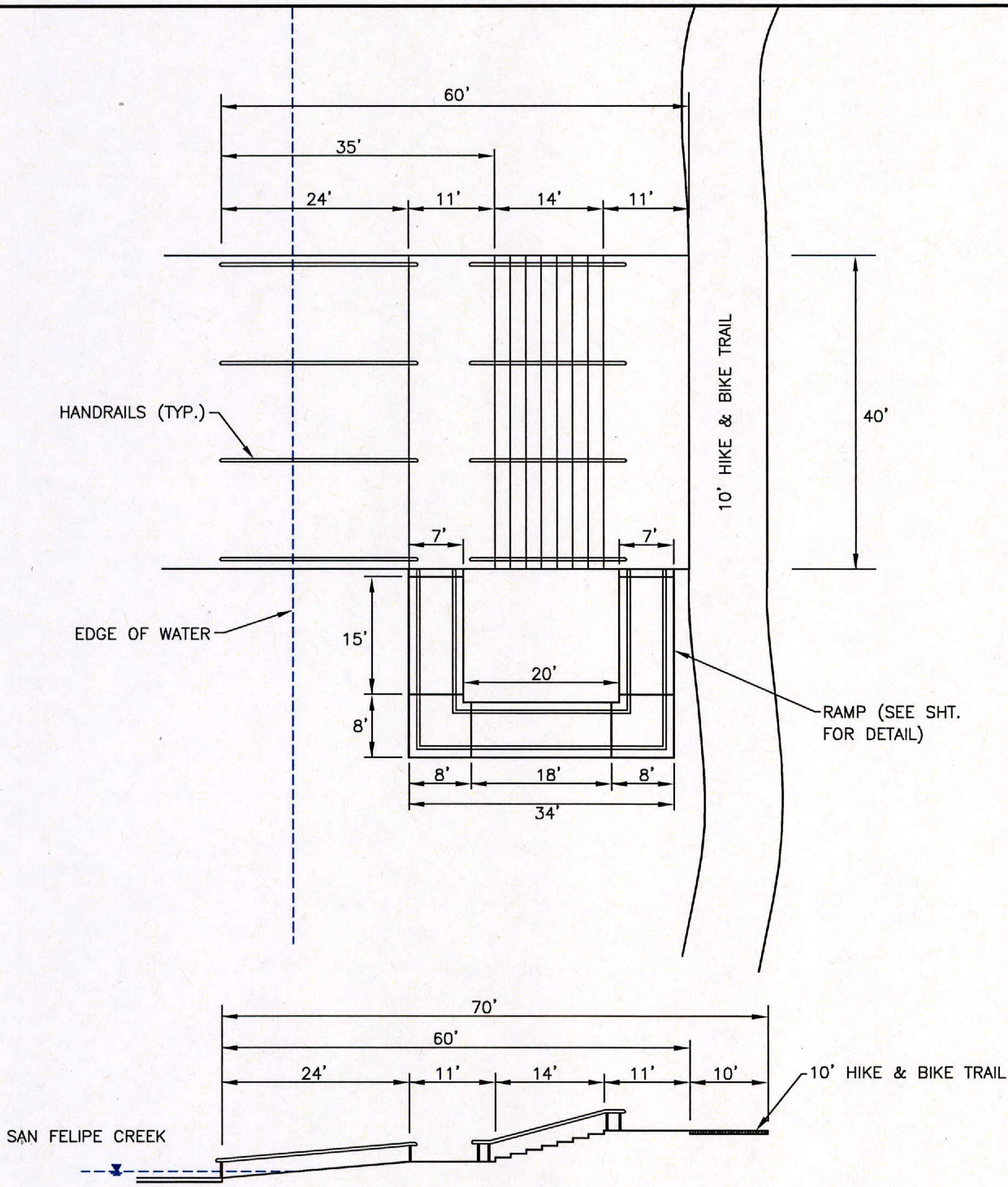
TBPE REGISTERED FIRM NO. F-355

FIGURE 23
SAN FELIPE CREEK AREA
FOCUSED ACCESS FEATURES &
KAYAK PUT-IN / TAKE-OUT
IMPROVEMENT AREAS
CITY OF DEL RIO, TEXAS

Drawn By: RPS	Appr. By: DBF	Scale: AS SHOWN	Dwg. NO.: 8267D11	Sheet
Checked By: DBF	Project No.: 8267	Date: 02/06/12	Rev.: 02/06/12	of



1 FOCUSED ACCESS FEATURE
TYPICAL DETAIL
NOT TO SCALE

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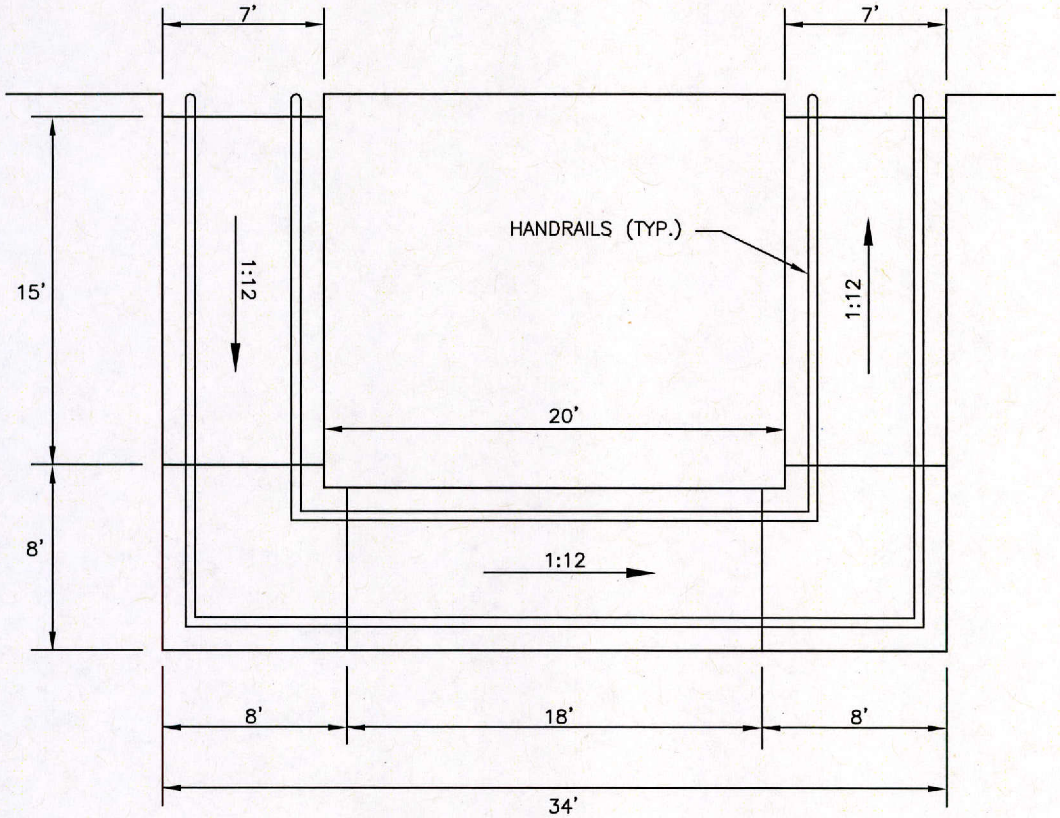
FIGURE 24 (1 of 3)

FOCUSED ACCESS FEATURE
DETAIL / SCHEMATIC
SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

Drawn By:	RPS	Appr. By:	DBF	Scale:	N.T.S.	Dwg. NO.:	8267A10	Sheet
Checked By:	DBF	Project No.:	8267	Date:	12/06/11	Rev.:	12/12/11	Of



RAMP
TYPICAL DETAIL
NOT TO SCALE

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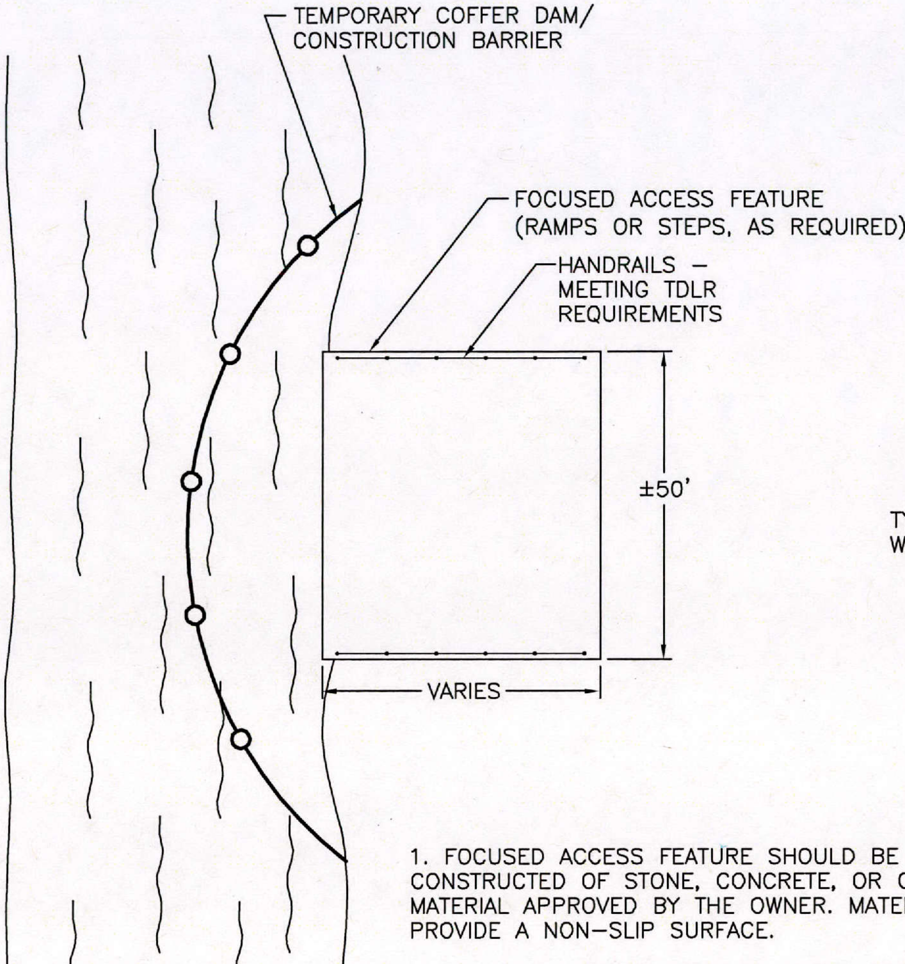
TBPE REGISTERED FIRM NO. F-355

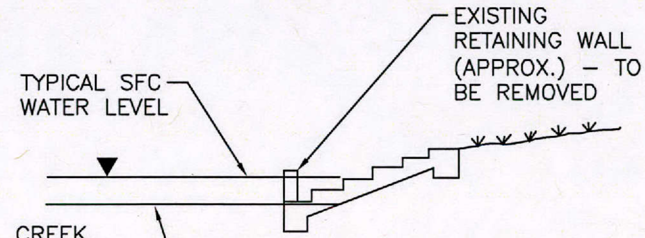
FIGURE 24 (2 of 3)

FOCUSED ACCESS FEATURE
DETAIL / SCHEMATIC

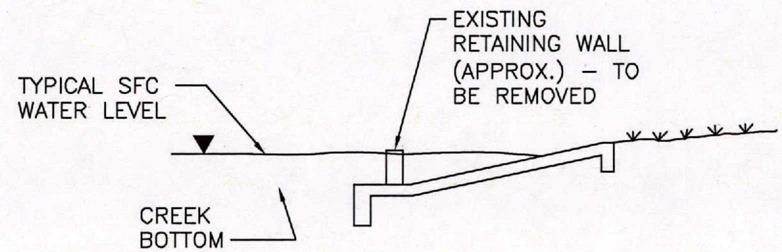
SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

Drawn By:	RPS	Appr. By:	DBF	Scale:	N.T.S.	Dwg. NO.:	8267A10	Sheet	
Checked By:	DBF	Project No.:	8267	Date:	12/06/11	Rev.:	12/12/11	Of	





OPTION 1
FOCUSED ACCESS FEATURE - STEPS



OPTION 2
FOCUSED ACCESS FEATURE - RAMP

1. FOCUSED ACCESS FEATURE SHOULD BE CONSTRUCTED OF STONE, CONCRETE, OR OTHER MATERIAL APPROVED BY THE OWNER. MATERIAL MUST PROVIDE A NON–SLIP SURFACE.

2. APPROVAL OF THE DESIGN MUST BE OBTAINED FROM THE TEXAS DEPARTMENT OF LICENSING & REGISTRATION (TDLR) FOR COMPLIANCE WITH THE TEXAS ACCESSIBILITY STANDARDS (TAS) PRIOR TO CONSTRUCTION.

3. A TEMPORARY COFFER DAM OR OTHER SUITABLE CONSTRUCTION BMP WILL BE REQUIRED.

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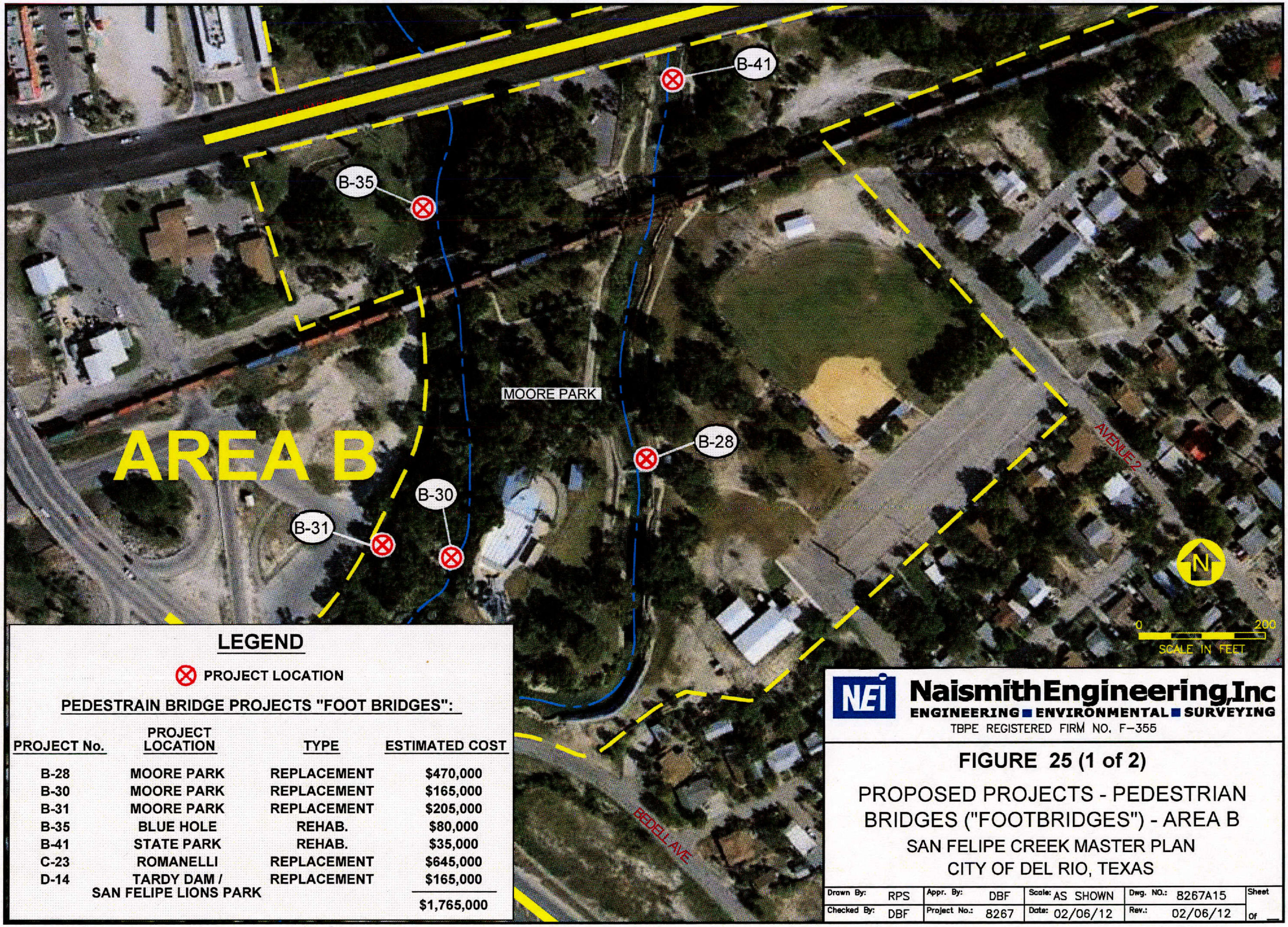
FIGURE 24 (3 of 3)

FOCUSED ACCESS FEATURE
DETAIL / SCHEMATIC

SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

Drawn By: JBS	Appr. By: DBF	Scale: N.T.S.	Dwg. NO.: A12	Sheet
Checked By: DBF	Project No.: 8267	Date: 11/28/11	Rev.: 02/02/12	Of



LEGEND

⊗ PROJECT LOCATION

PEDESTRAIN BRIDGE PROJECTS "FOOT BRIDGES":

PROJECT No.	PROJECT LOCATION	TYPE	ESTIMATED COST
B-28	MOORE PARK	REPLACEMENT	$470,000
B-30	MOORE PARK	REPLACEMENT	$165,000
B-31	MOORE PARK	REPLACEMENT	$205,000
B-35	BLUE HOLE	REHAB.	$80,000
B-41	STATE PARK	REHAB.	$35,000
C-23	ROMANELLI	REPLACEMENT	$645,000
D-14	TARDY DAM / SAN FELIPE LIONS PARK	REPLACEMENT	$165,000
			$1,765,000

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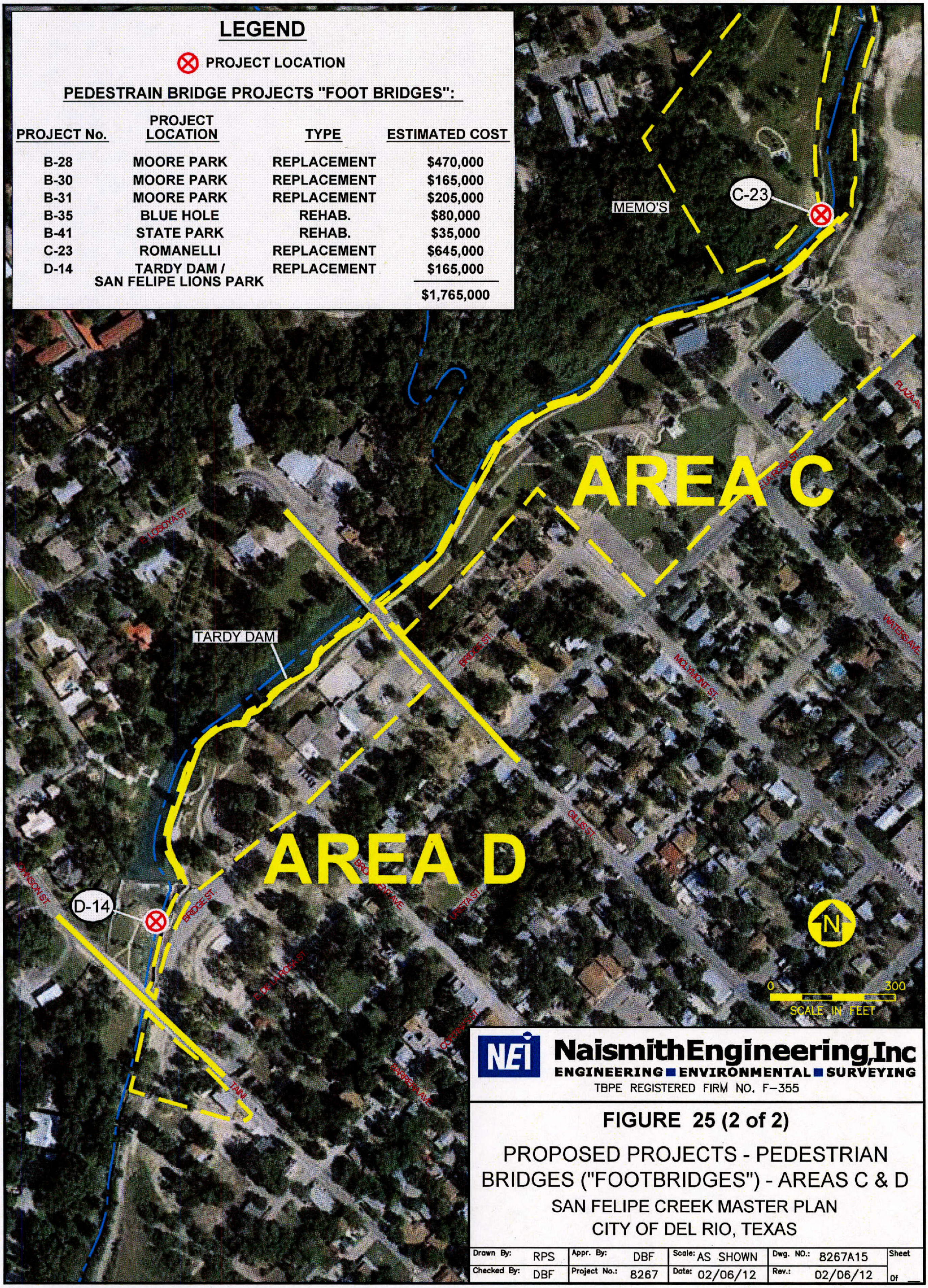
FIGURE 25 (1 of 2)

PROPOSED PROJECTS - PEDESTRIAN BRIDGES ("FOOTBRIDGES") - AREA B
SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

Drawn By: RPS	Appr. By: DBF	Scale: AS SHOWN	Dwg. NO.: 8267A15	Sheet
Checked By: DBF	Project No.: 8267	Date: 02/06/12	Rev.: 02/06/12	of



LEGEND

⊗ PROJECT LOCATION

PEDESTRAIN BRIDGE PROJECTS "FOOT BRIDGES":

PROJECT No.	PROJECT LOCATION	TYPE	ESTIMATED COST
B-28	MOORE PARK	REPLACEMENT	$470,000
B-30	MOORE PARK	REPLACEMENT	$165,000
B-31	MOORE PARK	REPLACEMENT	$205,000
B-35	BLUE HOLE	REHAB.	$80,000
B-41	STATE PARK	REHAB.	$35,000
C-23	ROMANELLI	REPLACEMENT	$645,000
D-14	TARDY DAM / SAN FELIPE LIONS PARK	REPLACEMENT	$165,000
			$1,765,000

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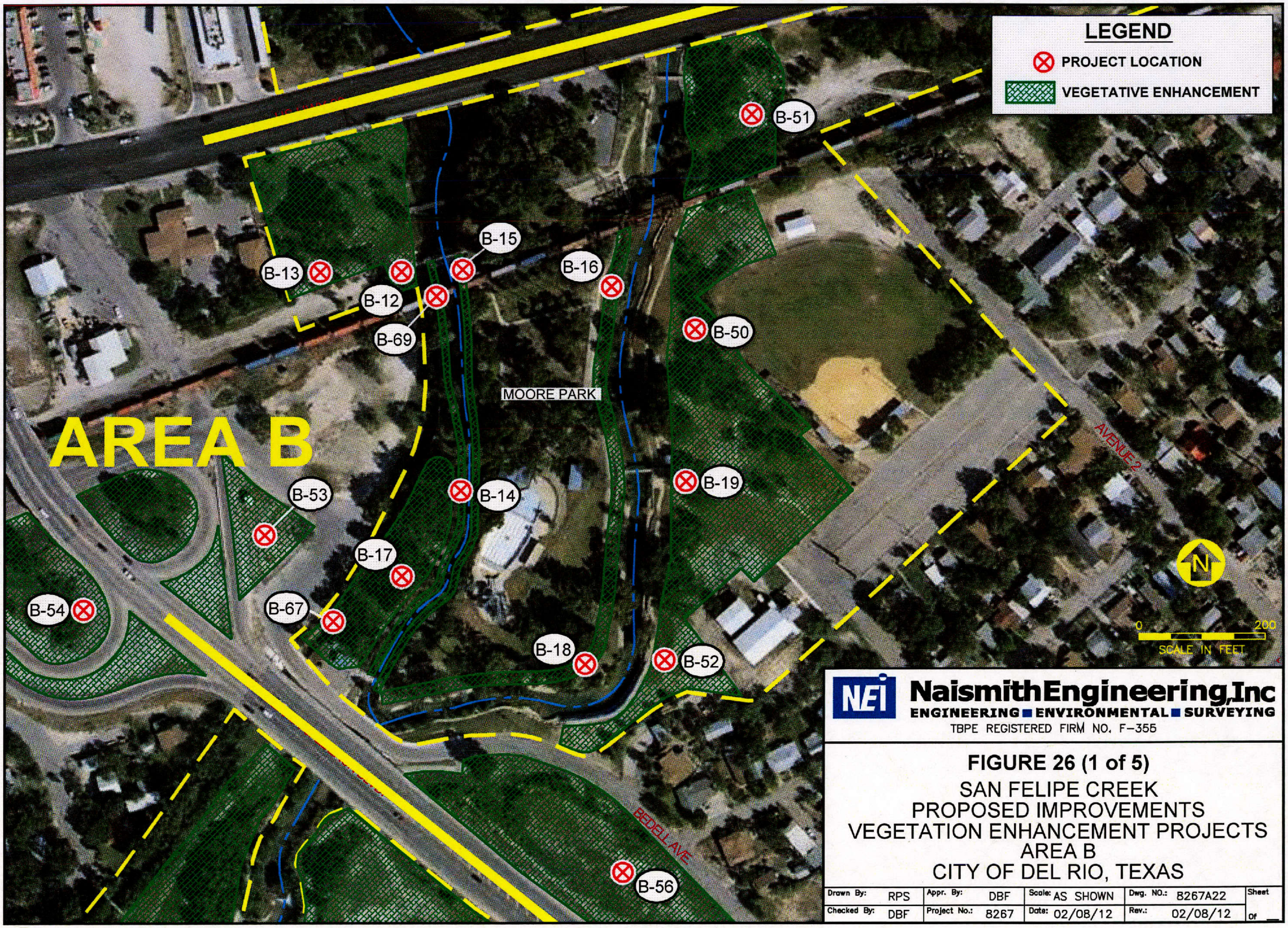
TBPE REGISTERED FIRM NO. F-355

FIGURE 25 (2 of 2)

PROPOSED PROJECTS - PEDESTRIAN BRIDGES ("FOOTBRIDGES") - AREAS C & D

SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

Drawn By: RPS	Appr. By: DBF	Scale: AS SHOWN	Dwg. NO.: 8267A15	Sheet
Checked By: DBF	Project No.: 8267	Date: 02/06/12	Rev.: 02/06/12	Of


LEGEND
PROJECT LOCATION
VEGETATIVE ENHANCEMENT
AREA B
MOORE PARK
B-12
B-13
B-14
B-15
B-16
B-17
B-18
B-19
B-50
B-51
B-52
B-53
B-54
B-56
B-67
B-69
AVENUE 2
BEDELL AVE
N
0
200
SCALE IN FEET
NEI
NaismithEngineering,Inc
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TBPE REGISTERED FIRM NO. F-355
FIGURE 26 (1 of 5)
SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
VEGETATION ENHANCEMENT PROJECTS
AREA B
CITY OF DEL RIO, TEXAS
Drawn By: RPS
Appr. By: DBF
Scale: AS SHOWN
Dwg. NO.: 8267A22
Sheet
Checked By: DBF
Project No.: 8267
Date: 02/08/12
Rev.: 02/08/12
of

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FIGURE 26 (2 of 5)
SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
VEGETATION ENHANCEMENT PROJECTS
AREA C
CITY OF DEL RIO, TEXAS

Drawn By: RPS	Appr. By: DBF	Scale: AS SHOWN	Dwg. NO.: 8267A22	Sheet
Checked By: DBF	Project No.: 8267	Date: 02/08/12	Rev.: 02/08/12	Of

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TBPE REGISTERED FIRM NO. F-355

FIGURE 26 (3 of 5)

SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
VEGETATION ENHANCEMENT PROJECTS
AREA D
CITY OF DEL RIO, TEXAS

Drawn By: RPS	Appr. By: DBF	Scale: AS SHOWN	Dwg. NO.: 8267A22	Sheet
Checked By: DBF	Project No.: 8267	Date: 02/08/12	Rev.: 02/08/12	Of

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TBPE REGISTERED FIRM NO. F-355

FIGURE 26 (4 of 5)
SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
VEGETATION ENHANCEMENT PROJECTS
AREA E
CITY OF DEL RIO, TEXAS

Drawn By: RPS	Appr. By: DBF	Scale: AS SHOWN	Dwg. NO.: 8267A22	Sheet
Checked By: DBF	Project No.: 8267	Date: 02/08/12	Rev.: 02/08/12	Of

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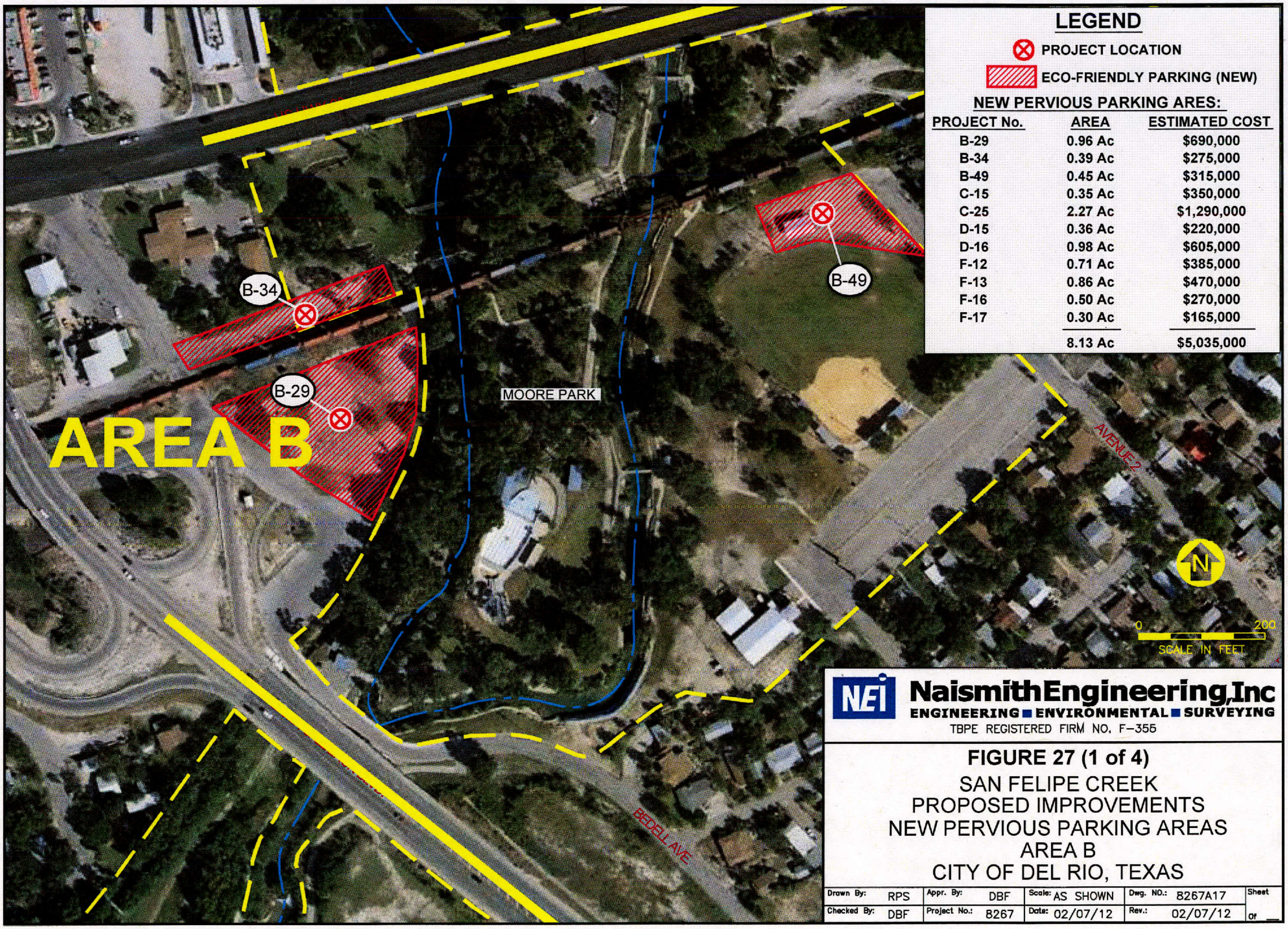
FIGURE 26 (5 of 5)
SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
VEGETATION ENHANCEMENT PROJECTS
AREA F
CITY OF DEL RIO, TEXAS

Drawn By:	RPS	Appr. By:	DBF	Scale:	AS SHOWN	Dwg. NO.:	8267A22	Sheet	
Checked By:	DBF	Project No.:	8267	Date:	02/08/12	Rev.:	02/08/12	Of	



LEGEND

PROJECT LOCATION

ECO-FRIENDLY PARKING (NEW)

NEW PERVIOUS PARKING ARES:

PROJECT No.	AREA	ESTIMATED COST
B-29	0.96 Ac	$690,000
B-34	0.39 Ac	$275,000
B-49	0.45 Ac	$315,000
C-15	0.35 Ac	$350,000
C-25	2.27 Ac	$1,290,000
D-15	0.36 Ac	$220,000
D-16	0.98 Ac	$605,000
F-12	0.71 Ac	$385,000
F-13	0.86 Ac	$470,000
F-16	0.50 Ac	$270,000
F-17	0.30 Ac	$165,000
	8.13 Ac	$5,035,000

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FIGURE 27 (1 of 4)
SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
NEW PERVIOUS PARKING AREAS
AREA B
CITY OF DEL RIO, TEXAS

Drawn By: RPS	Appr. By: DBF	Scale: AS SHOWN	Dwg. NO.: 8267A17	Sheet
Checked By: DBF	Project No.: 8267	Date: 02/07/12	Rev.: 02/07/12	Of ___

LEGEND

⊗ PROJECT LOCATION

ECO-FRIENDLY PARKING (NEW)

NEW PERVIOUS PARKING ARES:

PROJECT No.	AREA	ESTIMATED COST
B-29	0.96 Ac	$690,000
B-34	0.39 Ac	$275,000
B-49	0.45 Ac	$315,000
C-15	0.35 Ac	$350,000
C-25	2.27 Ac	$1,290,000
D-15	0.36 Ac	$220,000
D-16	0.98 Ac	$605,000
F-12	0.71 Ac	$385,000
F-13	0.86 Ac	$470,000
F-16	0.50 Ac	$270,000
F-17	0.30 Ac	$165,000
	8.13 Ac	$5,035,000

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FIGURE 27 (2 of 4)

SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
NEW PERVIOUS PARKING AREAS
AREA C
CITY OF DEL RIO, TEXAS

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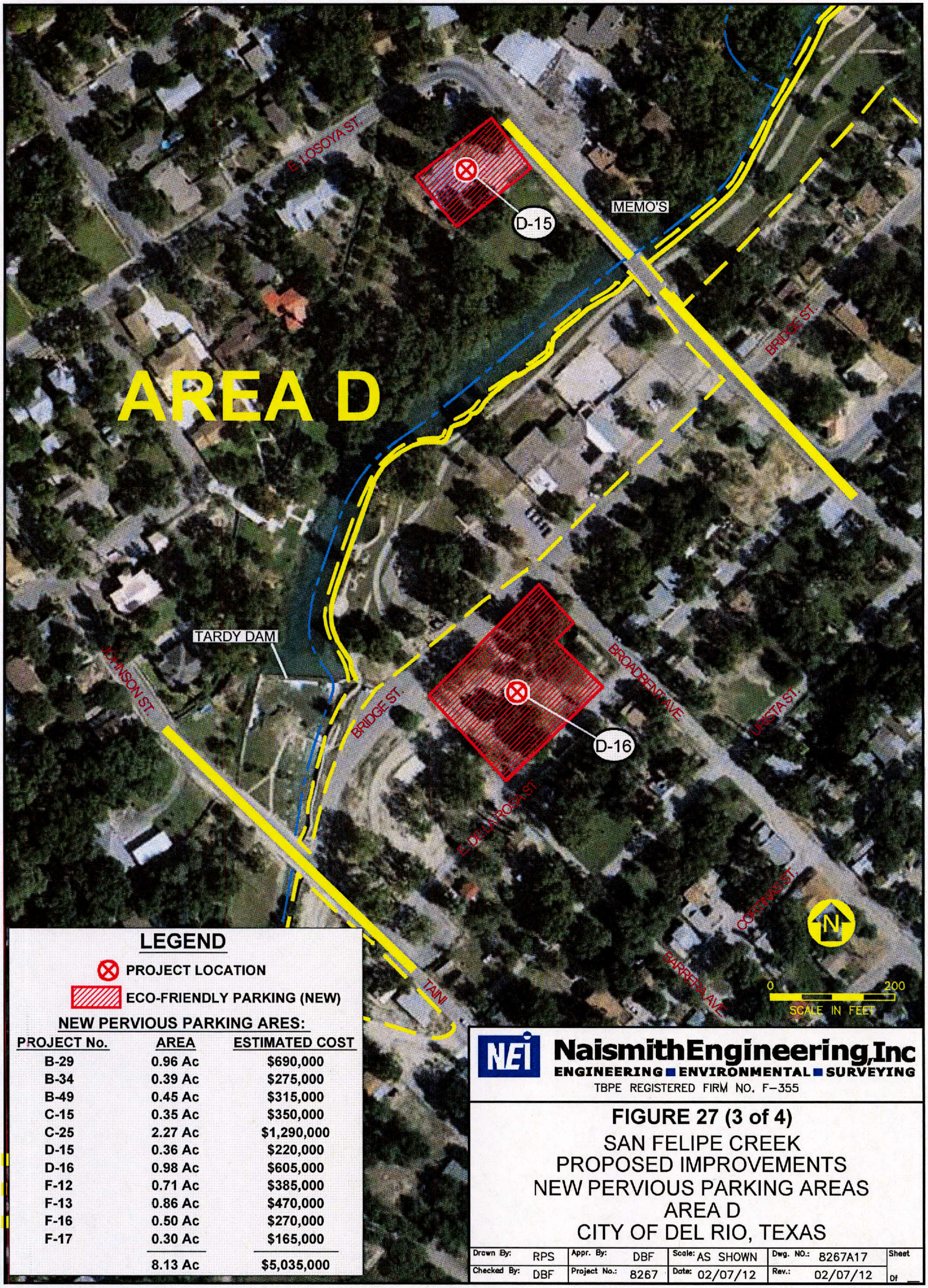

LEGEND

⊗ PROJECT LOCATION

ECO-FRIENDLY PARKING (NEW)

NEW PERVIOUS PARKING ARES:

PROJECT No.	AREA	ESTIMATED COST
B-29	0.96 Ac	$690,000
B-34	0.39 Ac	$275,000
B-49	0.45 Ac	$315,000
C-15	0.35 Ac	$350,000
C-25	2.27 Ac	$1,290,000
D-15	0.36 Ac	$220,000
D-16	0.98 Ac	$605,000
F-12	0.71 Ac	$385,000
F-13	0.86 Ac	$470,000
F-16	0.50 Ac	$270,000
F-17	0.30 Ac	$165,000
	8.13 Ac	$5,035,000

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FIGURE 27 (3 of 4)
SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
NEW PERVIOUS PARKING AREAS
AREA D
CITY OF DEL RIO, TEXAS

Drawn By:	RPS	Appr. By:	DBF	Scale:	AS SHOWN	Dwg. NO.:	8267A17	Sheet	
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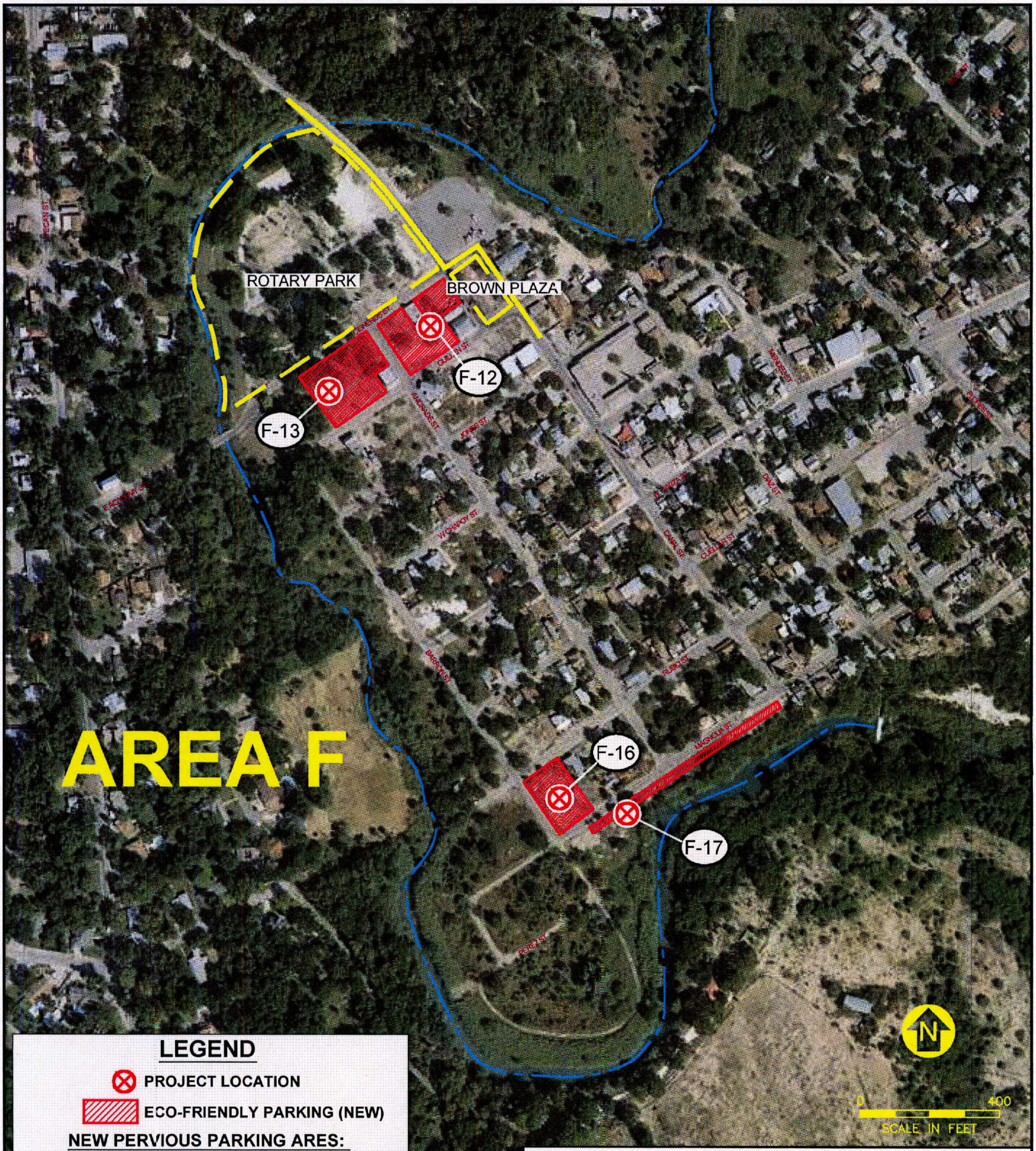

LEGEND

⊗ PROJECT LOCATION

ECO-FRIENDLY PARKING (NEW)

NEW PERVIOUS PARKING ARES:

PROJECT No.	AREA	ESTIMATED COST
B-29	0.96 Ac	$690,000
B-34	0.39 Ac	$275,000
B-49	0.45 Ac	$315,000
C-15	0.35 Ac	$350,000
C-25	2.27 Ac	$1,290,000
D-15	0.36 Ac	$220,000
D-16	0.98 Ac	$605,000
F-12	0.71 Ac	$385,000
F-13	0.86 Ac	$470,000
F-16	0.50 Ac	$270,000
F-17	0.30 Ac	$165,000
	8.13 Ac	$5,035,000

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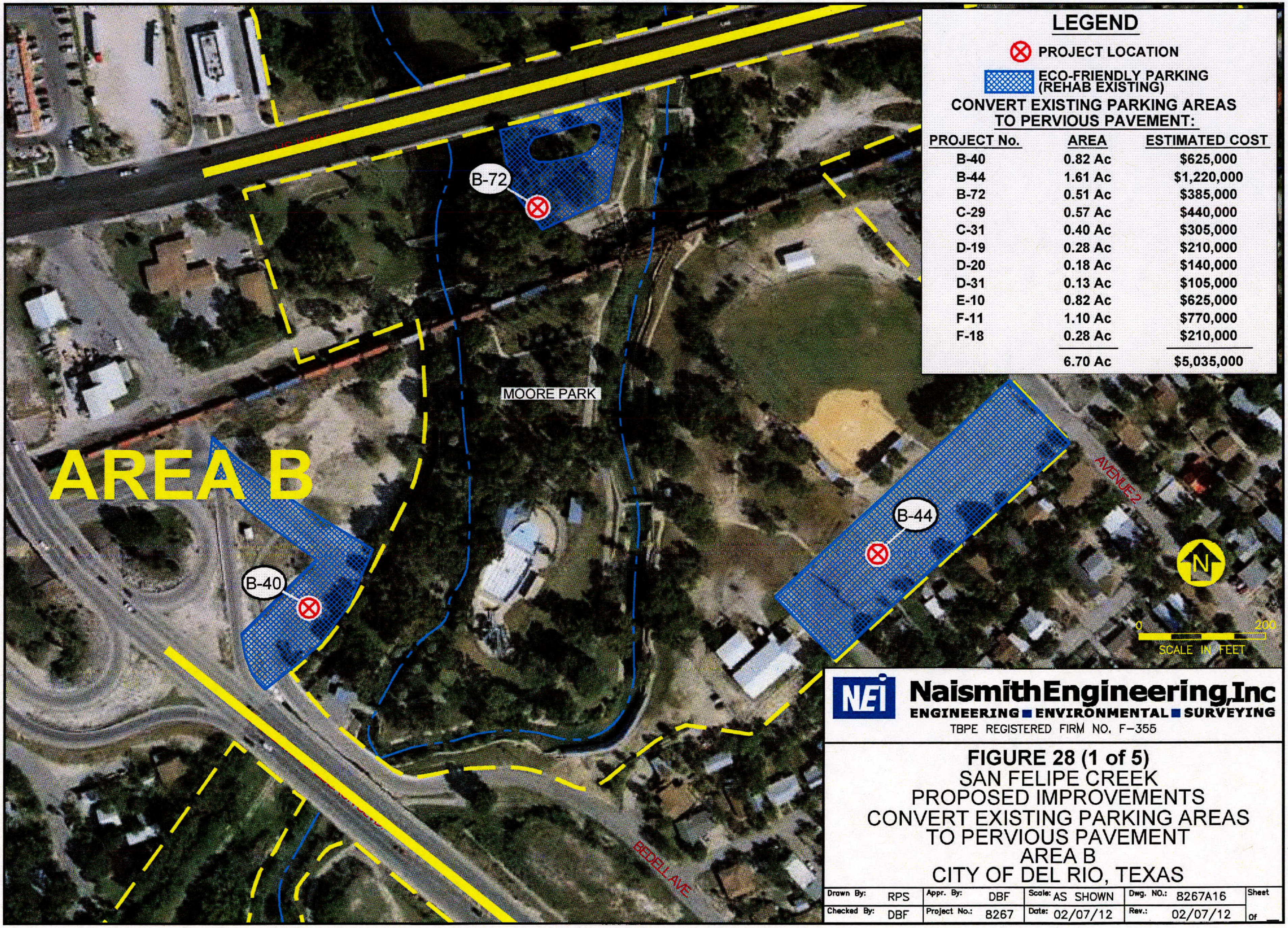
FIGURE 27 (4 of 4)

SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
NEW PERVIOUS PARKING AREAS
AREA F
CITY OF DEL RIO, TEXAS

Drawn By:	RPS	Appr. By:	DBF	Scale: AS SHOWN	Dwg. No.:	8267A17	Sheet	
Checked By:	DBF	Project No.:	8267	Date: 02/07/12	Rev.:	02/07/12	of	



LEGEND

⊗ PROJECT LOCATION

ECO-FRIENDLY PARKING (REHAB EXISTING)

CONVERT EXISTING PARKING AREAS TO PERVIOUS PAVEMENT:

PROJECT No.	AREA	ESTIMATED COST
B-40	0.82 Ac	$625,000
B-44	1.61 Ac	$1,220,000
B-72	0.51 Ac	$385,000
C-29	0.57 Ac	$440,000
C-31	0.40 Ac	$305,000
D-19	0.28 Ac	$210,000
D-20	0.18 Ac	$140,000
D-31	0.13 Ac	$105,000
E-10	0.82 Ac	$625,000
F-11	1.10 Ac	$770,000
F-18	0.28 Ac	$210,000
	6.70 Ac	$5,035,000

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FIGURE 28 (1 of 5)
SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
CONVERT EXISTING PARKING AREAS
TO PERVIOUS PAVEMENT
AREA B
CITY OF DEL RIO, TEXAS

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Checked By: DBF	Project No.: 8267	Date: 02/07/12	Rev.: 02/07/12	of

LEGEND

⊗ PROJECT LOCATION

ECO-FRIENDLY PARKING (REHAB EXISTING)

CONVERT EXISTING PARKING AREAS TO PERVIOUS PAVEMENT:

PROJECT No.	AREA	ESTIMATED COST
B-40	0.82 Ac	$625,000
B-44	1.61 Ac	$1,220,000
B-72	0.51 Ac	$385,000
C-29	0.57 Ac	$440,000
C-31	0.40 Ac	$305,000
D-19	0.28 Ac	$210,000
D-20	0.18 Ac	$140,000
D-31	0.13 Ac	$105,000
E-10	0.82 Ac	$625,000
F-11	1.10 Ac	$770,000
F-18	0.28 Ac	$210,000
	6.70 Ac	$5,035,000

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FIGURE 28 (2 of 5)
SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
CONVERT EXISTING PARKING AREAS
TO PERVIOUS PAVEMENT
AREA C
CITY OF DEL RIO, TEXAS

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LEGEND

PROJECT LOCATION

ECO-FRIENDLY PARKING (REHAB EXISTING)

CONVERT EXISTING PARKING AREAS TO PERVIOUS PAVEMENT:

PROJECT No.	AREA	ESTIMATED COST
B-40	0.82 Ac	$625,000
B-44	1.61 Ac	$1,220,000
B-72	0.51 Ac	$385,000
C-29	0.57 Ac	$440,000
C-31	0.40 Ac	$305,000
D-19	0.28 Ac	$210,000
D-20	0.18 Ac	$140,000
D-31	0.13 Ac	$105,000
E-10	0.82 Ac	$625,000
F-11	1.10 Ac	$770,000
F-18	0.28 Ac	$210,000
	6.70 Ac	$5,035,000

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FIGURE 28 (3 of 5)
SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
CONVERT EXISTING PARKING AREAS
TO PERVIOUS PAVEMENT
AREA D
CITY OF DEL RIO, TEXAS

Drawn By: RPS	Appr. By: DBF	Scale: AS SHOWN	Dwg. NO.: 8267A16	Sheet
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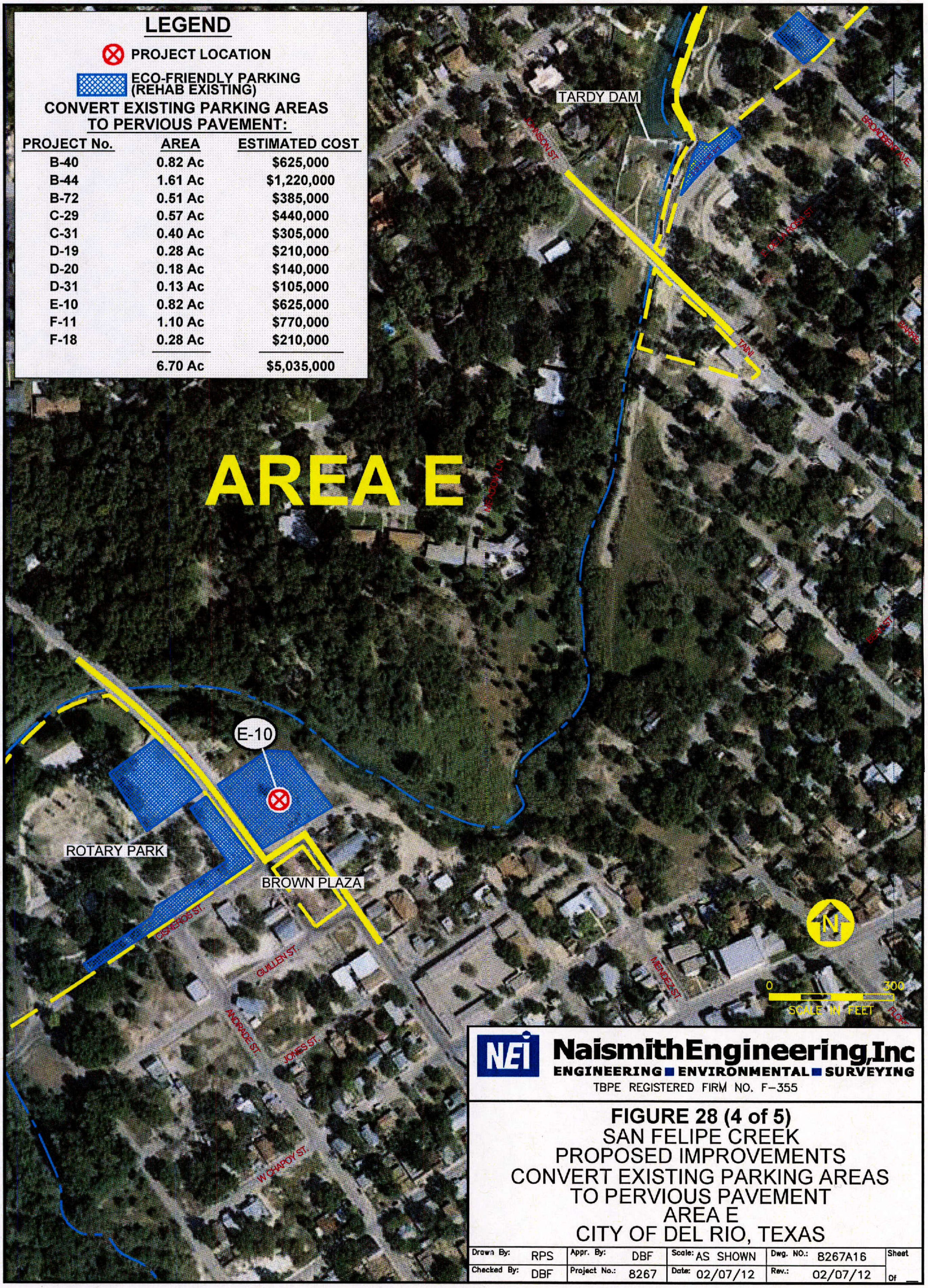

LEGEND

PROJECT LOCATION

ECO-FRIENDLY PARKING (REHAB EXISTING)

CONVERT EXISTING PARKING AREAS TO PERVIOUS PAVEMENT:

PROJECT No.	AREA	ESTIMATED COST
B-40	0.82 Ac	$625,000
B-44	1.61 Ac	$1,220,000
B-72	0.51 Ac	$385,000
C-29	0.57 Ac	$440,000
C-31	0.40 Ac	$305,000
D-19	0.28 Ac	$210,000
D-20	0.18 Ac	$140,000
D-31	0.13 Ac	$105,000
E-10	0.82 Ac	$625,000
F-11	1.10 Ac	$770,000
F-18	0.28 Ac	$210,000
	6.70 Ac	$5,035,000

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FIGURE 28 (4 of 5)
SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
CONVERT EXISTING PARKING AREAS
TO PERVIOUS PAVEMENT
AREA E
CITY OF DEL RIO, TEXAS

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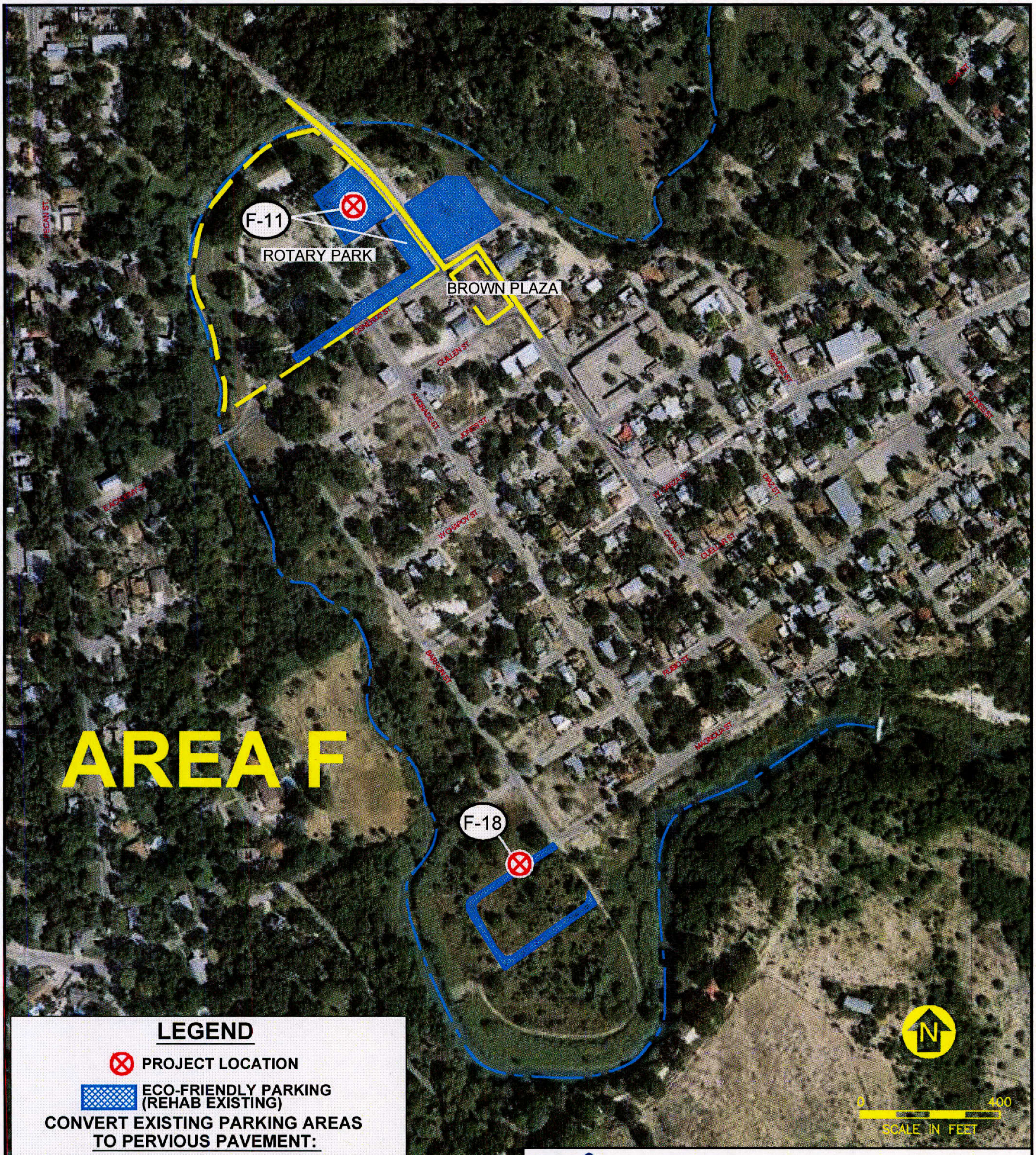

LEGEND

⊗ PROJECT LOCATION

ECO-FRIENDLY PARKING (REHAB EXISTING)

CONVERT EXISTING PARKING AREAS TO PERVIOUS PAVEMENT:

PROJECT No.	AREA	ESTIMATED COST
B-40	0.82 Ac	$625,000
B-44	1.61 Ac	$1,220,000
B-72	0.51 Ac	$385,000
C-29	0.57 Ac	$440,000
C-31	0.40 Ac	$305,000
D-19	0.28 Ac	$210,000
D-20	0.18 Ac	$140,000
D-31	0.13 Ac	$105,000
E-10	0.82 Ac	$625,000
F-11	1.10 Ac	$770,000
F-18	0.28 Ac	$210,000
	6.70 Ac	$5,035,000

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FIGURE 28 (5 of 5)
SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
CONVERT EXISTING PARKING AREAS
TO PERVIOUS PAVEMENT
AREA F
CITY OF DEL RIO, TEXAS

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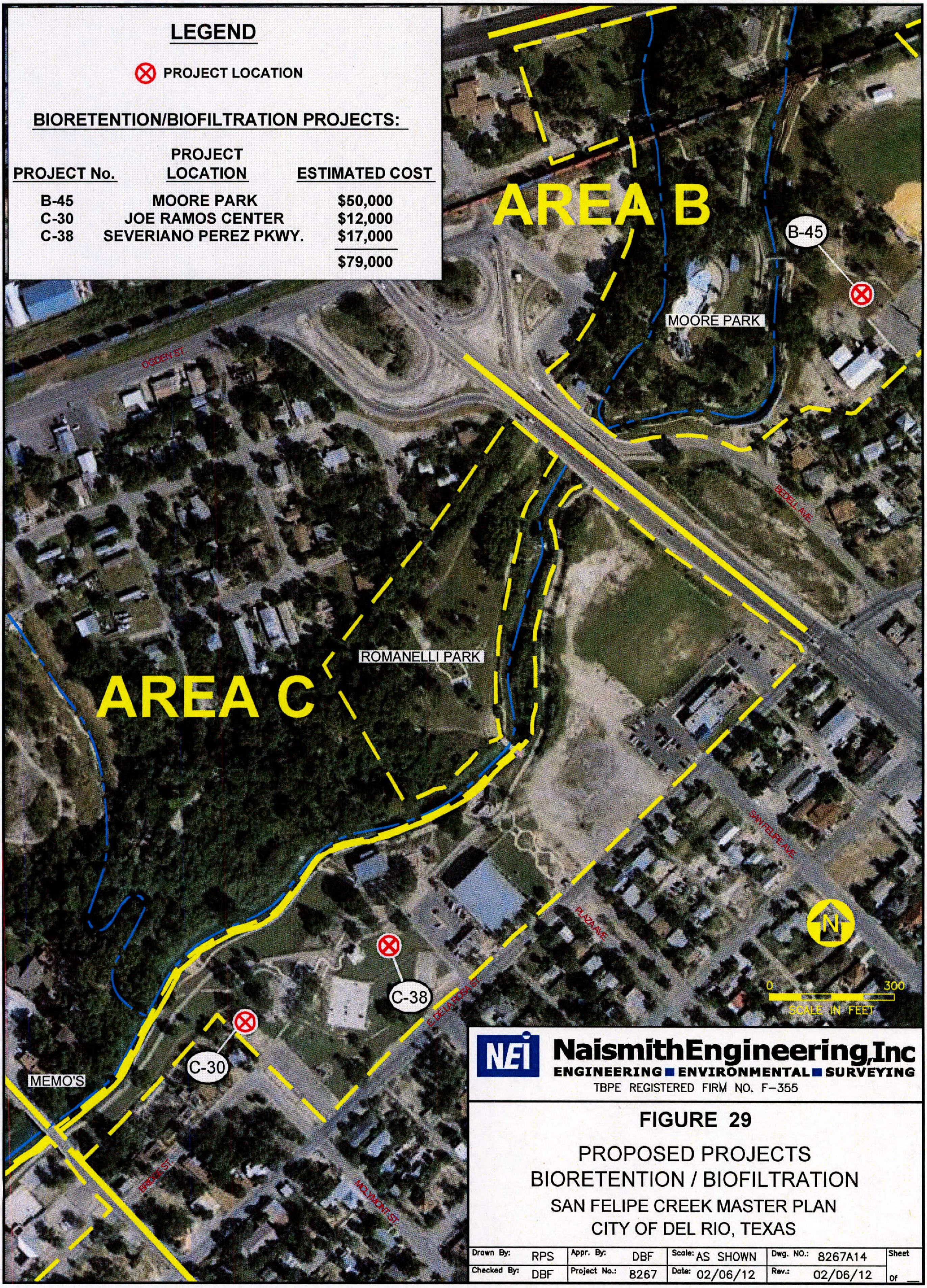

LEGEND

⊗ PROJECT LOCATION

BIORETENTION/BIOFILTRATION PROJECTS:

PROJECT No.	PROJECT LOCATION	ESTIMATED COST
B-45	MOORE PARK	$50,000
C-30	JOE RAMOS CENTER	$12,000
C-38	SEVERIANO PEREZ PKWY.	$17,000
		$79,000

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FIGURE 29

PROPOSED PROJECTS
BIORETENTION / BIOFILTRATION
SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

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Checked By:	DBF	Project No.:	8267	Date:	02/06/12	Rev.:	02/06/12	of

LEGEND

⊗ PROJECT LOCATION

HYDRODYNAMIC SEPARATOR PROJECTS:

PROJECT No.	PROJECT LOCATION	ESTIMATED COST
B-57	MOORE PARK	$57,000
D-28	TARDY DAM	$43,000
		$100,000

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FIGURE 30
SAN FELIPE CREEK
HYDRODYNAMIC SEPARATOR PROJECTS
PROPOSED IMPROVEMENTS
CITY OF DEL RIO, TEXAS

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Checked By: DBF	Project No.: 8267	Date: 02/07/12	Rev.: 02/07/12	Of

LEGEND

⊗ PUBLIC EDUCATION KIOSKS & SIGNS

PUBLIC EDUCATION KIOSKS & SIGNS:

PROJECT No.	No. of KIOSKS	PROJECT COST
B-59	1	$7,000
B-75	2	$17,000
C-40	2	$17,000
D-33	1	$10,000
E-15	1	$10,000
F-23	2	$17,000
	9	$78,000

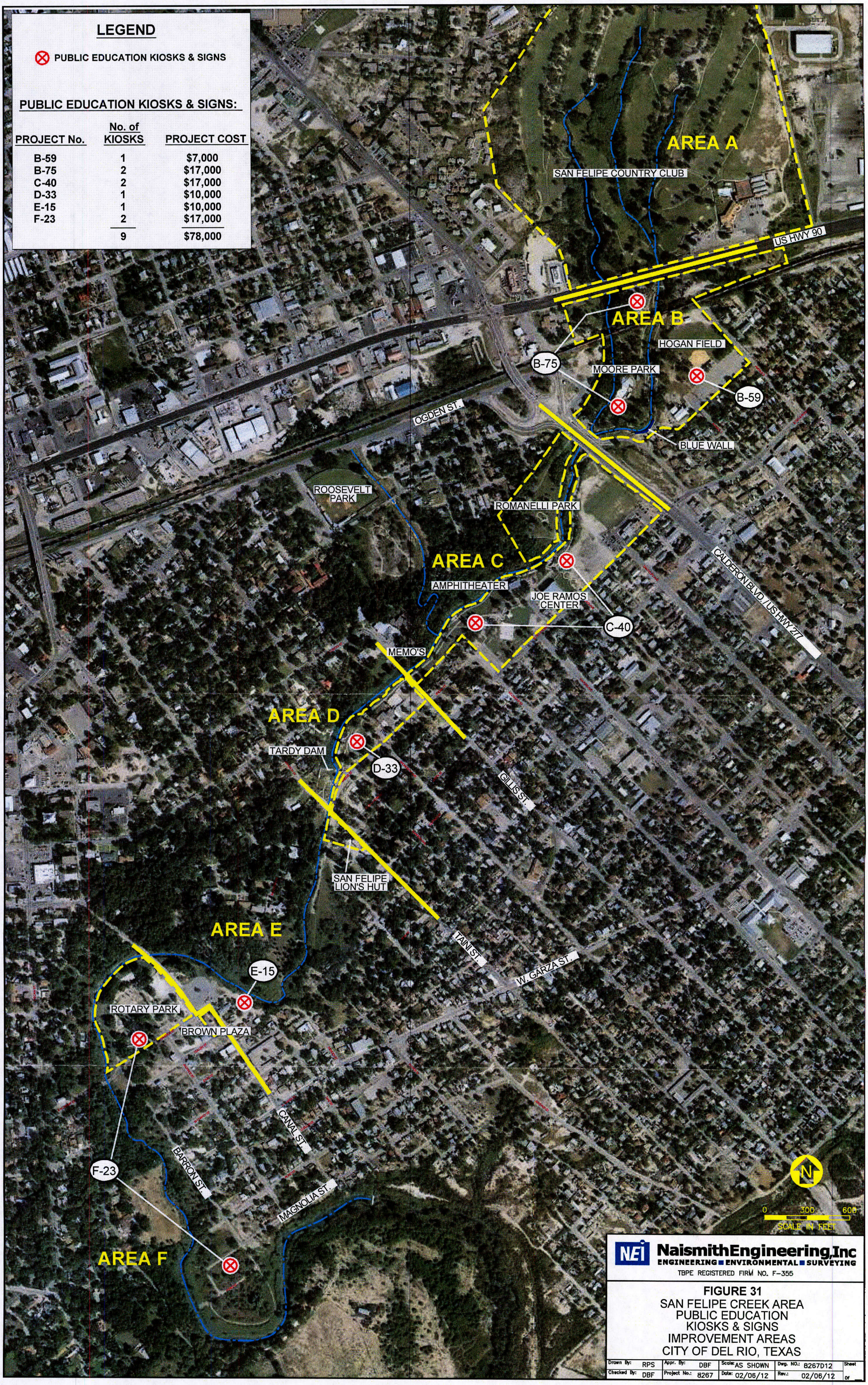

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FIGURE 31
SAN FELIPE CREEK AREA
PUBLIC EDUCATION
KIOSKS & SIGNS
IMPROVEMENT AREAS
CITY OF DEL RIO, TEXAS

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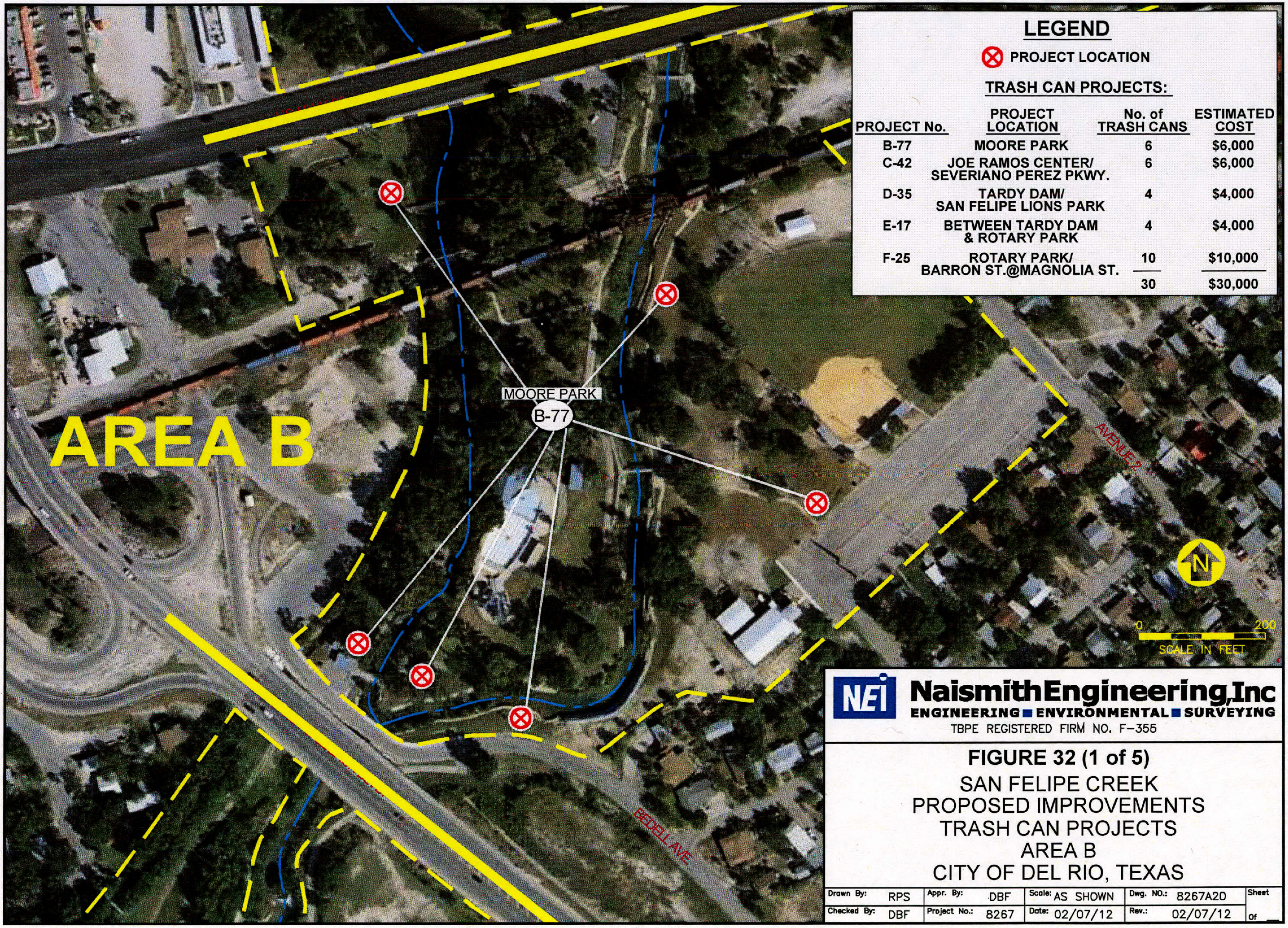

LEGEND

⊗ PROJECT LOCATION

TRASH CAN PROJECTS:

PROJECT No.	PROJECT LOCATION	No. of TRASH CANS	ESTIMATED COST
B-77	MOORE PARK	6	$6,000
C-42	JOE RAMOS CENTER/ SEVERIANO PEREZ PKWY.	6	$6,000
D-35	TARDY DAM/ SAN FELIPE LIONS PARK	4	$4,000
E-17	BETWEEN TARDY DAM & ROTARY PARK	4	$4,000
F-25	ROTARY PARK/ BARRON ST.@MAGNOLIA ST.	10	$10,000
		30	$30,000

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FIGURE 32 (1 of 5)

SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
TRASH CAN PROJECTS
AREA B
CITY OF DEL RIO, TEXAS

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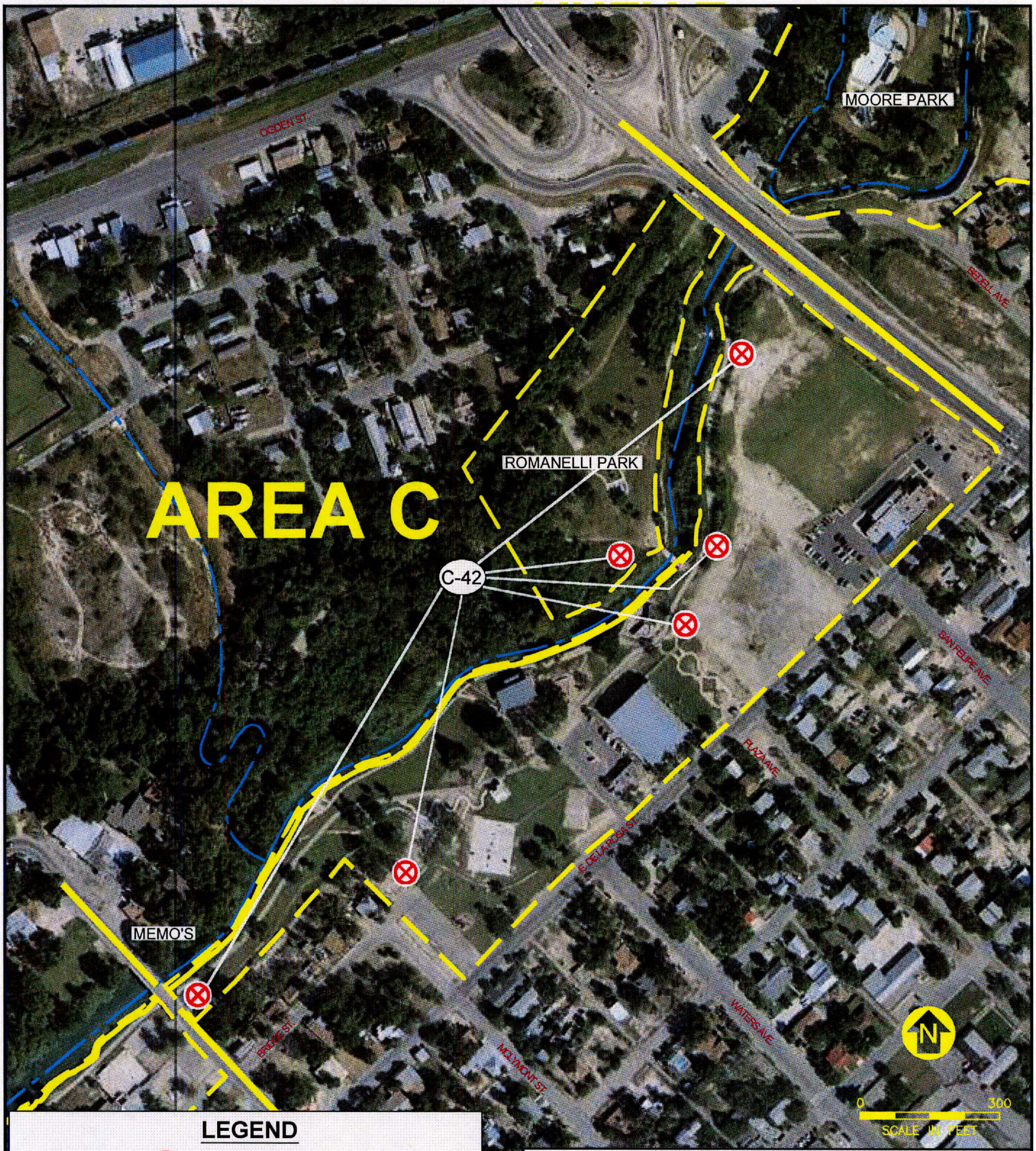
Checked By: DBF	Project No.: 8267	Date: 02/07/12	Rev.: 02/07/12	Of ___



LEGEND

⊗ PROJECT LOCATION

TRASH CAN PROJECTS:

PROJECT No.	PROJECT LOCATION	No. of TRASH CANS	ESTIMATED COST
B-77	MOORE PARK	6	$6,000
C-42	JOE RAMOS CENTER/ SEVERIANO PEREZ PKWY.	6	$6,000
D-35	TARDY DAM/ SAN FELIPE LIONS PARK	4	$4,000
E-17	BETWEEN TARDY DAM & ROTARY PARK	4	$4,000
F-25	ROTARY PARK/ BARRON ST.@MAGNOLIA ST.	10	$10,000
		30	$30,000

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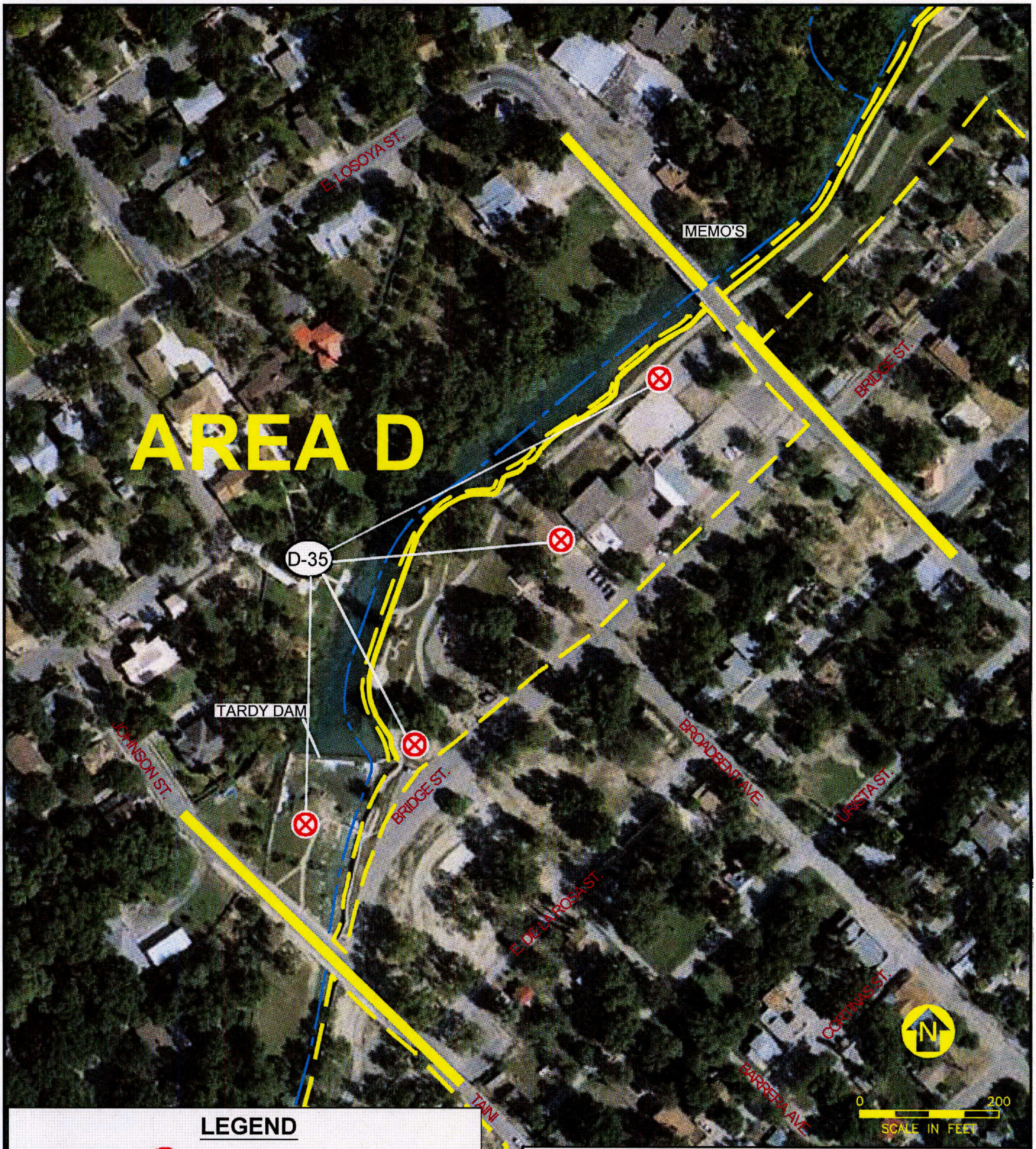
FIGURE 32 (2 of 5)
SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
TRASH CAN PROJECTS
AREA C
CITY OF DEL RIO, TEXAS

Drawn By: RPS	Appr. By: DBF	Scale: AS SHOWN	Dwg. NO.: 8267A20	Sheet
Checked By: DBF	Project No.: 8267	Date: 02/07/12	Rev.: 02/07/12	Of



LEGEND

⊗ PROJECT LOCATION

TRASH CAN PROJECTS:

PROJECT No.	PROJECT LOCATION	No. of TRASH CANS	ESTIMATED COST
B-77	MOORE PARK	6	$6,000
C-42	JOE RAMOS CENTER/ SEVERIANO PEREZ PKWY.	6	$6,000
D-35	TARDY DAM/ SAN FELIPE LIONS PARK	4	$4,000
E-17	BETWEEN TARDY DAM & ROTARY PARK	4	$4,000
F-25	ROTARY PARK/ BARRON ST.@MAGNOLIA ST.	10	$10,000
		30	$30,000

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FIGURE 32 (3 of 5)
SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
TRASH CAN PROJECTS
AREA D
CITY OF DEL RIO, TEXAS

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Checked By: DBF	Project No.: 8267	Date: 02/07/12	Rev.: 02/07/12	Of

LEGEND

⊗ PROJECT LOCATION

TRASH CAN PROJECTS:

PROJECT No.	PROJECT LOCATION	No. of TRASH CANS	ESTIMATED COST
B-77	MOORE PARK	6	$6,000
C-42	JOE RAMOS CENTER/ SEVERIANO PEREZ PKWY.	6	$6,000
D-35	TARDY DAM/ SAN FELIPE LIONS PARK	4	$4,000
E-17	BETWEEN TARDY DAM & ROTARY PARK	4	$4,000
F-25	ROTARY PARK/ BARRON ST.@MAGNOLIA ST.	10	$10,000
		30	$30,000

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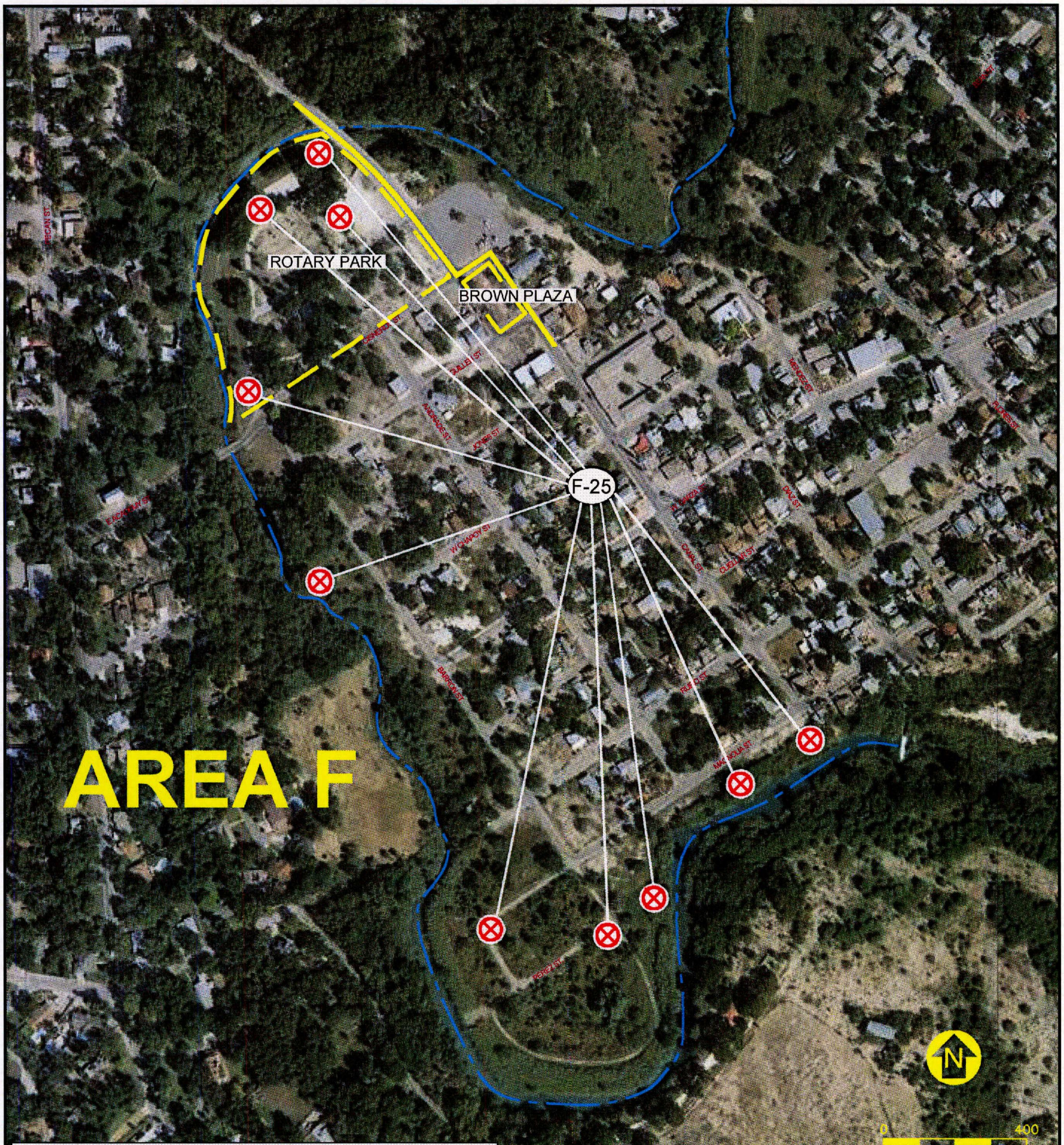
FIGURE 32 (4 of 5)
SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
TRASH CAN PROJECTS
AREA E
CITY OF DEL RIO, TEXAS

Drawn By: RPS	Appr. By: DBF	Scale: AS SHOWN	Dwg. No.: 8267A20	Sheet
Checked By: DBF	Project No.: 8267	Date: 02/07/12	Rev.: 02/07/12	Of



LEGEND

⊗ PROJECT LOCATION

TRASH CAN PROJECTS:

PROJECT No.	PROJECT LOCATION	No. of TRASH CANS	ESTIMATED COST
B-77	MOORE PARK	6	$6,000
C-42	JOE RAMOS CENTER/ SEVERIANO PEREZ PKWY.	6	$6,000
D-35	TARDY DAM/ SAN FELIPE LIONS PARK	4	$4,000
E-17	BETWEEN TARDY DAM & ROTARY PARK	4	$4,000
F-25	ROTARY PARK/ BARRON ST.@MAGNOLIA ST.	10	$10,000
		30	$30,000

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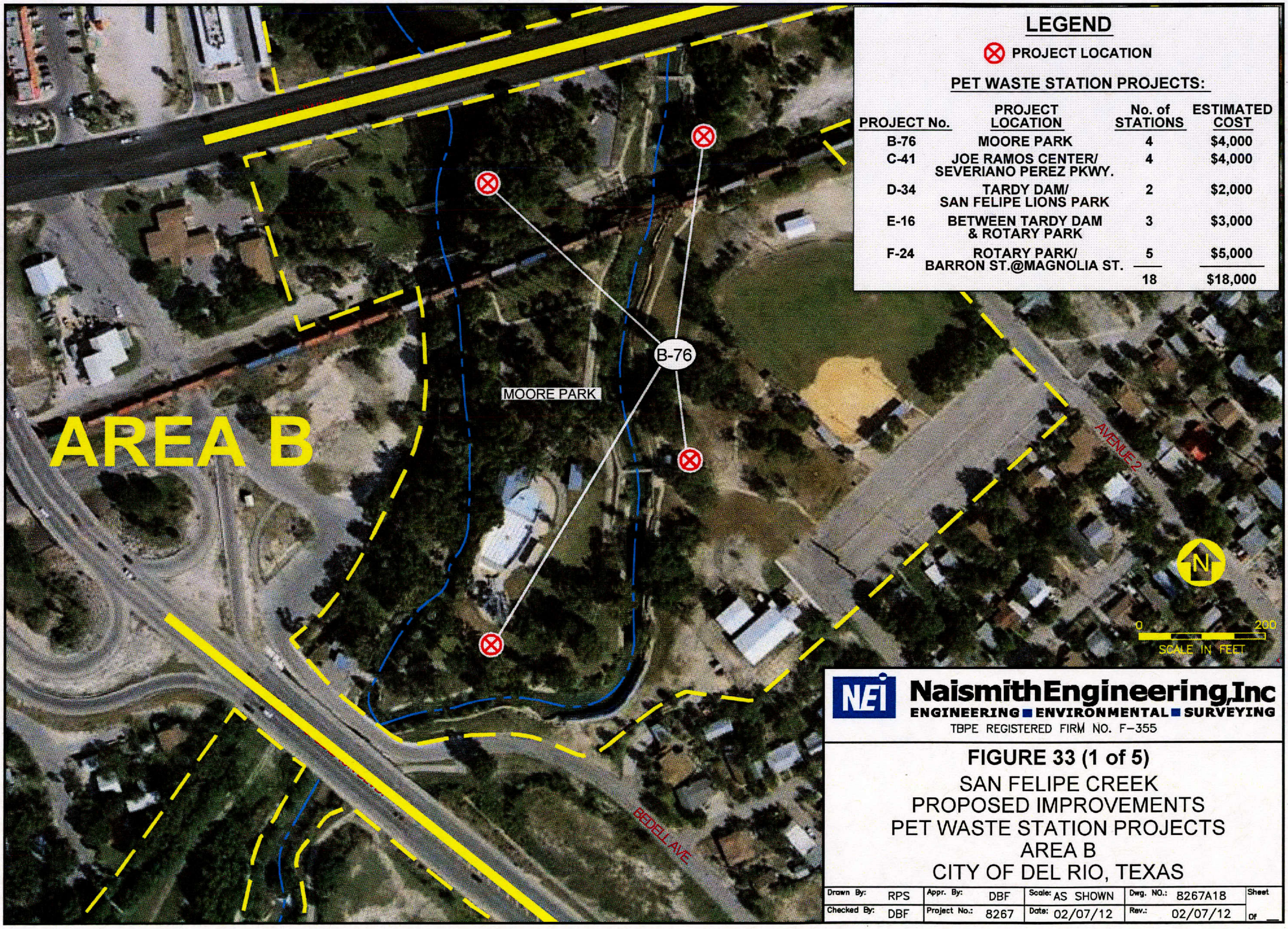
FIGURE 32 (5 of 5)
SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
TRASH CAN PROJECTS
AREA F
CITY OF DEL RIO, TEXAS

Drawn By: RPS	Appr. By: DBF	Scale: AS SHOWN	Dwg. NO.: B267A20	Sheet
Checked By: DBF	Project No.: 8267	Date: 02/07/12	Rev.: 02/07/12	Of



LEGEND

⊗ PROJECT LOCATION

PET WASTE STATION PROJECTS:

PROJECT No.	PROJECT LOCATION	No. of STATIONS	ESTIMATED COST
B-76	MOORE PARK	4	$4,000
C-41	JOE RAMOS CENTER/ SEVERIANO PEREZ PKWY.	4	$4,000
D-34	TARDY DAM/ SAN FELIPE LIONS PARK	2	$2,000
E-16	BETWEEN TARDY DAM & ROTARY PARK	3	$3,000
F-24	ROTARY PARK/ BARRON ST.@MAGNOLIA ST.	5	$5,000
		18	$18,000

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FIGURE 33 (1 of 5)
SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
PET WASTE STATION PROJECTS
AREA B
CITY OF DEL RIO, TEXAS

Drawn By: RPS	Appr. By: DBF	Scale: AS SHOWN	Dwg. NO.: 8267A18	Sheet
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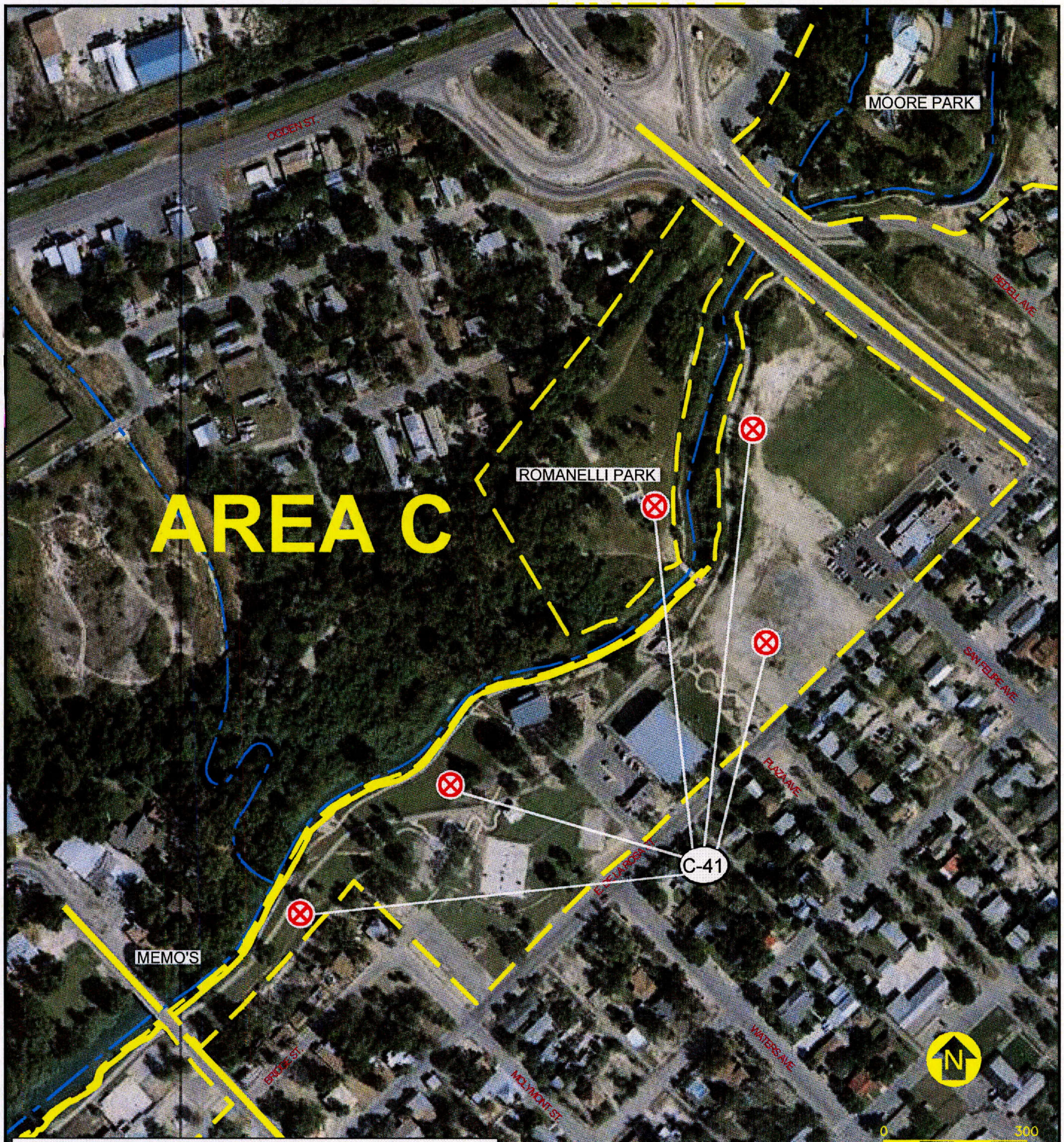

LEGEND

⊗ PROJECT LOCATION

PET WASTE STATION PROJECTS:

PROJECT No.	PROJECT LOCATION	No. of STATIONS	ESTIMATED COST
B-76	MOORE PARK	4	$4,000
C-41	JOE RAMOS CENTER/ SEVERIANO PEREZ PKWY.	4	$4,000
D-34	TARDY DAM/ SAN FELIPE LIONS PARK	2	$2,000
E-16	BETWEEN TARDY DAM & ROTARY PARK	3	$3,000
F-24	ROTARY PARK/ BARRON ST.@MAGNOLIA ST.	5	$5,000
		18	$18,000

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FIGURE 33 (2 of 5)
SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
PET WASTE STATION PROJECTS
AREA C
CITY OF DEL RIO, TEXAS

Drawn By: RPS	Appr. By: DBF	Scale: AS SHOWN	Dwg. NO.: 8267A18	Sheet
Checked By: DBF	Project No.: 8267	Date: 02/07/12	Rev.: 02/07/12	Of

LEGEND

⊗ PROJECT LOCATION

PET WASTE STATION PROJECTS:

PROJECT No.	PROJECT LOCATION	No. of STATIONS	ESTIMATED COST
B-76	MOORE PARK	4	$4,000
C-41	JOE RAMOS CENTER/ SEVERIANO PEREZ PKWY.	4	$4,000
D-34	TARDY DAM/ SAN FELIPE LIONS PARK	2	$2,000
E-16	BETWEEN TARDY DAM & ROTARY PARK	3	$3,000
F-24	ROTARY PARK/ BARRON ST.@MAGNOLIA ST.	5	$5,000
		18	$18,000

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FIGURE 33 (3 of 5)
SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
PET WASTE STATION PROJECTS
AREA D
CITY OF DEL RIO, TEXAS

Drawn By: RPS	Appr. By: DBF	Scale: AS SHOWN	Dwg. NO.: 8267A18	Sheet
Checked By: DBF	Project No.: 8267	Date: 02/07/12	Rev.: 02/07/12	Of

LEGEND

⊗ PROJECT LOCATION

PET WASTE STATION PROJECTS:

PROJECT No.	PROJECT LOCATION	No. of STATIONS	ESTIMATED COST
B-76	MOORE PARK	4	$4,000
C-41	JOE RAMOS CENTER/ SEVERIANO PEREZ PKWY.	4	$4,000
D-34	TARDY DAM/ SAN FELIPE LIONS PARK	2	$2,000
E-16	BETWEEN TARDY DAM & ROTARY PARK	3	$3,000
F-24	ROTARY PARK/ BARRON ST.@MAGNOLIA ST.	5	$5,000
		18	$18,000

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FIGURE 33 (4 of 5)
SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
PET WASTE STATION PROJECTS
AREA E
CITY OF DEL RIO, TEXAS

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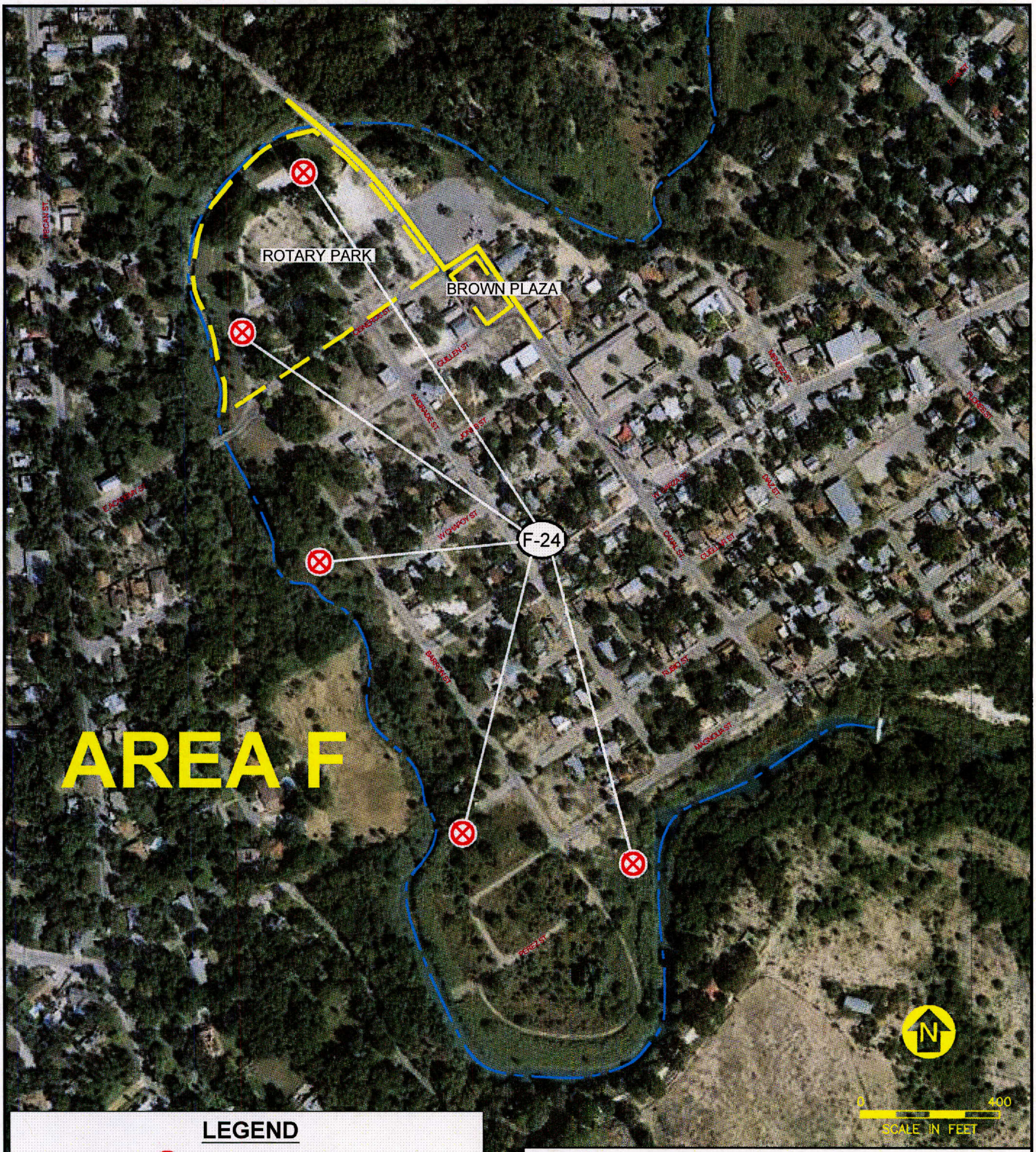

LEGEND

⊗ PROJECT LOCATION

PET WASTE STATION PROJECTS:

PROJECT No.	PROJECT LOCATION	No. of STATIONS	ESTIMATED COST
B-76	MOORE PARK	4	$4,000
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		18	$18,000

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FIGURE 33 (5 of 5)
SAN FELIPE CREEK
PROPOSED IMPROVEMENTS
PET WASTE STATION PROJECTS
AREA F
CITY OF DEL RIO, TEXAS

Drawn By: RPS	Appr. By: DBF	Scale: AS SHOWN	Dwg. NO.: B267A18	Sheet
Checked By: DBF	Project No.: 8267	Date: 02/07/12	Rev.: 02/07/12	Of

LEGEND
RESTROOM PROJECT LOCATION
RESTROOM PROJECTS:
PROJECT No. TYPE ESTIMATED COST
B-58 NEW $85,000
C-27 REHAB. $43,000
D-21 REHAB. $43,000
F-14 NEW $85,000
F-26 NEW $85,000
$341,000
AREA A
SAN FELIPE COUNTRY CLUB
US HWY 90
AREA B
HOGAN FIELD
MOORE PARK
B-58
BLUE WALL
OGDEN ST.
ROOSEVELT PARK
ROMANELLI PARK
AREA C
AMPHITHEATER
JOE RAMOS CENTER
C-27
CALDERON BLVD / US HWY 277
MEMO'S
AREA D
TARDY DAM
D-21
GILLIS ST.
SAN FELIPE LION'S HUT
AREA E
TAMI ST.
W. GARZA ST.
ROTARY PARK
F-26
BROWN PLAZA
CANAL ST.
BARRON ST.
MAGNOLIA ST.
F-14
AREA F
0 300 600
SCALE IN FEET
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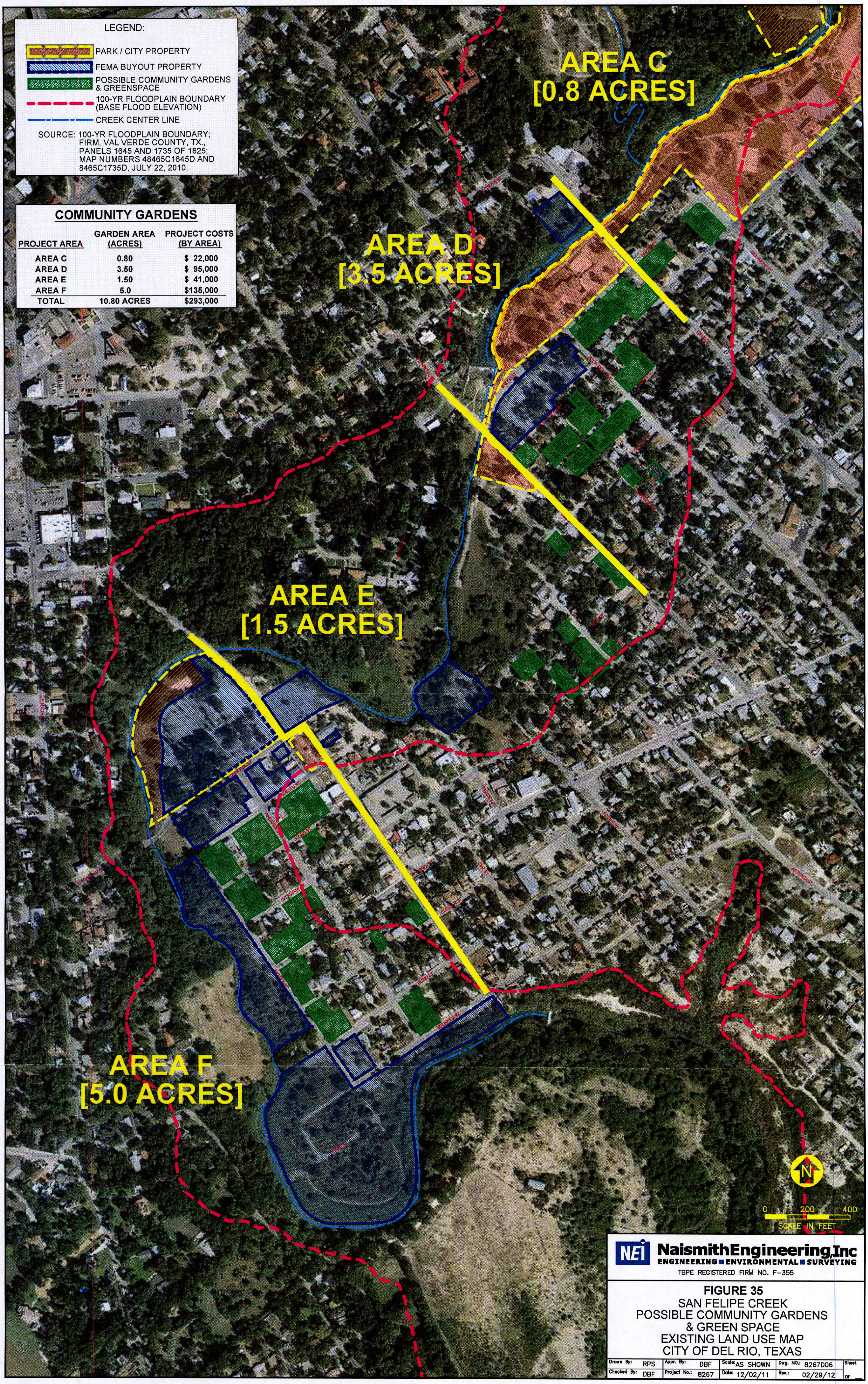
FIGURE 34
SAN FELIPE CREEK AREA
RESTROOM PROJECTS
IMPROVEMENT AREAS
CITY OF DEL RIO, TEXAS
Drawn By: RPS Appr. By: DBF Scale: AS SHOWN Dwg. NO.: 8267D13
Checked By: DBF Project No.: 8267 Date: 02/06/12 Rev.: 02/06/12



COMMUNITY GARDENS

PROJECT AREA	GARDEN AREA (ACRES)	PROJECT COSTS (BY AREA)
AREA C	0.80	$ 22,000
AREA D	3.50	$ 95,000
AREA E	1.50	$ 41,000
AREA F	5.0	$135,000
TOTAL	10.80 ACRES	$293,000

FIGURE 35
SAN FELIPE CREEK
POSSIBLE COMMUNITY GARDENS
& GREEN SPACE
EXISTING LAND USE MAP
CITY OF DEL RIO, TEXAS

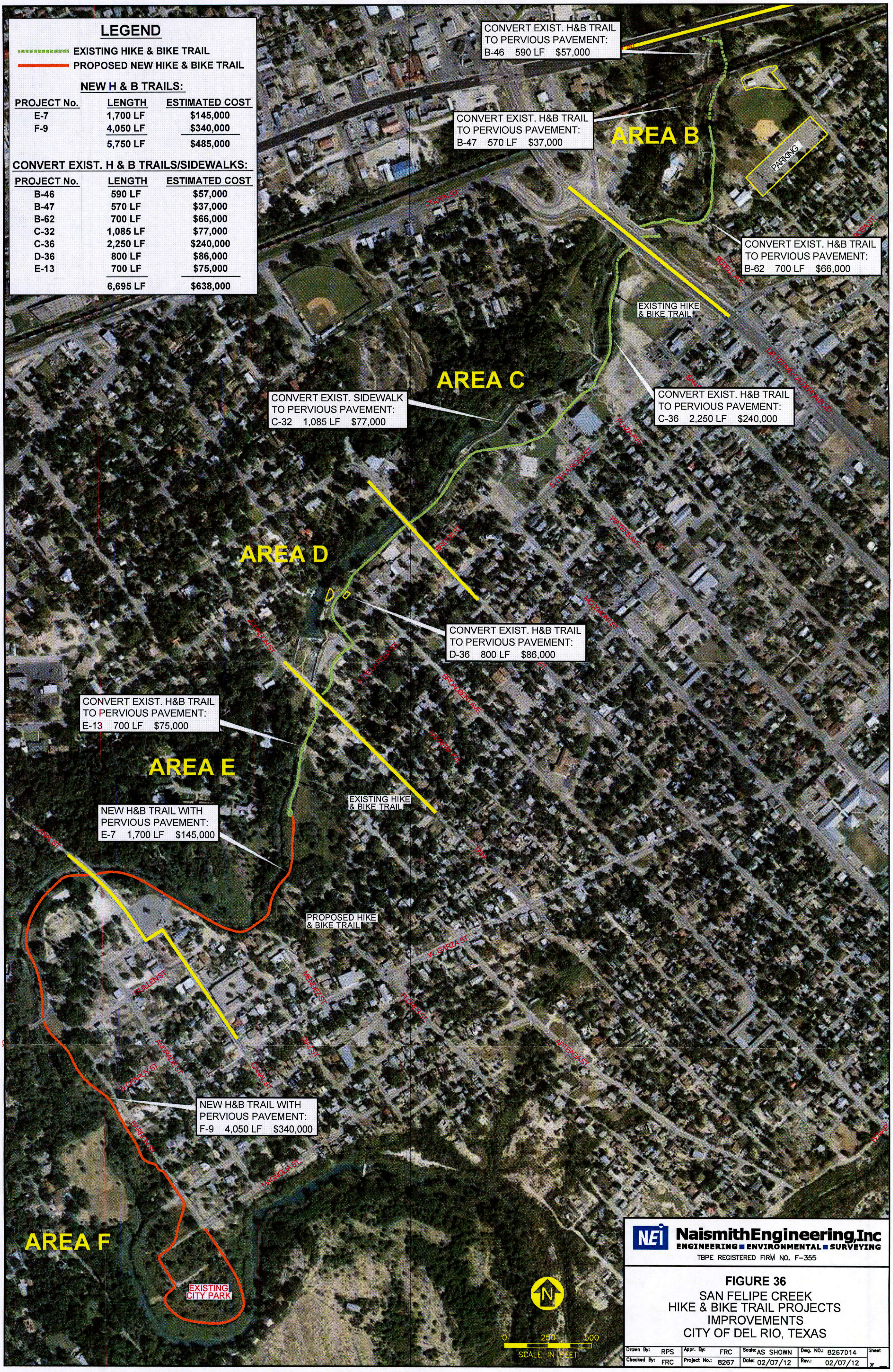
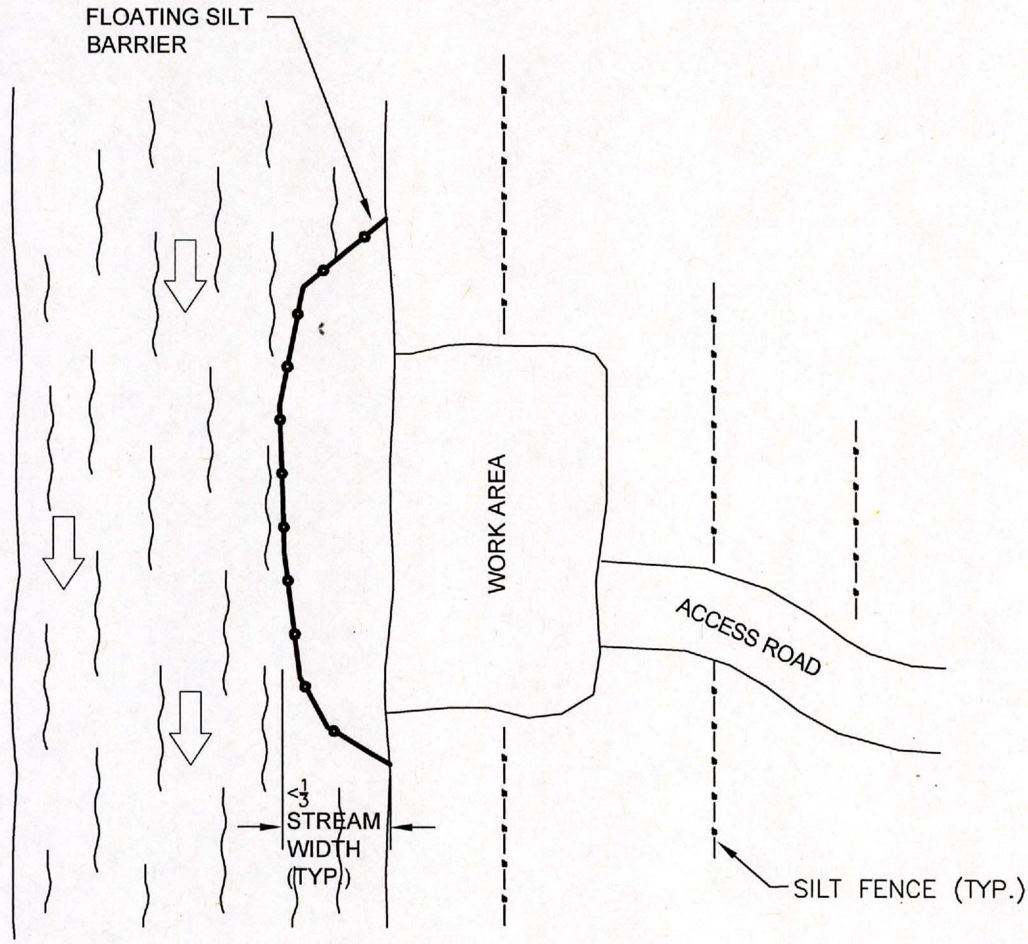
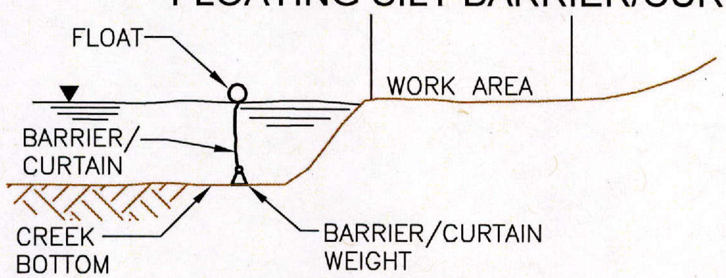


FIGURE 36
SAN FELIPE CREEK
HIKE & BIKE TRAIL PROJECTS
IMPROVEMENTS
CITY OF DEL RIO, TEXAS



PLAN VIEW
FLOATING SILT BARRIER/CURTAIN



CROSS-SECTION VIEW

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FIGURE 37
FLOATING SILT BARRIER/CURTAIN
SAN FELIPE CREEK MASTER PLAN
CITY OF DEL RIO, TEXAS

Drawn By:	JBS	Appr. By:	DBF	Scale:	N.T.S.	Dwg. NO.:	A06	Sheet
Checked By:	DBF	Project No.:	8267	Date:	11/28/11	Rev.:	02/02/12	Of

APPENDIX A

San Felipe Creek
Master Plan

Environmental Documentation

Prepared for:
The City of Del Rio

December 2011

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APPENDIX B- PHOTO LOG

APPENDIX C- USFWS MEETING AGENDAS

I. INTRODUCTION

Flowing for a total of nine miles San Felipe Creek passes through the center of the City of Del Rio and ultimately discharges an average of 50 to 90 million gallons of water per day, which is approximately 56,000 to 100,000 acre feet per year, directly into the Rio Grande. With much of the creek's drainage basin lying within an urbanized area, the creek and its ecosystem are vulnerable to activities typical of such an area and can have a significant impact on the species residing in the creek and the water supply of the Rio Grande downstream of Del Rio. The creek has been a focus of local planning efforts, which have included the development of ecological studies and flood analyses by local, State and federal agencies.

The proposed planning project would help to consolidate recommendations from previous plans and studies, as well as provide for the development of new water quality strategies, into one organized document to be known as the "San Felipe Creek Master Plan." This regional water quality plan would allow for the inclusion of the most up to date input from State and federal agencies, incorporation of the most appropriate water quality, habitat preservation, and habitat restoration best management practices (BMPs), and the identification of any new or recent State or federal regulations that may impact the proposed project area. The intent of this planning effort is to produce a document that will allow the City of Del Rio to effectively management the San Felipe Creek area in a way that improves water quality while allowing access by the citizens of Del Rio and the surrounding areas. This portion of the San Felipe Creek Master Plan includes the environmental documentation.

This environmental report was completed using 2011 City of Del Rio aerial photography (**Figure 1**), U.S. Geological Survey (USGS) 7.5' quadrangle maps (**Figure 2**), National Wetland Inventory (NWI) maps (**Figure 3**), Federal Emergency Management Agency (FEMA) maps (**Figure 4**), National Resources Conservation Service (NRCS) soil survey maps (**Figure 5**), the Texas Parks and Wildlife Department's (TPWD) National Diversity Database (NDD), the United States Fish and Wildlife Service (USFWS) Critical Habitat Mapper, National Hydrography Dataset (NHD) maps, and the Texas Historical Commission's (THC) Texas Historical Sites Atlas. The figures are located in **Appendix A**. A desktop review was completed before field work began. Field work, within the limits of the project area, was completed on July 6 and 7, 2011. Photos of the project area are located in **Appendix B**.

II. VEGETATION AND ECOLOGY

According to TPWD's *Vegetation Types of Texas* (TPWD, 1984), the project area lies within the Ceniza-Blackbrush-Creosotebush Brush vegetation cover. This area is distributed throughout the slopes of the Rio Grande River Basin from near Langtry in Val Verde County to near San Ygnacio in Zapata County. Some commonly associated plants include the Texas pricklypear, goatbush, yucca, curly mesquite, pink pappusgrass, and catclaw.

According to TPWD, the project area is also within the Texas-Tamaulipan Thornscrub (Level IV) ecoregion. This land is made up of gently rolling plains that are covered in low-growing vegetation and arroyos and streams. The increase of brush and decrease in grasses is due to three centuries of grazing, suppression of fire, and drought. Peak rainfall occurs in the spring and fall and droughts are common and quite often severe. There is little cultivated land and most of the land is used to raise beef cattle.

Field work was performed by CP&Y biologists in July 2011. During that time, various species of vegetation within the project area were identified and are listed in **Table 1**.

Table 1. Vegetation Observed Within the Project Area

Common Name	Scientific Name
Trees	
American sycamore	*Platanus occidentalis*
Anacua	*Ehretia anacua*
Bald cypress	*Taxodium distichum*
Black willow	*Salix nigra*
Chinaberry	*Melia azedarach*
Chinese tallow	*Sapium sebiferum*
Eastern cottonwood	*Populus deltoids*
Hickory	*Carya* sp.
Honey mesquite	*Prosopis glandulosa*
Huisache	*Acacia farnesiana*
Little walnut	*Juglans microcarpa*
Loquat	*Eriobotrya japonica*
Mulberry	*Morus* sp.
Netleaf hackberry	*Celtis reticulate*
Palm	Arecaceae family
Pecan	*Carya illinoiensis*
Plateau live oak	*Quercus fusiformis*
Retama	*Parkinsonia aculeate*
Saltcedar	*Tamarix* sp.
Sugarberry	*Celtis laevigata*
Texas ash	*Fraxinus texensis*
Waxleaf ligustrum	*Ligustrum lucidum*
Shrubs	
Roemer acacia	*Acacia roemeriana*
Seepwillow baccharis	*Baccharis salicipholia*
Spiny hackberry	*Celtis ehrenbergiana*
Texas snakewood	*Colubrina texensis*
Grasses	
Bermudagrass	*Cynodon dactylon*
Bushy bluestem	*Andropogon glomeratus*
Dallisgrass	*Paspalum dilatatum*
Eastern gamagrass	*Tripsacum dactyloides*
Giant reed	*Arundo donax*
Johnson grass	*Sorghum halpense*
King Ranch bluestem	*Bothriocholoa ischaemum*
Plains bristlegrass	*Setaria vulpiseta*
Silver bluestem	*Bothriochloa saccharoides*
Forbs, Annuals & Perennials	
American water-willow	*Justicia americana*

Common Name	Scientific Name
Bamboo	*Phyllostachys aurea*
Buffalo gourd	*Cucurbita foetidissima*
Coontail	*Ceratophyllum demersum*
Elephant ears	*Colocasia* sp.
Giant ragweed	*Ambrosia trifida*
Goldenrod	*Solidago* sp.
River primrose	*Oenothera jamesii*
Silverleaf nightshade	*Solanum elaeagnifolium*
Texas lantana	*Lantana utricoides*
Texas prickly pear	*Opuntia engelmannii*
Water lily	*Nymphaea odorata*
Western ragweed	*Ambrosia psilostachya*
White sagebrush	*Artemisia ludoviciana*
Vines	
Carolina snailseed	*Cocculus diversifolius*
Dewberry	*Rubus trivialis*
Japanese honeysuckle	*Lonicera japonica*
Mustang grape	*Vitis mustangensis*
Old man's beard	*Clematis drummond*
Poison oak	*Toxicodendron diversilobum*
Sawleaf greenbriar	*Smilax bona-nox*
Trumpet vine	*Campsis radicans*
Virginia creeper	*Parthenocissus quinquefolia*

Source: CP&Y, July 2011.

Common native species identified within the project area include pecan, netleaf hackberry, sugarberry, sycamore, willow, retama, cottonwood, mesquite, huisache, greenbriar, and dewberry. Non-native species within the project area include elephant ears and chinaberry. Invasive species within the project area include Chinese tallow, Japanese honeysuckle, fragrant water lily, saltcedar, and giant reed. As stated in the San Felipe Creek Vision Plan, natural vegetation needs encouragement by removing non-native vegetation, only native plants should be planted, and riparian habitat is very important along the creek (San Felipe Creek Commissioners, 2007).

Giant reed was introduced to the region from Southwestern Europe (Spain) in the 1600s to feed cattle and goats. It also provided thatching materials for roofs. However, this species demands a large amount of water and can grow up to four inches per day, reaching heights of 25 to 30 feet. Giant reed outcompetes native vegetation and it is now illegal to plant or sell it in Texas without a Texas Department of Agriculture permit. Giant reed is now epidemic along the Rio Grande River spreading at a rate of 2.36 percent per year. There are approximately 15,000 acres of giant reed between the cities of Del Rio and San Ignacio in Texas.

Efforts will be made during planning and construction to avoid impacts to native vegetation to the maximum extent possible.

III. WATERS OF THE U.S. AND WETLANDS

The term "Waters of the U.S." includes all waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, ponds, etc; and tributaries of these waters. Wetlands are areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of wetland vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. USGS 7.5-minute topographic maps, NHD information, NWI maps (**Figure 3**), and soil survey maps (**Figure 5**) were used to search for potential waters of the U.S. and wetlands in the project area.

Based on information from these maps, there are two types of NWI-classified wetlands that occur in the project area. Near the northern limits of the project area at US 90 are PUBHh wetlands (palustrine, unconsolidated bottom, permanently flooded, diked/impounded). There is also a PUBHh area on San Felipe Creek north of the dam at Johnson Street. San Felipe Creek is classified by the NWI as R2UBH (riverine, lower perennial unconsolidated bottom, permanently flooded).

The portion of San Felipe Creek in the project area is perennial, according to the USGS topographic map and multiple field visits. NHD data describes the stream segments passing through the project area as a mixture of mostly perennial streams (those that have flowing water year-round during a typical year) and artificial paths, as well as a few intermittent streams (those that contain water only part of the year) and canals/ditches. Field work was conducted in July 2011 to delineate the limits of the ordinary high water mark (OHWM) and to determine if any wetlands are present in the project area. The OHWM width of San Felipe Creek varies from approximately 8 feet to 150 feet in the project area, and the stream segments total roughly 13,560 feet in length. No wetlands were observed. The two NWI mapped wetlands mentioned above were assessed and it was determined that no wetlands existed in this area, only the creek.

San Felipe Creek flows from San Felipe Springs, which is the third largest spring system in Texas. The project area is located within the outcrop of the Edwards-Trinity (Plateau) aquifer. This aquifer extends across much of the southwestern part of Texas. Most of the water pumped from the aquifer is used for irrigation, while the remainder is for municipal use and livestock (TWDB, 1995).

IV. SOIL SURVEY

According to the NRCS, the stream segments within the project area cross two different types of soil. These soils can be seen in **Figure 4** and are described as "CoB," or Coahuila clay loam, 0-3% slopes; and, "Ra," or Reynosa silty clay loam.

Hydric soils are soils that are formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part. The NRCS database identifies four hydric soils in Val Verde County; however, none are located within the project area.

V. FEDERALLY- AND STATE-LISTED THREATENED AND ENDANGERED SPECIES

According to the endangered species list maintained by the USFWS, seven federally-listed endangered, threatened, or candidate species occur within Val Verde County. According to TPWD's Annotated County Lists of Rare Species, there are 29 state-listed endangered or threatened species within Val

Verde County. Refer to **Table 2** for information on the federally and state-listed species within Val Verde County.

TPWD maintains a database of rare, threatened, and endangered species sightings referred to as the NDD. According to the NDD data obtained on May 16, 2011, there are two records of occurrences of federally-listed species in the project area. These records are from 1989 and are for occurrences of the Devils River minnow. Mike Montagne, project leader for the Texas Fish and Wildlife Conservation Office, has also documented occurrences of the Devils River minnow in April of 2011 in San Felipe Creek. Additionally, USFWS has mapped critical habitat for the Devils River minnow within San Felipe Creek in the project area. The critical habitat was designated in 50 CFR Part 17 (Federal Register, 2008) and the location can be seen in **Figure 6**. There have also been occurrences of the Interior Least Tern within seven miles of the project area.

Table 2. Federally- and State-listed Threatened and Endangered Species of Val Verde County

Species	Species Group	Species Information	Federal Status	State Status
American Peregrine Falcon *Falco peregrines anatum*	Birds	This species is state-listed as threatened in Texas, but has been de-listed from the federal list. This species has been known to nest in west Texas and typically in a scrape or depression dug in gravel on a cliff ledge. Rarely, peregrines will nest in a tree cavity or an old stick nest (USFWS, 1999).	-	T
Black bear *Ursus americanus*	Mammals	This species is state-threatened and federally threatened by similarity of appearance. It inhabits desert lowlands and high elevation forests and woodlands and dens in tree hollows, rock piles, cliff overhangs, caves, and under brush piles.	-	T
Black-capped Vireo *Vireo atricapilla*	Birds	This species prefers habitat including rangelands with scattered clumps of shrubs separated by open grassland.	E	E
Blotched gambusia *Gambusia senilis*	Fishes	This species was likely extirpated in the Devils River following the construction of Amistad Reservoir. This fish prefers habitats such as stream channels, edges, springs, outflows, marshes, vegetated quiet pools and backwater.	-	T
Blue sucker *Cycleptus elongates*	Fishes	The blue sucker occupies channels and flowing pools with a moderate current and an exposed bedrock, hard clay, sand, or gravel bottom.	-	T
Common Black-Hawk *Buteogallus anthracinus*	Birds	Common Black-Hawk habitat includes cottonwood-lined rivers and streams, and willow tree groves on the lower Rio Grande floodplain.	-	T
Conchos pupfish *Cyprinodon eximius*	Fishes	The Conchos pupfish distribution ranges from the Rio Conchos in Chihuahua, Mexico to the Devils river in Texas. This species also occurs in Alamito Creek.	-	T
Devils River minnow *Dionda diaboli*	Fishes	The Devils River minnow is found in small spring-fed streams of fast flowing waters over gravel substrates often associated with emergent aquatic vegetation. This species has been found in the San Felipe Creek located in the eastern part of Del Rio.	T	T
False spike mussel *Quadrula mitchelli*	Mollusks	This mussel was thought to be extinct in Texas, but was recently (August 2011) found in the San Saba River.	-	T

Species	Species Group	Species Information	Federal Status	State Status
Gray wolf *Canus lupus*	Mammals	This species has been extirpated from Texas, but is still state-listed as endangered. The species was formerly known to live in the western two-thirds of the state in forests, brush lands, and grasslands, but have been absent since 1970.	-	E
Interior Least Tern *Sterna antillarum*	Birds	Nesting habitat for this species includes bare or sparsely vegetated sand, shell, and gravel beaches, sandbars, islands, and salt flats associated with rivers and reservoirs. This species prefers open habitat and tends to avoid thick vegetation and narrow beaches.	E	E
Mexican fawnsfoot mussel *Truncilla cognate*	Mollusks	This mussel is endemic to the central Rio Grande drainage. Extensive historical and current environmental modifications along the Rio Grande suggest there may be surviving populations (TPWD, 2009).	-	T
Mountain Plover *Charadrius montanus*	Birds	The Mountain Plover is a migratory bird and is native to short-grass prairie and shrub-steppe landscapes. Unlike other plovers, Mountain Plover are not found near water, and will only inhabit areas with bare ground or sparse vegetation (USFWS, 2011).	PT	
Ocelot *Leopardus pardalis*	Mammals	Ocelot habitat includes the dense, thorny scrublands of the Lower Rio Grande Valley and Rio Grande Plains. The ocelot also has potential travel corridors at the Nueces, Leona, and Frio Rivers.	-	E
Pecos River pupfish *Cyprinodon pecosensis*	Fishes	The Pecos River pupfish is known to occur in the Pecos River in Texas and New Mexico. It is nearly extirpated in Texas due to hybridization with the introduced sheepshead minnow (*Cyprinodon variegatus*).	-	T
Proserpine shiner *Cyprinella proserpina*	Fishes	This species lives both in the rocky runs and the pools of creeks and small rivers.	-	T
Reticulate collared lizard *Crotaphytus reticulates*	Reptiles	This species is listed as state-threatened and occupies a variety of habitats, including rock piles, escarpments, and burrows in brushy environments.	-	T
Rio Grande darter *Ethostoma graham*	Fishes	Suitable habitat includes gravel and rubble riffles of creeks and small rivers.	-	T
Rio Grande silvery minnow *Hybognathus amarus*	Fishes	This minnow is presumably extirpated in the state of Texas.	-	E

Species	Species Group	Species Information	Federal Status	State Status
Salina mucket *Potamilus metnecktayi*	Mollusks	The Salina mucket is endemic to the central Rio Grande drainage. It has a very limited distribution in Texas and has undergone dramatic declines.	-	T
San Felipe gambusia *Gambusia clarkhubbsi*	Fishes	The San Felipe gambusia is a spring-adapted mosquito fish that is endemic only to San Felipe Creek in Val Verde County. This species was discovered in 1997 by Gary Garrett, a research biologist for TPWD. The species is not listed on the USFWS threatened and endangered species list; however, a lawsuit was filed with USFWS to get the San Felipe gambusia listed. Since then, the species has had a positive finding in the 90 day review and is now in the 12 month review process.	-	T
Texas horned lizard *Phrynosoma cornutum*	Reptiles	This lizard inhabits open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees. Their diet consists mostly of harvester ants.	-	T
Texas hornshell *Popenaias popei*	Clams	The Texas hornshell is a freshwater mussel found in Val Verde County. This species grows out of crevices on steep limestone bluffs or cliff faces along streams and dry creek beds. They can also grow in the dry gravels of streambeds or on thin soils overlying limestone ledges.	C	T
Texas indigo snake *Drymarchon melanurus erebennus*	Reptiles	The Texas indigo snake can be found in Texas south of the Guadalupe River and Balcones Escarpment in the thornbush-chapparal woodlands of south Texas.	-	T
Texas snowbells *Styrax texama*	Flowering plants	Texas snowbells grow out of crevices on steep limestone bluffs or cliff faces along streams and dry creek beds. It can also grow in the dry gravels of streambeds or in thin soils overlaying limestone ledges.	E	E
Texas tortoise *Gopherus berlandieri*	Reptiles	This species prefers open brush areas with a grass understory and avoids areas with only open grass and/or bare ground.	-	T
Tobusch fishhook cactus *Ancistrocactus tobuschii*	Flowering plants	The Tobusch fishhook cactus grows in very shallow gravelly soil over limestone in shortgrass areas within live oak-juniper shrublands. These plants flower beginning in late January until late March or sometimes early April.	E	E

Species	Species Group	Species Information	Federal Status	State Status
Trans-Pecos black-headed snake *Tantilla cucullata*	Reptiles	This species was previously thought to be two different races of the same species; the Devil's River black-headed snake and the black hooded snake. They are now known as two pattern phases of the same species. Three head patterns occur: all black, black with an uninterrupted white collar, and black with an interrupted white collar. Only found in Western Texas, they prefer rocky canyons but can be found in low, arid, grassland.	-	T
White-nosed coati *Nasua narica*	Mammals	The habitat of the white-nosed coati includes woodlands and riparian corridors and canyons, ranging from the southwestern United States through northern Argentina. Most individuals of this species are probably transients from Mexico.	-	T
Zone-tailed hawk *Buteo albonotatus*	Birds	The Zone-tailed Hawk inhabits arid, open county, including open deciduous or pine-oak woodland, mesa or mountain country, often near watercourses, and wooded canyons and tree-lined rivers along middle-slopes of desert mountains. It nests in various habitats and sites, ranging from small trees in lower desert, giant cottonwoods in riparian areas, to mature conifers in high mountain regions.	-	T

Source: USFWS, July 2011; TPWD, July 2011.

C – candidate; E – endangered; T – threatened; PT – proposed threatened

Federally listed species are protected by the Endangered Species Act of 1973. A discussion of the federally listed species and potential effects to these species as a result of the proposed project is provided below.

Black-capped Vireo *(Vireo atricapilla)*

The Black-capped Vireo prefers habitat including rangelands with scattered clumps of shrubs separated by open grassland. These birds nest in Texas during April through July, and spend the winter on the western coast of Mexico. They build cup-shaped nests in the fork of a branch 2 to 4 feet above the ground. Black-capped Vireos are endangered because the low growing woody cover they need for nesting has been cleared or overgrazed by livestock and deer. Also, range fires, which used to keep the land open and the shrubs growing low to the ground, are not as frequent today as in the days before people settled Texas. Another problem is that Brown-headed Cowbirds lay their eggs in vireo nests, causing the vireos to abandon their nest. Val Verde County is known to contain nesting habitat for the Black-capped Vireo. However, no suitable habitat exists within the project area. Therefore, this project would not affect this species.

Devils River minnow *(Dionda diaboli)*

The Devils River minnow is found in small spring-fed streams of fast flowing waters over gravel substrates often associated with emergent aquatic vegetation. This species has been found in the San Felipe Creek located in the eastern part of Del Rio. A voluntary Conservation Agreement for the Devils River minnow between TPWD, USFWS, and the City of Del Rio was developed in 1998 in order to expedite conservation measures needed to ensure the continued existence and facilitate recovery of the species. The City of Del Rio also has a Management Plan for San Felipe Creek and the Devils River Minnow that makes recommendations to protect, preserve, restore, and manage the San Felipe Creek watershed in addition to the natural and cultural resources.

In September 2005, the USFWS developed a Devils River Minnow Recovery Plan with the intent to reduce threats to the species by securing adequate habitat conditions (clean, free-flowing springs and streams), allowing viable, self-sustaining populations to persist in the wild throughout its remaining range (includes controlling non-native species), and where feasible, to restore populations within the historic range. The primary focus is to protect naturally functioning spring and stream ecosystems within its current and potentially restorable historic range. The following tasks were discussed in the recovery plan in order to improve and maintain habitat in San Felipe Creek

- Protect adequate stream & spring flows
- Reduce pollutants (point & non-point)
- Manage non-native species
- Improve riparian area

Because the proposed project includes segments of San Felipe Creek, coordination with USFWS is currently ongoing regarding the conservation of the Devils River minnow. USFWS consultation is explained below.

Interior Least Tern *(Sterna antillarum)*

The Interior Least Tern is migratory, breeding along inland river systems in the U.S. and wintering along the Central American coast and northern coast of South America (TPWD, 2006). Nesting habitat for this species includes bare or sparsely vegetated sand, shell, and gravel beaches, sandbars, islands, and salt flats associated with rivers and reservoirs. This species prefers open habitat and tends to avoid thick vegetation and narrow beaches. Suitable habitat for this species does not exist in the project area; therefore, the proposed project would not affect the Interior Least Tern.

Mountain Plover (*Charadrius montanus*)

The Mountain Plover is a migratory bird and is native to short-grass prairie and shrub-steppe landscapes. Unlike other plovers, Mountain Plover are not found near water, and will only inhabit areas with bare ground or sparse vegetation (USFWS, 2011). Suitable habitat for this species does not exist in the project area; therefore, the proposed project would not affect the Mountain Plover.

Texas Hornshell (*Popenaias popei)*

The Texas hornshell is a freshwater mussel found in Val Verde County. This species are most often located in crevices, undercut riverbanks, travertine shelves, and under large boulders, where small-grained material such as clay, silt, or sand gathers and provides suitable substrata for anchoring. The Texas hornshell is known only from discrete sections of the Rio Grande River in Texas and a short segment of the Black River in New Mexico. The discovery of 30 individuals in a Webb County portion of the Rio Grande River in 2003 provides the only evidence of an extant population in Texas (TPWD, 2011). It is unlikely that this species occurs in the project area, since it is outside of the species' current range. However, BMPs would be utilized to ensure water quality in San Felipe Creek is not degraded during or after construction of this project. Should any mussels, including Texas hornshells, be found during construction, the contractor shall stop work in the immediate area and contact the Project Manager. USFWS will then be contacted to determine how to proceed.

Texas Snowbells (*Styrax texama)*

Texas snowbells grow out of crevices on steep limestone bluffs or cliff faces along streams and dry creek beds. It can also grow in the dry gravels of streambeds or in thin soils overlaying limestone ledges. These plants flower from March to November. This species was not observed within the project area and would not be affected by the proposed project.

Tobusch fishhook cactus *(Ancistrocactus tobuschii)*

The Tobusch fishhook cactus grows in very shallow gravelly soil over limestone in shortgrass areas within live oak-juniper shrublands. Field surveys of the project site determined that live oak-juniper shrublands do not exist within the project area. Vegetation assemblages in the project area are typically characterized by pecan/hackberry/retama mixed woodlands, patches of giant reed, and maintained grassy areas. No Tobusch fishhook cacti or suitable habitat for the cacti were observed within the project area. Therefore, this project would not affect this species.

VI. USFWS COORDINATION

Since the proposed project is located on critical habitat for an endangered species, coordination with USFWS is necessary. CP&Y and Naismith originally met with Nathan Allan about the proposed project; however, by the time the contract was signed for this project Mr. Allan had taken another position with USFWS. When a new point of contact was requested, Mike Montagne was originally identified and then it was concluded that Bill Seawell would be the point of contact for this project. Three meetings have been held thus far. Project consultants met with Mike Montagne on June 13, 2011 and Bill Seawell on July 19 and November 17, 2011. Information on each of the meetings are described below.

June 13, 2011 Meeting

CP&Y and Naismith met with Mike Montagne, the project leader for the Texas Fish and Wildlife Conservation Office. Mr. Montagne completed surveys for the Devils River Minnow at San Felipe Creek in April of 2011 and stated that Devils River Minnows were observed in San Felipe Creek. Mr. Tom Brown, from Naismith, provided detailed background information on the project and project area. Other attendees added additional information, when warranted. When Tardy Dam was mentioned, Mr. Montagne discussed the National Fish Passage Program and stated that the USFWS provides funding ($150,000 maximum) and technical assistance toward removing or bypassing barriers to fish movement.

After additional topics were discussed, Mr. Montagne led a tour at the Texas Fish and Wildlife Conservation Office. Meeting attendees saw numerous Devils River Minnows in captivity.

The *City of Del Rio Management Plan for San Felipe Creek and the Devils River Minnow* states "No Mow zones should be designated in open space areas adjacent to the creek... As a practical guide, no mowing should take place within and under the drip line of existing trees. No Mow zones also serve to provide habitat for birds and other wildlife." The no mow zone has numerous potential issues including fire hazard, limited visibility, security risk, and the influx of invasive species. After the meeting Mr. Montagne sent an email stating "I had a chance to talk with Nathan Allan yesterday about the no mow zones. He said that they were really the idea of TPWD and he did not know the exact reasons behind them other than to keep Bermuda and St Augustine grass from being planted right up to the edge of the river. He said that ideally the no mow zone would be developed on a site by site basis, with some flexibility."

July 19, 2011 Meeting

The agenda from the meeting with Mr.Bill Seawell can be seen in Appendix C. The meeting began with introductions, a description of the project, and a discussion of the T&E species listed in the county. During this meeting, no mow zones and the methodology for the removal of giant reed was were also discussed. Mr. Seawell indicated that USFWS would not be inclined to approve the spraying of herbicide on the giant reed since San Felipe Creek and Devils River minnow critical habitat is in the vicinity. Mr. Seawell stated that the cut and paint method is recommended, even though it is time intensive.

After the attendees discussed proposed ideas for addressing water quality issues in and around the creek, Mr. Seawell stated that all of the proposed work should be finalized and separated by segments along the creek. The City of Del Rio should then conduct informal consultation with USFWS on the portions of work that will be completed within five to ten years.

The no mow zones were also discussed; however, it was determined that Gary Garrett, with TPWD, must be contacted since the creation of the no mow zones were their idea. After the meeting, Mr. Seawell sent an email stating "I did talk to Gary Garrett briefly about the no mow zones. He said that they were not intended to apply to non-native invasives like giant river cane."

November 17, 2011 Meeting

The agenda from the meeting with Bill Seawell can be seen in Appendix C. The meeting began with updates since the July 19th meeting. Mr. Fusilier brought a detailed memorandum outlining the project description and proposed plans and designs for the water quality work in and around San Felipe Creek. The memorandum also included specifics on length and locations of proposed bank improvements, existing water quality issues, and proposed steps to eradicate the giant reed within the project area. This document was referred to numerous times during the meeting.

A discussion on the armored catfish was initiated. Mr. Seawell knows that this invasive species is a problem in the area and the attendees discussed how large of a problem they have become. Dr. Dan Foley has estimated that there are three million armored catfish in San Felipe Creek. Not only are they eating the same food source as the Devils River minnow, they burrow into banks to create spawning cavities that are branching, horizontal holes up to one yard deep. This has added to bank erosion along and siltation within San Felipe Creek. *The Devils River Minnow 5-Year Review* stated "In 2007, TPWD funded a study through a Wildlife Action Grant to investigate dietary overlap of Devils River minnow and the non-native armored catfish in San Felipe Creek. The study will also investigate possible control methods for the catfish. The study is ongoing and should be completed in 2009." Mr. Seawell did not recall seeing a copy of the dietary overlap study and he couldn't find anything in the files.

The attendees also concluded that the no mow zones did not originally anticipate problems with invasive species and the City could mow the problem areas. The outline for this document was discussed after the recreational plans along the creek were explained. A background on Tardy Dam and potential improvements to the dam were discussed. Improvements to strengthen the dam are being proposed. The attendees discussed the kayak trail and possible construction of fish ladders. Mr. Seawell stated that he has not seen a lot of success with fish ladders.

Proposed steps, different methods, and research conducted on eradicating the giant reed were discussed. Mr. Seawell stated that when the timing is approved by the City, the USFWS will need to know the exact area of removal, toxicity of the herbicide, steps proposed, money allocated, timing, assumption on amount of initial spraying and subsequent years of spraying, and if spraying how much is likely to get into the water course.

Mr. Seawell indicated that he liked the pervious pavement idea although he was worried about the public access points. It is likely that formal consultation with USFWS will be required and a Biological Opinion will be prepared before work can commence. At the end of the meeting, Mr. Seawell said that the project is "generally headed in the right direction". When the City finalizes the exact work and timeframe, USFWS will be contacted again.

Future USFWS Coordination

Future discussions with USFWS are in order to discuss the proposed work within the Devils River minnow critical habitat, exact areas and timeline of proposed work, and giant reed eradication. In addition, the City should keep USFWS informed on the no-mow zones, present the San Felipe Creek Master Plan to USFWS and TPWD for their review, submit construction plans for individual projects to USFWS and TPWD for approval prior to construction, and coordinate and update USFWS throughout the process. It is assumed that formal consultation with USFWS will be required. An assessment and Biological Opinion will be prepared before work can commence. Additional information and requirements will be finalized throughout the ongoing USFWS coordination. As stated in the *San Felipe Creek Vision Plan* the City should "work with U.S. Fish and Wildlife Service to monitor steam flow, the Devils River minnow, and habitat health."

VII. USACE PERMITTING

Based on the desktop review, field work, and background knowledge, the proposed water quality work completed within the OHWM of San Felipe Creek would likely be permitted by the U.S. Army Corps of Engineers (USACE) as an Individual Permit (IP). An IP would be required due to the fact that the project is located within Critical Habitat for the Devils River minnow. As stated in the Nationwide Permit (NWP) guidance "No activity is authorized under any NWP which is likely to jeopardize the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Federal Endangered Species Act (ESA), or which will destroy or adversely modify the critical habitat of such species." As project plans progress, and a timeframe for project completion can be estimated, the USACE should be contacted to finalize permitting requirements. Coordination with USFWS and other agencies would be required to finalize the IP.

VIII. HISTORIC RESOURCES

San Felipe Springs is the third largest spring in Texas and extends two miles along the San Felipe Creek northeast of Del Rio. Archeological evidence, including cave paintings and artifacts, suggest human occupation of the area for over 11,000 years- likely due in part by the presence of the springs and creek. The San Felipe Creek Archeological District was established as an area of documented archeological sites near the creek (exact location is restricted, but documentation is located at the THC). In 1535, Spanish Explorer Cabeza De Vaca brought the first European-descent people through this area of the Edwards Plateau, probably crossing paths with Lipan Apaches, Coahuiltecans, Jumanos and Tamaulipan tribes. In 1590, Spanish Explorer Gaspar Catano de Sosa stopped at the springs while en route to New Mexico. Later, Comanches camped at the springs on their war trail into Mexico. In 1675, it is believed that Franciscan priests celebrated a Mass at San Felipe Springs as they traveled through northern Mexico, and named the springs after the King of Spain. A historical marker in the City of Del Rio marks the supposed location of the Mass, which is now located on the golf course (San Felipe Creek Commissioners, 2007).

The rugged terrain and remote location of San Felipe Springs thwarted attempts made by the Spanish Government of New Spain to establish a permanent settlement in this area. Other Spanish explorers followed, and by 1808, a mission was established near San Felipe Springs, on San Felipe Creek. In 1849, explorer Captain S.G. French described the San Felipe Springs as a "beautiful spring of water, fifty feet in diameter at the surface, the sides of which incline towards a centre, like an inverted cone, and then, sinking into a cylindrical form to a depth of twenty-eight feet, through a soil of hard clay, afford a passage for the water to rise (French, 1850). By 1856-57, the San Felipe Springs were a stop of the 1,470-mile San Antonio to San Diego mail route. The springs were on the Chihuahua Road for wagons hauling silver and gold from Mexico to Indianola, an early Texas port. The first recorded settlement of San Felipe Creek would not come until 1859, when a man named Johnson and his wife and two children established a homestead, though 1862 marks the first permanent settlement when James Taylor and his wife Paula Losoya Taylor planted the seed for the soon-to-be prosperous community of Del Rio along San Felipe Springs (San Felipe Creek Commissioners, 2007).

Perhaps the largest endeavor undertaken to utilize the springs was the establishment of the intricate canal irrigation system which transformed this Rio Grande Valley community from a dry landscape into a thriving agricultural region and provided means to sustain the economy. As settlers flocked to Texas and the Rio Grande Valley, irrigation ditches fed by San Felipe Springs and San Felipe Creek were dug. The irrigation ditches were first designed by Native American and Spanish inhabitants of the area. By 1869, a group of landowners founded the San Felipe Agricultural, Manufacturing and Irrigation Company. The San Felipe Creek was damned just below the springs, and canals were built to divert water to 1,500 acres of land. The company promoted settlement by offering land along the Creek to employees (THC, 1975). The canal system consisted of the five-mile-long Madre Ditch and the one-mile-long San Felipe Ditch, along with a lateral canal.

By 1884, two gristmills utilized the springs for power and railroad lines reached Del Rio, furthering population growth, and the need for additional irrigated acreage. In 1886, Geologists R.T. Hill and T.W. Vaughan recorded observations about the San Felipe Creek and Springs:

> "From the deep-seated rock at its bottom the water can be seen welling up in a great column, and has the same peculiar greenish-blue color as that of the other streams of this class. No trees surround it; it is alone - a fountain in the desert. The rocks from which it bursts - the Fort Worth limestones - have the same kind of joints and faults as are found at San Antonio and Austin. The outflow from the pool forms a bold, rushing stream that runs off to the Rio Grande, some 5 miles distant. The spring stream, in addition to running a mill and supplying the village with water, is partially utilized to supply 15 miles of irrigation ditch and to irrigate 5,000 acres, and can furnish water for the irrigation of several thousand acres more (Hill/Vaughn, 1896)."

By 1901, a hydroelectric and ice plant also reaped benefits of the water source (Brune, 2011). It is no surprise the springs are mentioned in early historical documents, or that the Kings Highway (or the Comino Real) from San Antonio to El Paso runs adjacent to the springs. For centuries, the springs have provided clean and clear water sources for inhabitants, travelers and wildlife. In addition to supporting numerous flora and fauna species habitats and irrigation efforts, the deep clear pools created ideal recreational spots in the hot Texas summers. The springs are currently the sole water supply for the City of Del Rio and Laughlin Air Force Base.

The Canal System of Del Rio is commemorated with two Official Texas Historical Markers with one located at the Whitehead Museum on Main Street and one at the intersection of Griner Street and Canal Street in Del Rio. The San Felipe Springs are recognized as a Recorded Texas Historic Landmarks (RTHL). The Texas Department of Transportation (TxDOT) is currently conducting National Register of Historic Places (NRHP) evaluations of select irrigation systems of the Rio Grande Valley. The Del Rio system has not yet been formally assessed for eligibility for inclusion in the NRHP, though the THC and TxDOT have agreed to treat the historic-age South Texas irrigation system as an eligible and historically significant resource. TxDOT is currently preparing a comprehensive map of all primary and secondary components of the system.

San Felipe Springs is also managed by structures and infrastructure, including stone retaining walls and dams. The historical significance (if any) of these features are unknown, however, they may be considered important historical elements to the Springs, and may therefore warrant preservation protection or rehabilitation measures. The Master Plan effort may benefit from the inclusion of a preservation or rehabilitation plan of historical features associated with the Springs.

IX. PUBLIC AWARENESS

Highlighting the rich natural and cultural features of the Springs through interpretive or educational tools will provide visitors an opportunity to appreciate the ecologically diverse and historically significant resource. Educational signs would be placed in strategic locations throughout the park. Specific signs may include information on threatened and endangered species, such as the Devils River minnow and San Felipe Creek gambusia, or invasive species such as the armored catfish, or by illustrating the historical events or archeological finds associated with the creek.

Biological Resources

Another way to increase public awareness of plant species and vegetation communities in the area is to provide educational plaques near select plants in an area accessible to and regularly used by the public. Since Spanish is commonly spoken in Del Rio, the plaques would be bilingual. The locations of the plaques and specific plants called out would be determined at a later time, but example plant plaques, along with interesting facts on each plant, are listed below.

American sycamore (*Platanus occidentalis)*

- can attain the largest truck diameter of any of the eastern U.S. hardwoods
- Smooth white truck with peeling grayish brown bark
- maple-like leaves

Bald cypress (*Taxodium distichum*)

- Can live up to 600 years old
- Can reach heights of 100 to 150 feet
- Native to southeastern US
- Deciduous, meaning it loses its leaves in the winter
- When growing in water, it has shallow roots that often arise from the soil in the shape of cones called pneumatophores, or "knees"

Black willow (*Salix nigra*)

- Typically found near streams and swamps
- Roots help stabilize creek banks and prevent erosion
- Leaves are feathery and narrow; bark is dark brown or black with ridges
- Good food source for deer, rabbits, small rodents, and beavers which eat the bark, stems and twigs. The nectar is consumed by bees, butterflies and other insects. Leaves are eaten by the caterpillars of many species of butterflies and moths

Eastern cottonwood (*Populus deltoides*)

- Spade-shaped leaves
- Mature cottonwood bark is among the thickest of all trees in North America
- In late spring/early summer, the fruits open and release their cottony seeds

Honey mesquite (*Prosopis glandulosa*)

- Yellowish green compound leaves, that is a single leaf composed of several small leaflets
- Produces edible legumes (beans or pods)
- Has straight, very stout spines
- Vital resource for food, fuel, medicine, and implement-making for Native Americans and early settlers

Netleaf hackberry (*Celtis reticulate*)

- Heat and drought tolerant native tree
- A twisted, hobbitlike growth form with raised, corky ridges on the bark
- Pea-sized orange fruits from midsummer through fall
- Has conspicuous net-like veins on the undersides of the leaves, upper surface feels like sandpaper

Pecan (*Carya illinoiensis*)

- State tree of Texas
- Flaky bark, long narrow leaves

- Pecans are important food source for squirrels, raccoons, opossums, javelinas, even crows and blue jays

Roemer acacia (*Acacia roemeriana*)
- Sometimes called "catclaw" because of its small curved thorns
- Young trunks are covered with smooth bark which becomes scaly with age
- Fragrant, cream to greenish flowers
- Good source of honey for bees and other nectar insects

Spiny hackberry (*Celtis ehrenbergiana*)
- Also called "granjeno"
- Produces sweet, bright orange drupes on which numerous bird species, raccoons, deer, and rabbits feed
- Blooms provide bees good source of honey
- Its spiny branches zigzag up to attain a typical height of 20 feet

Texas snakewood (*Colubrina texensis*)
- Light gray, zigzag branches with bark that resembles snakeskin when mature
- Fruit is a reddish-brown to black drupe that is a favorite of birds and other wildlife
- Very drought and heat tolerant

Elephant ears (*Colocasia* sp.)
- Non-native to Del Rio
- Occurs along San Felipe Creek
- Easy to identify broad heart-shaped leaves

Giant reed (*Arundo donax*)
- Non-native and extremely invasive
- Can grow to 20 feet tall
- Flowers appear to be upright, feathery plumes
- Very little wildlife value
- Negative security and safety impacts since it is so dense

Texas pricklypear (*Opuntia engelmannii*)
- State plant of Texas
- The red fruits, or tunas, are edible
- The name cactus is derived from the Greek word "kaktos", which means prickly plant

Old man's beard (*Clematis drummond*)
- Climbing vine that covers fences and shrubs
- When its seeds mature, the female vine is covered with great masses of silky, feathery plumes that resemble an old man's beard

Western poison oak (*Toxicodendron diversilobum*)
- Leaves, twigs, and berries contain a surface oil, urushiol, which causes an allergic reaction in some people

- Can be vine, forbs, or woody
- Distinctive three leaves on a stem

Of course, information on threatened and endangered species in Val Verde County could be described on a kiosk. Information on the Devils River minnow, including physical description, habitat requirements, a map of critical habitat, and importance of water quality, could also be explained on a kiosk or on a separate sign next to San Felipe Creek. Information on the invasive armored catfish and the negative impacts it is making on the creek would also be very useful as an educational tool and to increase public knowledge on why this species should be eradicated. Adding signage that says "sensitive areas" or "endangered species habitat" would also be beneficial.

Historical Resources

In addition to supporting numerous species of flora and fauna, the San Felipe Creek is a resource with an interesting history that expands over centuries, and provides a natural connection with exploration, early settlement, and the agricultural development of Del Rio. The illustration or display of archeological artifacts is an excellent way to tell a story about a place, and provide tangible evidence of early inhabitants to an area where the public recreates. In addition, the intricate irrigation canal system that transformed the landscape to fertile agricultural land is an important feature to highlight.

Some potential interpretive and educational efforts to express the historical significance of the park may include:

- Foundation outline (if archeological/physical evidence) of former grist mill(s) that utilized the springs, and an interpretive plaque discussing grist mill operations;
- Map outlining the areas that the Springs were irrigated for agricultural support (orchards, wineries, gardens, etc);
- Images of the historic Val Verde Winery and discussion of how the Springs were utilized in the wine-making process;
- Map outlining the location and features of the irrigation canals that feed into the Springs;
- A timeline plaque discussing the route explorers took that included the Springs;
- Include paths along the creek with a Historic Walking Tour of Del Rio;
- Historic pictures of the creek, including flood events;
- Pamphlets of interesting historic facts, tools used, and quotes from explorers;
- Plaques or images of artifacts discovered near the creek
- Develop educational tools for school-age children, such as an interactive web program that provides images and facts on the creek (integrating both cultural and natural features) that walk students through the importance of the creek. This could be a tool utilized prior to field trips to the creek where they could then experience the natural and cultural environment after reading about it in the classroom.
- Organize "Explorers of the San Felipe Creek" activities or "Del Rio Day" highlighting the importance of the creek for cultural, natural, agricultural and recreational purposes. This could provide opportunities to educate the public on the importance of preserving the heritage associated with the creek;
- The above activities could include a public archeology day at a known site associated with the creek overseen by qualified archeologist(s).

X. CONCLUSION

Based on the environmental desktop review and field work conducted in July 2011, there is one water of the U.S. (San Felipe Creek) and no jurisdictional wetlands in the project area. San Felipe Creek is perennial and varies from 8 to 150 feet in width. The Devils River minnow has documented occurrences in the San Felipe Creek within the project area. Coordination with USFWS is ongoing to determine how to avoid impacts to this species. It is assumed that no other federally-listed threatened or endangered species would be potentially affected by the proposed project. Based on consultation with USFWS and TPWD, the City of Del Rio can mow the areas where the giant reed is overgrown and causing issues. In addition to the sensitive natural environmental conditions in and around the creek, historically, the creek provided many uses to early settlements and explorers, as it does today. The area is rich in cultural resources, both archeological and architectural. The historical significance of resources should be assessed and affects of projects in and around the creek should take into account the effects on historic resources.

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Appendix A

Project Area

NHD Flowline

0 250 500 1,000

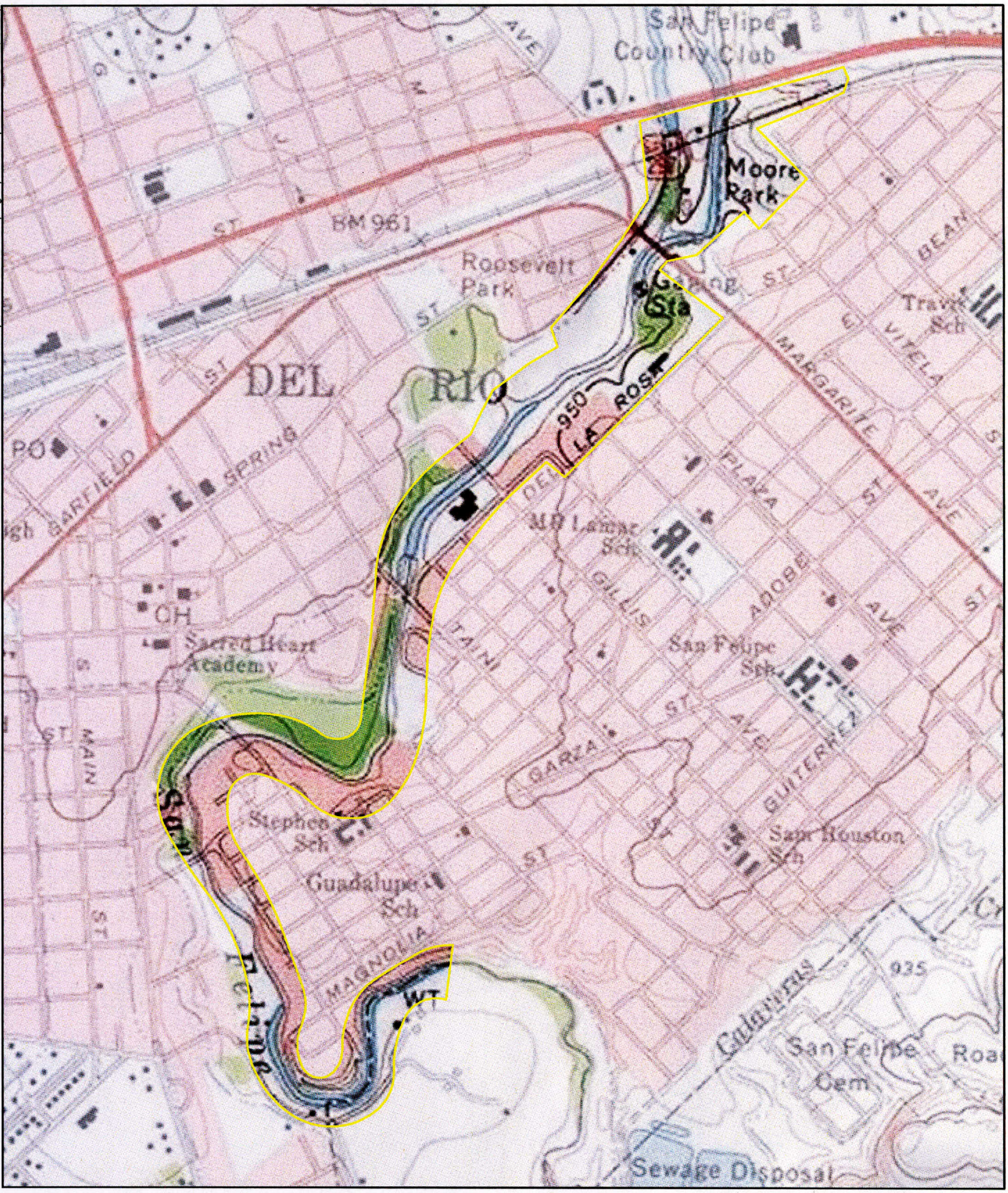
Feet

FIGURE 1

Aerial Photographic Map with National Hydrography Database

SAN FELIPE CREEK MASTER PLAN

Basemap Source: USGS Topographic Map - Del Rio SW (1972)



N

0 250 500 1,000
Feet

Project Area

FIGURE 2
USGS Topographic Map

SAN FELIPE CREEK MASTER PLAN

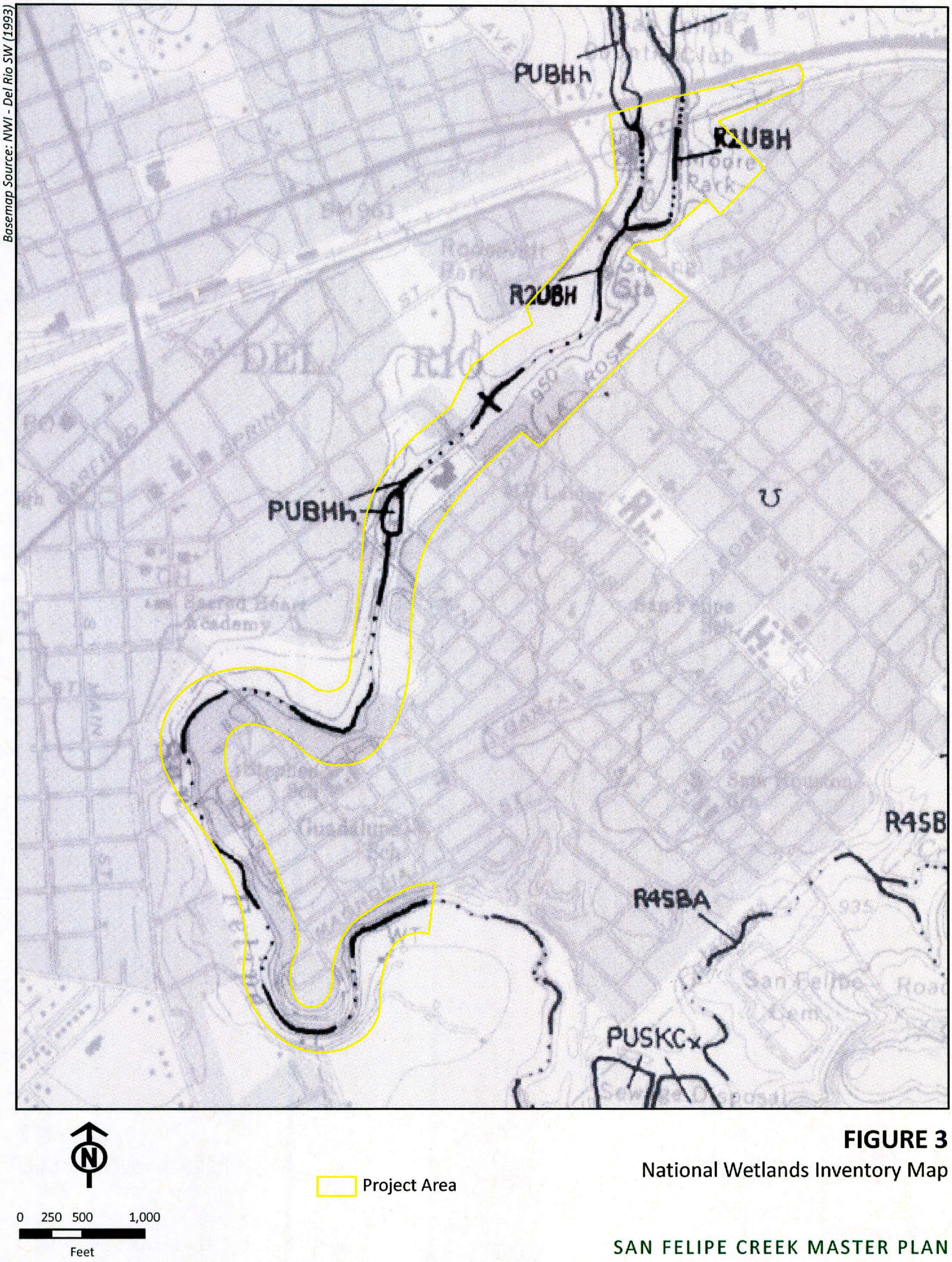
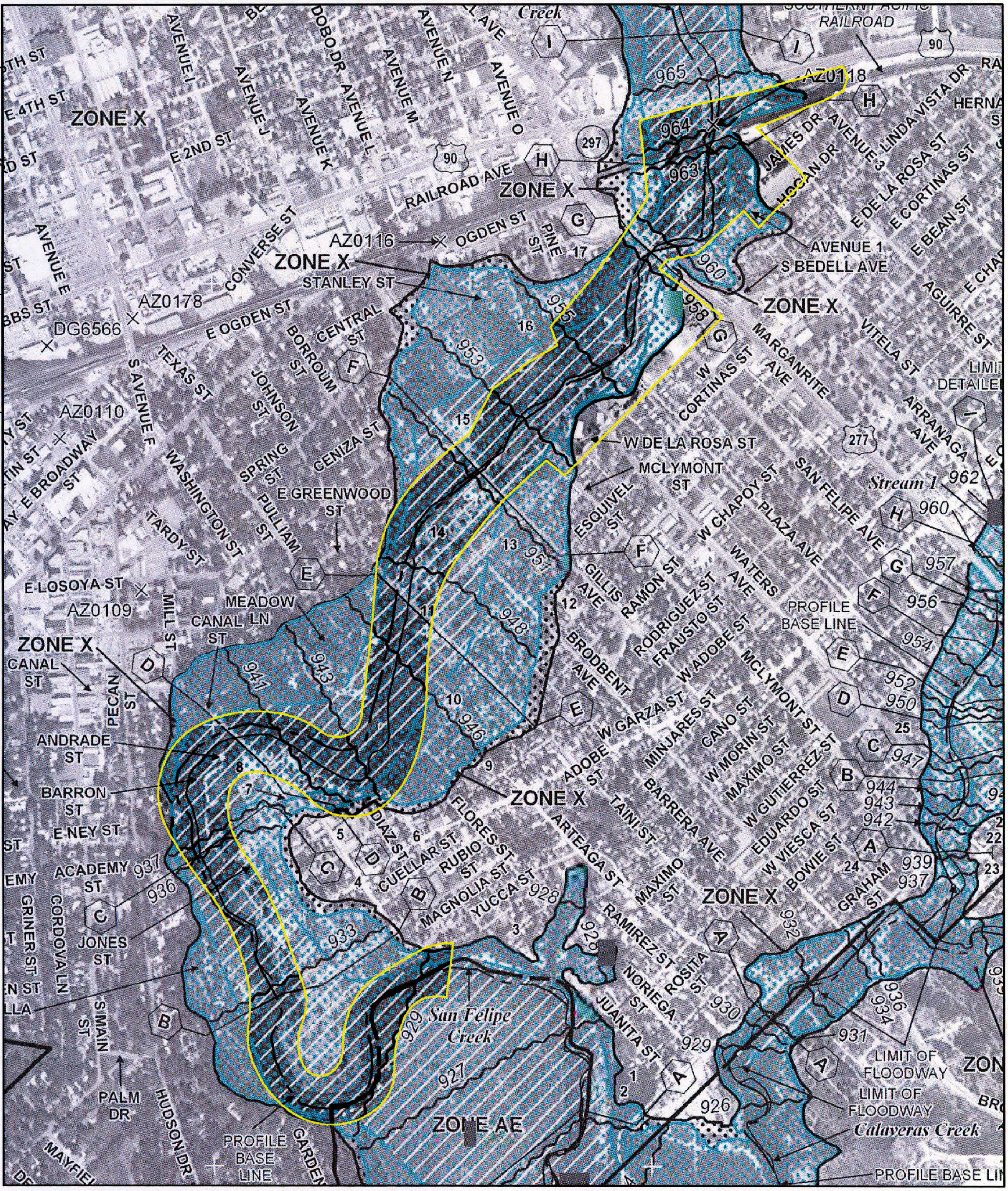


FIGURE 3

National Wetlands Inventory Map

SAN FELIPE CREEK MASTER PLAN



Project Area

0 250 500 1,000
Feet

FIGURE 4

Federal Emergency Management Agency
Flood Insurance Rate Map

0 250 500 1,000

Feet

Project Area

NRCS Soil Boundary

FIGURE 5

Natural Resources Conservation Service

Soil Data Map

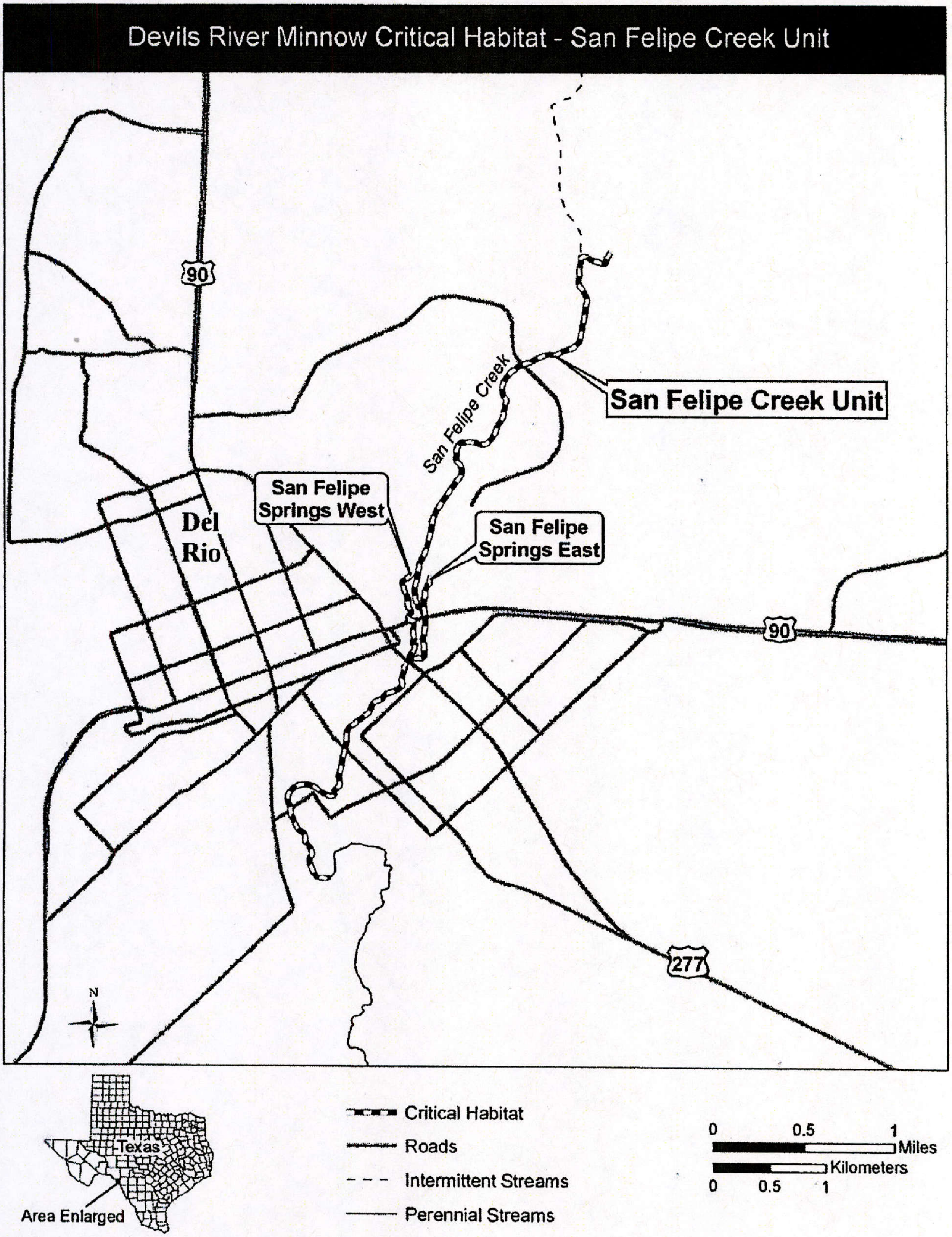

Devils River Minnow Critical Habitat - San Felipe Creek Unit
San Felipe Creek Unit
San Felipe Creek
San Felipe Springs West
San Felipe Springs East
Del Rio
90
90
277
N
Texas
Area Enlarged
Critical Habitat
Roads
Intermittent Streams
Perennial Streams
0
0.5
1
Miles
Kilometers
0
0.5
1

FIGURE 6

Appendix B

Photo 1. A typical view of San Felipe Creek within the project area.

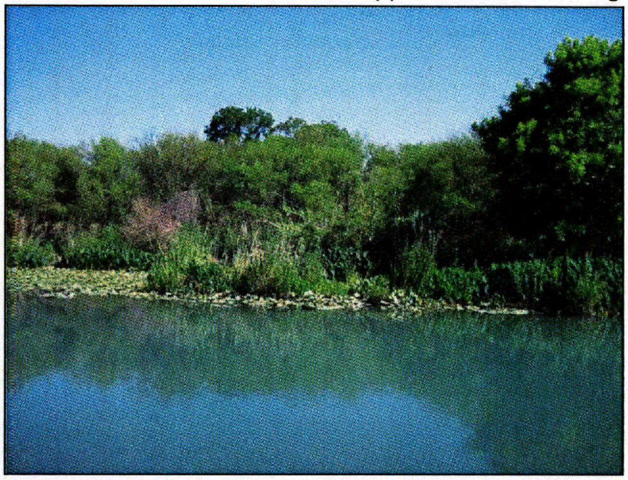


Photo 2. San Felipe Creek in the southern portion of the project area.

Photo 3. The no-mow zone adjacent to San Felipe Creek was implemented by TPWD to help maintain water quality.

Photo 4. Giant reed (*Arundo donax*) is an invasive species that has spread along the creek throughout most of the project area.

Photo 5. Elephant ears (*Colocasia* sp.), an invasive species, grow in many locations along the banks of San Felipe Creek.

Photo 6. Invasive species saltcedar (*Tamarix* sp.) trees were observed near San Felipe Creek.

Photo 7. No mow zone located adjacent to San Felipe Creek.

Photo 8. Invasive species such as this chinaberry tree (*Melia azedarach*) are located in the project area.

Photo 9. Palm trees were observed within the project area.

Photo 10. Historic canal near East Canal Street.

Photo 11. Historic canal.

Photo 12. San Felipe Creek facing downstream from East Canal Street.

Photo 13. San Felipe Creek, facing upstream.

Photo 14. Public park is used by locals of all ages.

Photo 15. Semi-circle wading pool, facing upstream.

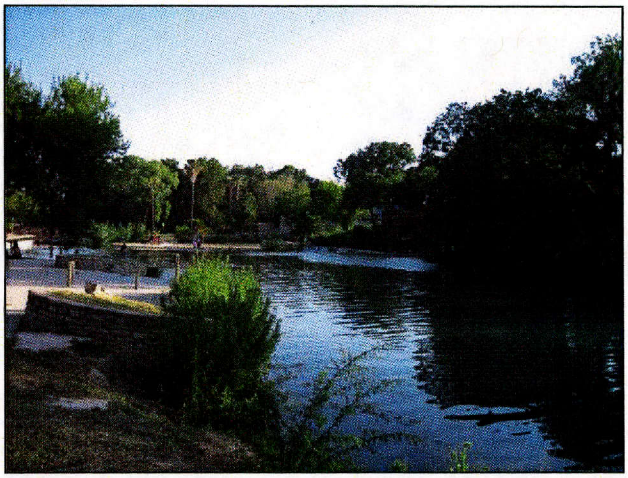


Photo 16. San Felipe Creek, facing downstream.

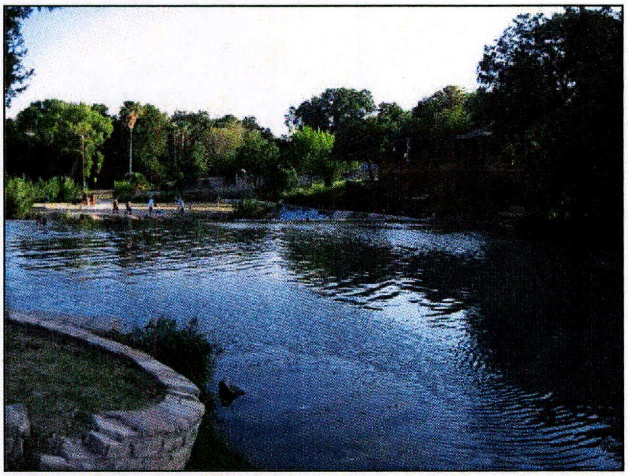


Photo 17. San Felipe Creek, north of Tardy Dam facing, downstream.

Photo 18. San Felipe Creek, south of Tardy Dam, facing downstream.

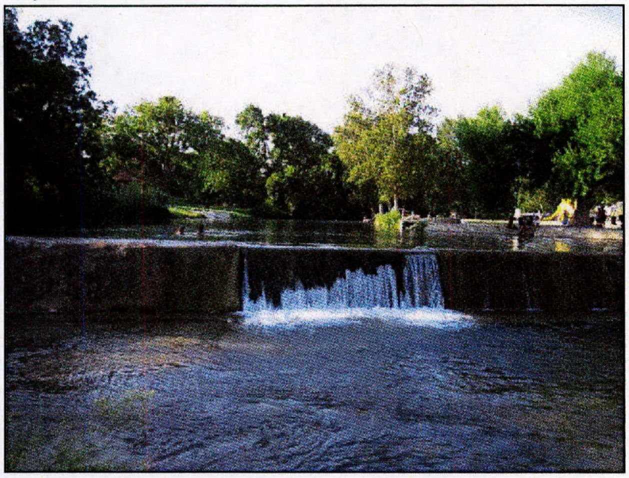


Photo 19. Tardy Dam, facing upstream.

Photo 20. Severe erosion at public park. Location of old diving board.

Photo 21. Another view of San Felipe Creek.

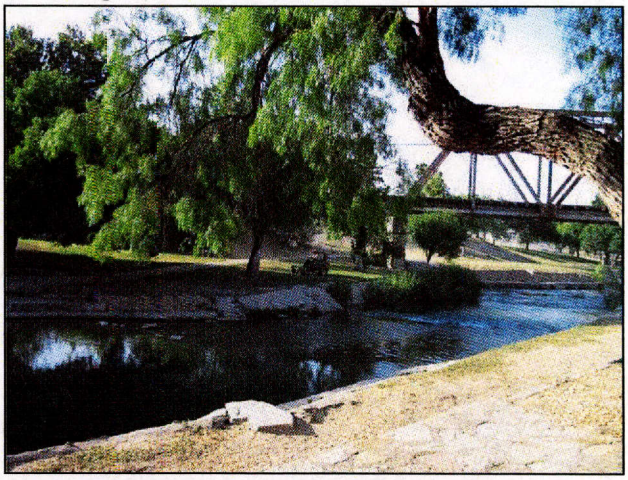


Photo 22. Another view of San Felipe Creek.

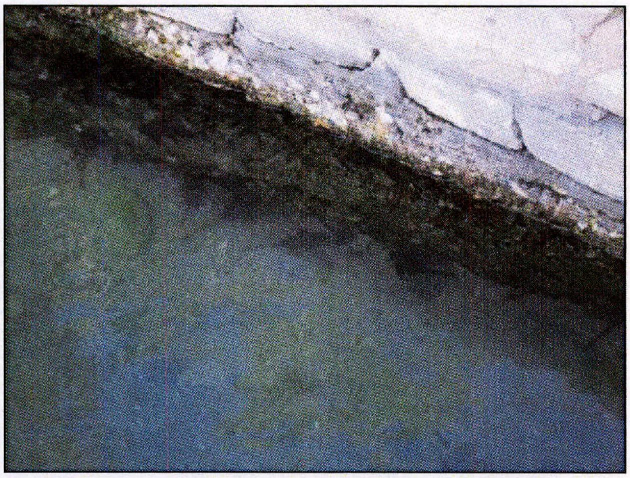


Photo 23. Invasive catfish have proliferated in the creek and are outcompeting native species and causing banks to erode.

Photo 24. San Felipe Creek without a riparian corridor.

Photo 25. Sidewalks are breaking apart in some locations due to severe erosion under them.

Photo 26. Picture of historic footbridge and Blue Hole. Note US HWY 90 in the background.

Photo 27. Historic bridge over San Felipe Creek within the park.

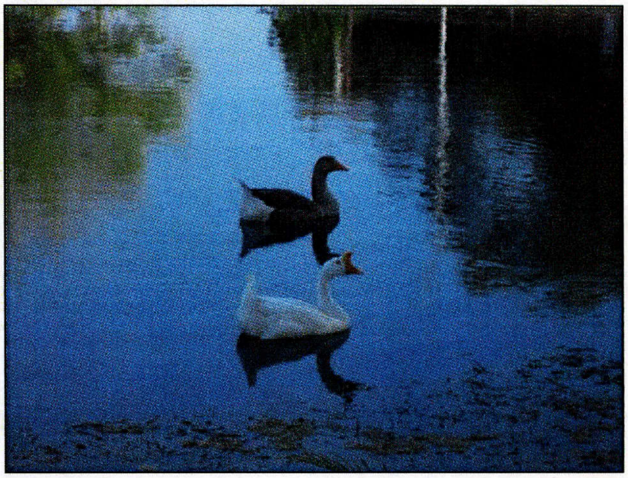


Photo 28. Geese in the creek at the park.

Photo 29. In some locations in the project area, the channel banks are eroding away due to catfish burrowing, high water events, and lack of bank stabilizing techniques.

Photo 30. Romanelli Park on the west side of San Felipe Creek.

Appendix C

Agenda

Date: July 19, 2011

Meeting Time: 9:30 am

Location: CP&Y, Inc. Austin Office (10415 Morado Circle, Building 1, Suite 200, Austin, Texas 78759)

Purpose: Options of Working in and around Critical Habitat for the Devils River Minnow

Attendees: Bill Seawell, USFWS; David Fusilier, Naismith Engineering; Tom Brown, Naismith Engineering; Bonnie Doggett, CP&Y, Inc.; Sarah Itz, CP&Y, Inc.

Agenda Items

I. Project description and background information (Naismith)

II. Threatened and endangered species of Val Verde County (CPY)

  a. Black-capped Vireo, Interior Least Tern, Texas snowbells, Tobusch fishhook cactus
  b. Mountain plover
  c. Texas hornshell
  d. Devils River Minnow

III. Devils River minnow critical habitat (CPY)

IV. San Felipe gambusia (CPY)

V. Possible work in the San Felipe Creek (Naismith)

VI. USFWS Input on possible work in San Felipe Creek (USFWS)

VII. Invasive species discussion (CPY)

VIII. No mow zones (CPY)

Agenda

Date: November 17, 2011

Meeting Time: 9:30 am

Location: CP&Y, Inc. Austin Office (10415 Morado Circle, Building 1, Suite 200, Austin, Texas 78759)

Purpose: Options of Working in and around Critical Habitat for the Devils River Minnow

Attendees: Bill Seawell, USFWS; David Fusilier, Naismith Engineering; Tom Brown, Naismith Engineering; Bonnie Doggett, CP&Y, Inc.; Sarah Itz, CP&Y, Inc.

Agenda Items

I. Updates since the July 19th meeting (CPY)

II. Devils River minnow (CPY)

III. Project plans and designs (Naismith)

IV. Giant reed (*Arundo donax*) proposed work (Naismith then CPY)

V. Armored catfish discussion (CPY)

VI. USFWS Input on proposed work in San Felipe Creek (USFWS)

VII. No mow zones (CPY)

VIII. Outline for environmental portion of SFC Master Plan (CPY)

IX. Possible Improvements to Tardy Dam (Naismith then CPY)

APPENDIX B

Delineation and Recommendations for Eradication of Giant River Cane (*Arundo donax*) along San Felipe Creek Del Rio, Texas

Submitted to Naismith Engineering, Inc.

By
Dan H. Foley III, Ph.D.

August 18, 2011

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Introduction

Giant River Cane (*Arundo donax*) is a perennial C3 grass (Poaceae)(Milton 2004) native to the Mediterranean regions of Europe, the Middle East and Northern Africa (Perdue 1958). *Arundo donax* was introduced to North America, possibly around the 1600's, from the Mediterranean regions of Europe (Dunmire 2004). The specific genotype for the Giant River Cane clonal colony which has become invasive along the Rio Grande River Basin has been determined to have originated from the Mediterranean region of Spain (Goolsby and Moran 2009). Initial introductions were most likely by Spanish settlers that brought along the plant to provide silage for cattle and goats and secondarily to be used as thatching material for dwelling roofs. With the colonization and industrialization of North America, more nutritious livestock feeds and efficient building materials were developed. As a consequence, stands of *Arundo* were no longer utilized and managed and as such were allowed to go fallow. Giant River Cane is now found throughout the Southern United States from Maryland to California, as well as in Hawaii and throughout much of Mexico (Bell 1997).

The problems created by Giant River Cane are a result of its incredible growth potential. Individual shoots can grow upwards of 4 inches per day and at maturity stands of giant River Cane can approach 30 feet tall (Dudley 2000) (Figure 1). To support such high growth rates, Giant River Cane necessarily requires large quantities of water. In fact, Giant River Cane consumes approximately three times more water than typical native vegetation (Jackson et al. 2002; Oakins 2001; Zembal and Hoffman 2000). Therefore, Giant River Cane is typically restricted to wetlands, riparian corridors, and around the margins of lakes and ponds. Because of its extreme growth pattern and huge water demands, few, if any, native vegetative species can compete. As a result, once established Giant River Cane quickly becomes the dominant species creating large monoculture stands (Figure 2). The status of Giant River Cane has reached epidemic proportions. The USDA has recently estimated that along a small stretch (~170 miles) of the Rio Grande River from Del Rio, TX to San Ignacio, TX 15,000 acres of *A. donax* has become established (March-Mifsut and Martínez-Jiménez 2008; Yang et al. 2009). Furthermore, the rate of expansion of Giant River Cane along the Rio Grande River has been estimated at about 2.36% per year (Seawright 2009). Consequently, the state of Texas has passed legislation making it illegal to sell or plant *A. donax* without a permit from the Texas Department of Agriculture. The utter quantity of the biomass of Giant River Cane along the Rio Grande River is such that it is now imposing a significant economic impact on the agricultural industries of south Texas. USDA scientists have calculated that along the Rio Grande River Giant River Cane consumes on average 4.37 acre feet (~1.4 million gallons) of water per acre per year. For the 170 miles of river from Del Rio to San Ignacio, the USDA has estimated Texas will incur revenue losses of between $97.8 and $159.9 million from the loss of salable water for agricultural purposes alone over the next 50 years (Seawright 2009).

Figure 1. Photograph indicating the incredible growth potential of Giant River Cane.

Figure 2. Photograph indicating the invasiveness of Giant River Cane along the Rio Grande River adjacent to Del Rio, TX.

Reproductive Biology of Giant River Cane

In order to implement an effective strategy of control over Giant River Cane, first it is necessary to have an adequate understanding of its reproductive biology. Although *A. donax* does produce large feathery flower stalks, the resulting seeds are sterile and not fertile (Bell 1997). Instead Giant River Cane reproduces via asexual vegetative cloning. Three forms of vegetative propagation are known to occur: 1) **Rhizome reproduction** occurs via its pachymorph (carbohydrate-storing) rhizome, which can grow up to 3 feet in diameter. The rhizome contains nodes from which new shoots can sprout (Figure 3). 2) **Fragmentation** occurs when either a piece of a shoot or rhizome breaks ways from the parental plant. If the fragment drifts downstream, it can sprout once settled or covered with soil (Figure 4). 3) **Layering** primarily occurs during flooding events which can cause the canes to bend over to such an extent that the tips of the canes come in contact with the soil. If these tips become covered with silt and soil, the tip of the cane can sprout and form new independent shoots (Boland 2006).

Figure 3. Photograph illustrating the extensive underground rhizomes of Giant River Cane and new shoots sprouting from these rhizomes.

Figure 4. Photograph illustrating adventious sprouting of a dislodged segment of Giant River Cane.

Eradication Methods

Currently three control protocols have been tested to control the growth and proliferation of Giant River Cane: mechanical, chemical and biological. Additionally, any combination of these three treatment protocols can be an effective treatment option.

Mechanical Control

Mechanical control involves physically removing all portions of the living plant, including the rhizomes. This method is very labor intensive and often requires tools such as axes, grubbers, chain-saws, tractors, shredders and chippers. Mechanical control can be very effective; however, complete removal of the plant often requires significant soil disruption and can lead to excessive erosion. Any attempt to remove Giant River Cane by hand is really only practical for very small isolated patches less than 20 feet in diameter.

Due to Giant River Cane's high silica content, the plant is very flammable and highly susceptible to burning, even when green. However, burning has proven to be ineffective and can actually lead to the plant's expansion as it out competes native vegetation during its re-growth stage. While the shoots of the plant are easily burned, the shallow rooted rhizomes are protected and not destroyed by fire. Therefore, after a burn, Giant River Cane's rhizomes will re-sprout and can spread into adjacent areas previously occupied by native vegetation.

Chemical Control

The use of herbicides has proven very effective for the control and eradication of Giant River Cane. Specifically, herbicides containing glyphosate as the active ingredient have proven to be most effective. Glyphosate kills plants by interfering with the synthesis of the aromatic amino acids phenylalanine, tyrosine and tryptophan. These amino acids are used as building blocks in peptides, and to produce secondary metabolites such as folates, ubiquinones and naphthoquinone. X-ray crystallographic studies show that glyphosate functions by occupying the binding site of the phosphoenolpyruvate, mimicking an intermediate state of the ternary enzyme substrates complex. This pathway is not present in animals, which instead obtain the aromatic amino acids phenylalanine, tyrosine and tryptophan from their diet.

The Environmental Protection Agency (EPA) has approved one particular brand of glyphosate – Rodeo® for use in and around aquatic environments. Studies have indicated that for effective control of Giant River Cane, a 3% - 5% Rodeo® concentration (Spencer et al. 2008) is required to obtain at least a 60% kill ratio (Hart and Hatler 2009). Furthermore, to enhance the effectiveness of the glyphosate, a surfactant is recommended. Most plants, and especially Giant River Cane, have a protective waxy covering on their stems and leaves. This waxy coating can prevent the maximal absorption of the herbicide. Surfactants work by decreasing the surface tension of water molecules and thereby preventing the "beading-up" of the liquid herbicide on the plant; this allows for greater surface contact and therefore greater herbicide absorbency. The use of a .5% concentration of the surfactant DyneAmic® has been shown to significantly increase the effectiveness of the herbicide Rodeo® in the control of Giant River Cane (Spencer 2008).

For control of Giant River Cane, the recommended application rate is 100 gallons of solution per acre. Therefore, a 100 gallon 3% solution will consist of 3 gallons of Rodeo® herbicide, ½ gallon of DyneAmic® surfactant and 96.5 gallons of water. Herein lies the major disadvantage of herbicidal control of Giant River Cane. Both chemicals, Rodeo® and DyneAmic® are rather expensive. Currently, Rodeo® costs approximately $40 per gallon and DyneAmic® costs $75 per gallon. Therefore, for the chemicals alone, the cost to treat one acre of Giant River cane is approximately $157.50. This does not take into account the cost of the water, equipment, or the salaries of the personnel necessary to administer the herbicide.

Biological Control

Because of the sheer quantity of Giant River Cane already established along the Rio Grande Basin, neither mechanical nor chemical control methods are economically feasible. Consequently, the United States Department of Agriculture (USDA) has been investigating the potential of various biological control agents to reduce Giant River Cane's abundance. Four insect species have been identified as potentially effective control agents.

The Arundo Wasp (*Tetramesa romana*) is a parthenogenic (asexual - all female species) insect which utilizes Giant River Cane as its site for egg ovoposition and subsequent larval development. This small (~5mm) solitary, stingless wasp exclusively utilizes the grow tips of Giant River Cane to house her eggs. Upon hatching the larvae feed on the inner tissues of the plant, thereby weakening the plant. Once mature the adult wasps chew their way out of the plant stems, leaving a small opening whereby fungi and/or other pathogens could enter and further weaken the plant.

The Arundo Wasp has already undergone extensive testing at USDA laboratories and has been deemed effective at impacting Giant River Cane health while not affecting any other agricultural or native species of plants. Consequently, permits were obtained for the release of the Arundo Wasp in 2008 and subsequent releases have already established initial populations of this insect around Laredo, Eagle Pass and Del Rio, Texas.

The Arundo Armored Scale (*Rhizaspidiotus donacis*) is another insect species deemed valuable for negatively impacting the health of Giant River Cane. This diminutive (1-2mm) insect damages plants by puncturing mesophyll and parenchyma cells of leaves, stems and rhizomes with their maxillary-mandibular stylets. This piercing and subsequent nutrient removal by the scale reduces and deforms plant growth and sometimes induces necrotic reactions to the insects' saliva. In the spring of 2010 permits were granted for initial field testing of the Arundo Scale. Experimental field populations are currently be evaluated in Laredo and Del Rio, TX.

Additionally, two other insects, the Arundo Fly (*Cryptonevra* sp.) and the Arundo Leafminer (*Lasioptera donacis*) have been targeted as potentially effective at impacting the health of Giant River Cane. These insect are currently in the laboratory testing phase. It is anticipated that within the next 3-5 years both of these insect will also be approved for release and field testing.

Giant River Cane along San Felipe Creek

For the purpose of delineating the quantity of Giant River Cane along San Felipe Creek, the creek was arbitrarily divided into three sections: 1) San Felipe Country Club, 2) Central San Felipe Creek, 3) Southern San Felipe Creek. Recent geo-referenced satellite images were imported into GIS software and polygrams were drawn around the large and visually distinct patches of Giant River Cane adjacent to the creek. The total areas of each polygram were then calculated.

San Felipe Country Club

This length of San Felipe Creek includes that portion of the creek which lies within the property boundary of San Felipe Country Club. Approximately 1.06 miles of creek exist among 3 separate tributaries within San Felipe Country Club property. Along this section of the San Felipe Creek, approximately 7.74 acres of Giant River Cane were identified (Figure 5).

Central San Felipe Creek

This segment of San Felipe Creek starts where US Hwy 90 crosses over San Felipe Creek and continues downstream until Tardy Dam. This segment of San Felipe Creek is approximately 1.3 miles in length and contains approximately 1.55 acres of Giant River Cane (Figure 6).

Southern San Felipe Creek

This segment of San Felipe Creek extends from Tardy Dam downstream just past the city limits of Del Rio until the creek meanders adjacent to "Round Mountain." This segment of San Felipe Creek is approximately 2.3 miles in length and possesses approximately 28.39 acres of Giant River Cane (Figure 7).

In total, within the city limits of Del Rio, a 4.65 mile segment of San Felipe Creek was assessed and found to possess approximately 37.68 acres of Giant River Cane.

Figure 5. Satellite image of the "San Felipe County Club" portion of San Felipe Creek with the regions affected by Giant River Cane delineated.

Figure 6. Satellite image of the Central portion of San Felipe Creek with areas infected by Giant River Cane delineated.

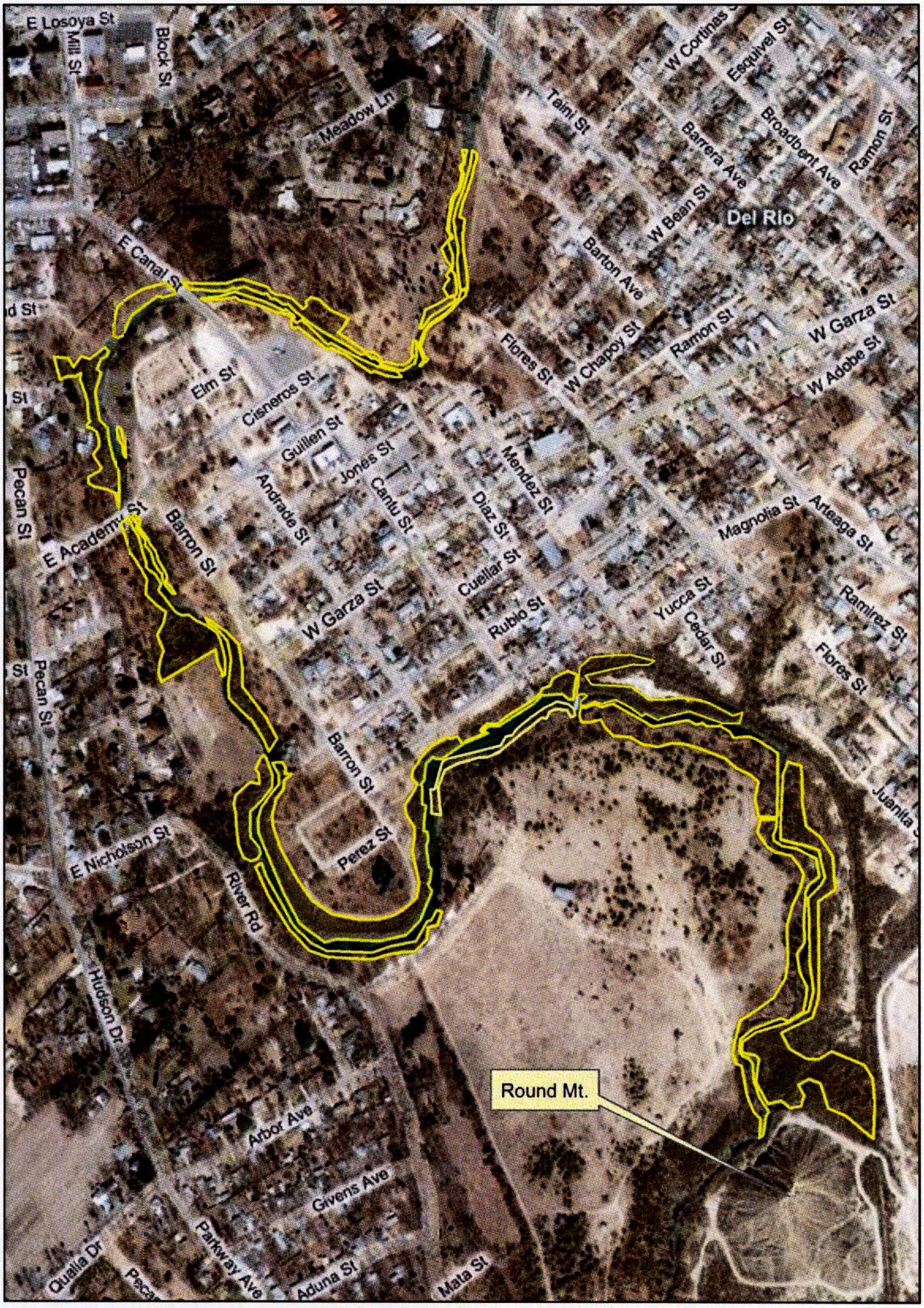

Figure 7. Satellite image of the Southern portion of San Felipe Creek with areas infected by Giant River Cane delineated.

Recommendations

While the portion San Felipe Creek within the Del Rio city limits is significantly infected with Giant River Cane, it has not achieved an "unmanageable" state. For the 4.65 miles of creek surveyed, approximately 38 acres of cane currently exists. Therefore, a combination of mechanical and chemical removal seems appropriate. Because of the nature of how this plant can establish new populations from pieces of cane which have drifted downstream from dislodged upstream plants, it would behoove any treatment strategy to start at the upper most reaches of San Felipe Creek and proceed in a downstream direction.

For rather small cane patches, less than 20 feet in diameter, hand cutting with an ax and/or machete could effectively remove the above ground biomass. Hand cutting should be implemented during mid-summer (approximately mid-July) after the cane has produced it sterile flower heads. It is important to remember that any cut stalk has the potential to re-sprout and establish new plants if left on the ground. Therefore, it is *imperative* that all cut stalks be chopped up into pieces less than one inch in length. The best method to achieve this would be to pass all cut stalks through a shredder or chipper. After initial cutting and chipping of the above ground biomass, the underground rhizomes need to be addressed. While digging with pick-axes could be utilized to remove the rhizomes, this would require significant labor and result in significant soil damage and subsequent siltation into the creek. Chemical control methods offer a better and more effective control method for dealing with the rhizomes. After the initial above ground biomass has been removed, the rhizomes will begin actively growing and producing new shoots. During this new "growth" spurt the new shoots are highly susceptible to chemical treatments. Approximately a month after the initial cutting (mid-August), the new shoots should be about 2-3 feet tall. Application of 3% - 5% solution of Rodeo® and DyneAmic® during this "re-growth" period will effectively drive the active ingredients of the herbicide into the rhizome permanently killing the plant. Several months later during the winter, the resulting dead canes should be removed and shredded. Repeat this schedule the following summer on any fragments of cane which have survived the initial treatment efforts.

For patches larger than 20 feet in diameter and accessible to large pieces of equipment, a tractor or brush-hog would be suitable for removing the majority of above ground biomass. However, again it must be emphasized, none of the resulting cut stalks of cane should be allowed remain on the ground or allowed to fall in the creek and float downstream. All of the stalks must be gathered and passed through a shredder or chipper. A follow-up application of herbicide must be applied several weeks after the initial removal of the above ground biomass and the rhizomes have re-sprouted.

For patches too big to be cut by hand and not accessible to heavy equipment, the best method is simply to spray the mature cane with herbicide. This herbicide application should be applied mid-summer (approximately mid-July) after the cane has produced its sterile flower heads. During the winter months, when the cane is dormant and not actively growing, the resulting dead cane should be removed. These "dead" stalks should be carefully gathered and passed through a shredder or chipper. During the following summer, after any unaffected plant rhizomes have re-sprouted and flowered, re-application of herbicide may be necessary. Again during the winter months, cut and shred all resulting dead canes. Continue with this schedule until the cane patch has been successfully reduced in size, at which point it can be treated and maintained by hand.

In reality these recommendations are simply a method to "control" Giant River Cane. Until the USDA can successfully establish numerous self-sustaining populations of multiple biological control agents along the Rio Grande River, the real possibility of re-establishment of Giant River Cane along San Felipe Creek exists. Therefore, for the foreseeable future mechanical and chemical control methods need to be implemented by Del Rio's Parks and Recreation Department. The initial expenditures both monetarily and physically may be substantial. Both time and money need to be budgeted by the city of Del Rio to effectively control Giant River Cane. However, as the population of Giant River Cane along the creek becomes under control, both of these costs will diminish significantly. Initial estimates for the treatment of approximately 38 acres of cane currently established along San Felipe Creek are $5,985. These estimates are for the price of herbicide and surfactant alone. They do not take into consideration the cost of water, equipment or labor. Moreover, experiments indicate that at best only 60% kill ratios can be expected (Hart and Hatler 2009). Therefore, after the initial treatment the city can reasonably expect approximately 15-16 acres of Giant River Cane to survive and need follow-up treatments the next year. This will require approximately $2,520 worth of chemicals during the second year of treatment. During the third year approximately 6 acres of cane will probably still survive and require an additional $957 in chemicals. During the fourth and subsequent years it is reasonable to expect 2-3 total acres of cane to continually reestablish and persist along San Felipe Creek, requiring an annual chemical expense of approximately $472.

The encouragement of a diverse, native riparian plant community adjacent to the creek will further help to prevent the re-establishment of Giant River Cane along the banks of San Felipe Creek. The best way to establish this native plant community is with a "managed riparian zone" along the banks of the creek. This zone should extend perpendicular, at least 30 feet in width, from the soil – water interface. Depending upon the overall size of the Giant River Cane patch being treated, it may be necessary to temporarily plant fast growing annual plants, during the first few years of mechanical and/or chemical control. These "temporary" plantings will serve to minimize soil erosion while the cane is being removed. Once the cane has been eliminated or reduced to a manageable size, native plants species can be planted. As these newly established "managed riparian zones" mature, they will help prevent the establishment of invasive exotic plant species. However, it is important to understand that these newly established "managed riparian zones" must not be treated as "hands-off" areas. Quite the contrary, these newly established "managed riparian zones" must be continually monitored to prevent any future establishment of Giant River Cane or any other exotic invasive species. If any invasive species are encountered trying to re-establish themselves, they must be quickly and swiftly removed. A continual monitoring and "spot" treating of Giant River Cane along San Felipe Creek will be the most effective and economically efficient protocol for long term control.

A permanent solution is going to have to necessarily rely on the success of various biological control measures currently being tested by the USDA. Therefore, the continuation of a collaborative and cooperative relationship with the USDA, which encourages the use of San Felipe Creek as an inoculation site for current and future biological control agents, would be most beneficial to all parties involved.

Tools for Application

For the chemical control of Giant River Cane two types of foliar sprayers will be required. High-volume foliar sprayer should be used for the reclamation of larger areas where the cane has achieved heights greater than 6-8 feet and a density of 1,500 stem per acre or higher. These types of sprayers can accommodate spray solutions between 100 – 400 gallons per acre Figure 8). Low-volume foliar sprayers should be used for the treatment of smaller patches, where the cane is usually less than 6-8 feet and fewer than 500 stems per acre. Typically, these are back-pack style sprayers that can accommodate spray solutions of 5 – 30 gallons per acre. Additionally, low-volume foliar sprayers require fewer personnel, allowing for a quicker more precise application, at close range, resulting in minimal drift of herbicide spray (Figure 9).

Figure 8. Use of a High-Volume Foliar Sprayer.

Figure 9. Use of a back-pack style Low-Volume Foliar Sprayer.

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APPENDIX C

SAN FELIPE CREEK VISION PLAN

Developed by:
San Felipe Creek Commissioners
June 2007

SAN FELIPE CREEK
VISION PLAN

MISSION STATEMENT

The San Felipe Creek Vision Plan reflects the values of the Del Rio community as it interacts with the ecosystem of San Felipe Creek. The Vision Plan seeks to restore the natural ecosystem of the creek through community education, preservation and rehabilitation efforts by utilizing local, state and federal resources available to civic and government entities. The Vision Plan aims to create a balanced environment between recreation, development and preservation of the natural beauty of San Felipe Creek.

VISION STATEMENT

The San Felipe Creek Vision Plan must achieve a sense of harmony between nature and human enjoyment

SCOPE OF VISION PLAN

The San Felipe Creek Vision Plan covers all areas of the creek within the city limits.

SAN FELIPE CREEK VISION PLAN
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SAN FELIPE CREEK
VISION PLAN

CHAPTER I
INTRODUCTION

Setting

San Felipe Creek is primarily located within the City of Del Rio, in Val Verde County, Texas. The major source of water comes from the San Felipe Springs; flows typically range from 50 to 90 MGD (million gallons per day; 77-139 cfs). The creek flows into the Rio Grande just below Amistad International Dam.

Del Rio is situated in a biological transition zone in south central Texas; here three major biotic communities join. The Chihuahuan Desert, exemplified by the Big Bend country to the west, reaches its eastern limits in Val Verde County. The Edwards Plateau, or Balconian, community (known to Texans as the 'Hill Country'), lies to the north. The Tamaulipan Shrubland comes up from south Texas and Mexico and reaches its northern limits here. Flora and fauna characteristic of all three communities enrich Val Verde County, and create an attraction for residents and visitors alike.

Geologically, the Del Rio area is underlain by thick beds of 100 million year-old Cretaceous limestone formed in an ancient sea bed. Like all limestone, the rock is porous and can contain and convey vast quantities of water.

Climatologically, the Del Rio area is generally under the influence of the Gulf of Mexico. Tropical storms, and even a rare hurricane, occasionally make their way up the Rio Grande with disastrous and tragic results. Moving west from Del Rio, the climate becomes more continental- drier and less humid. This is why the semi-tropical Tamaulipan Shrubland eventually gives way to the arid Chihuahuan Desert.

San Felipe Creek, therefore, is at a biological and climatologically crossroads. The varieties of habitats and resources that include the creek and its environs have attracted people for thousands of years. Modern humans continue to focus their attention on the creek.

CHAPTER II
HISTORY

A. Settlement along San Felipe Creek

Archeological evidence demonstrates that human beings have lived in the area now known as Val Verde County for thousands of years. At the edge of the Chihuahuan Desert, San Felipe Creek is the third largest natural spring in Texas. As early as 1590, explorers marveled at such an oasis of life, vegetation, and water at the edge of a barren land mass. Over 43 spring sites have been recorded in the Val Verde County area. The springs are a natural attraction to life and settlers.

Archeologists have found evidence of settlements at least 11,000 years old. Hundreds of cave paintings found throughout the area are evidence of early human presence in the Val Verde County area. The National Park Service accounts for over 400 different archeological sites of early human presence throughout their recreation area with an unknown number currently on private land and in Seminole Canyon State Park and Historic Site.

Archeologists are unclear as to the nature of the tribes that settled along this jewel in the desert. As many as 15 different tribes may have permanently or seasonally inhabited the San Felipe Creek region. Record of these tribes come from archeological sites and recorded history from Spanish explorers who traveled the area around 1590 on their way to explore parts of New Spain.

Between 1672 and 1783 several attempts were made by the Spanish government of New Spain to settle near San Felipe. Settlements were not successful because of their remote location and the rugged terrain. Local legend credits the naming of the springs to Fray Juan Larios and Spanish priests who celebrated mass along the springs and named them San Felipe Springs. Although unverified, San Felipe Country Club currently has a historic marker on golf course property commemorating the first mass celebrated along the creek.

San Felipe Creek saw no new attempts at European settlement until after Texas became a part of the United States in 1845. Between 1845 and 1858, San Felipe Creek and modern day Del Rio became a high traffic area for travel west to El Paso and California. The route was carved out to capture trade from Mexico and all points west. However, no settlements were established along San Felipe Creek until 1859, when a man named Johnson settled along San Felipe Creek with his wife and two children.

The Johnson settlement did not last very long; therefore, the first permanent settlement and the one considered to be the founding of Del Rio is that established by James Taylor and his wife Paula Losoya Taylor in 1862. The Taylor settlement quickly became the economic and religious center of the new community along San Felipe Springs. The new community of San Felipe Del Rio was born.

1. Development Along the creek
After the Taylor settlement, development along the creek was quick. Between 1862 and 1890, San Felipe Del Rio grew exponentially due to cultivation of the rich soil along the creek banks by the Taylor *hacienda*. Sacred Heart Church was established in 1891 signaling the significant growth that had occurred in the previous 28 years of settlement. One year after the blessing of Sacred Heart Church in 1905, a new parish was established – Our Lady of Guadalupe Parish. San Felipe Del Rio continued to grow with the establishment of a third parish– Saint Joseph's– in 1927.

Development progressed due to the vision of James Taylor and some associates who established the San Felipe Agricultural, Manufacturing and Irrigation Company in 1868. The company paved the way for the cultivation of land along the San Felipe Creek and the establishment of the creek's engineering marvels – the San Felipe irrigation canal system. Along with the Taylors, many prominent businessmen settled in San Felipe Del Rio making it a viable town. In 1875, the community applied for a charter from the Secretary of State. Despite this, Del Rio was not incorporated as a city and the first government was not organized until 1905; the first elections were held June 21, 1905. Boundaries were set for the city that constituted modern day downtown Del Rio and the properties along the San Felipe Creek in the proximity of downtown.

With the establishment of a city government, San Felipe Del Rio continued its growth. Development along the creek created large tracks of land for irrigation and cultivation, and economic growth was focused on the downtown area which was away from the creek banks. Development along the creek from the establishment of San Felipe Del Rio in 1905 until today has been predominately residential. The beauty of the area has attracted many residents to build large homes along the banks of the creek. Very few commercial businesses have opened along the creek; the most successful is Memo's Restaurant.

The irrigation system continues to supply water to private homes and agricultural fields along the creek. Today the amount of water diverted from the San Felipe Creek for use in the canal system is regulated by the Texas Commission on Environmental Quality. Currently the commission set the yearly usage at 5,000 acre feet. However, the average amount of water pumped out of the San Felipe Creek into the irrigation canals is about 3,000 acre feet per year. These irrigation canals were engineering marvel that made Del Rio's growth possible. The Taylor vision, the irrigation system, and the abundant water of San Felipe Springs made the settlement of San Felipe Del Rio a reality and the community we see today.

2. The Flood of 1998
As in many watersheds, structures along San Felipe Creek carry some risk of damage by the waters that rush through the creek. In 1998, disaster struck the residents of Del Rio and the homes along San Felipe Creek. The remains of Tropical Storm Charley settled over the Del Rio area in August dumping over 18 inches of rain. The result of the heavy downpour was a massive increase in the flow of San Felipe Creek.

The increased rainfall on San Felipe Creek created floodwaters higher than the 1954 flood. The wall of water destroyed over 200 homes along the banks of the creek and killed nine residents of Del Rio. The homes along the southern banks of the creek were devastated by the floodwater. Homes in the San Felipe neighborhood were washed away or destroyed completely. Many more homes were damaged beyond repair.

3. Today

The San Felipe Creek area is still recovering from the devastation of the '98 flood. With the help of the Federal Emergency Management Administration (FEMA), the City of Del Rio bought many of the properties damaged by the flood. Those individuals who lost their homes to the flood were issued temporary housing on Hwy 90 East. The City of Del Rio in currently in the process of reviewing ideas for the utilization of the properties bought with the FEMA flood plain money.

San Felipe Creek continues to be the centerpiece of Del Rio life. Children and adults alike find comfort, relaxation, and recreation along the banks of the creek. The enjoyment that the creek provides the citizens of Del Rio should be shared with the world. San Felipe Creek can become Del Rio's major tourist attraction.

Current Condition of San Felipe Creek:

1. 6,072 linear feet (1.15 linear miles) of the creek banks are rock-lined.
2. 9,640 linear feet (1.825 linear miles) of the creek is dominated by exotic cane (Arundo donax).
3. Currently the creek has six walkway bridges and seven street bridges in place.
4. The bulk of recreation is around Blue Hole, off of HWY 90. During the summer months this area is used for swimming and gatherings.

B. Events and Recreation at San Felipe Creek

1. San Felipe Creek Historic Events

San Felipe Creek has been the site of many historic events. The creek has been the center of life and recreation for the San Felipe Del Rio community since the first permanent settlements were established in the area. The community of Del Rio has used the creek as the center of all communal activities.

As with any other settlements in the Southwest, the church was the center of all celebrations, births, deaths and events. San Felipe Del Rio is no different. Doña Losoya would hold mass in her *hacienda* near the creek for the small Mexican community that worked on her property. The *hacienda* was the center of all political and religious activities around the creek. The religious community of San Felipe crossed the creek to have their children baptized until 1895 when the Sacred Heart Parish was established.

Many other events became part of the creek, especially the events established by the Mexican community in San Felipe. *Cinco de Mayo* was the biggest celebration in the San Felipe community. However, the community was unable to celebrate in a central location until 1908 when G.W. Brown donated a large tract of land for the purpose of creating a plaza or square near the creek. Plaza Brown was born along the San Felipe Creek landscape with the generosity of Mr. Brown and the hard work of the San Felipe community. The Plaza Brown served as the unifying force for the community that lived along San Felipe Creek and the entertainment center for San Felipe.

Many bands have played in the kiosk build in the Plaza and many politicians have asked for the San Felipe vote from that kiosk. Just like G.W. Brown envisioned, Plaza Brown has become the recreation center for Del Rio. Not only is *Cinco de Mayo* celebrated at Plaza Brown, but *Dieciseis de Septiembre* (Mexican Independence Day) has become a major celebration for San Felipe Creek.

Along with the celebrations on the Plaza many organizations have used the San Felipe Creek as the gathering place for showcasing their hard work or for fundraising events. San Felipe Creek has seen many car shows and motorcycle enthusiasts. Many of the organizations will hold food sales on the banks of the creek to raise funds for local charitable causes or for their operations.

The most important of celebrations has been held on the banks of the San Felipe Creek. The Fourth of July celebration is the cornerstone of all creek events. Once held at Moore Park, the celebration is now held at the Amphitheater. The Amphitheater has become the jewel of San Felipe Creek and the center of many important events on the creek.

2. San Felipe Creek Historic Recreation Areas

Moore Park has been the focus of recreation for Del Rio and San Felipe Creek for many years. The four acre park stands at the north end of San Felipe Creek just after it crosses Highway 90E. Equipped with the City of Del Rio pool, Moore Park serves as an alternative to the clear cool waters of San Felipe Creek and as a gathering place for birthday celebrations.

As San Felipe Creek crosses under the overpass from Highway 277S, a rock path leads to Del Rio's Amphitheater. Built during Mayor Gutierrez's tenure, the Amphitheater stands as a tribute to the beauty of the San Felipe Creek. Only under the restful, clear waters of the creek, can our community come together to celebrate and relax, listen to music, or watch a theater production. At no other time does this statement ring true than on the Fourth of July. On this day Del Rio becomes one community celebrating independence at the Amphitheater on San Felipe Creek.

Another of San Felipe Creek's unifying features is Plaza Brown. Built specifically to create a gathering place for the community of San Felipe; Plaza Brown serves as a cultural reminder of Del Rio's rich Mexican heritage. The *Dies y Seis de Septiembre* and *Cinco de Mayo* are the centerpiece of this unique community asset. Hundreds of citizens come to Plaza Brown to be part of the celebrations every year. Plaza Brown also serves as the focal point for the business community of San Felipe. Once, it was surrounded by a theater and hotel. Now, it is bound by the Casa de la Cultura and Del Rio's Legal Aid Office.

3. San Felipe Creek Education Program

The education and involvement of children are vital to the environmental awareness that needs to be promoted in the community. By the San Felipe Creek Commissioners partnering with the San Felipe Consolidated Independent School District and The Casa de la Cultura the importance of the creek and the habitat that it supports can be expressed to children through educational programs. A hands-on approach with children would be the preferred way to encourage the importance of maintaining the natural integrity of the San Felipe Creek and the habitat that relies on its existence.

C. Economic and Community Development

1. History of Economic Development on San Felipe Creek

One of the oldest businesses along the San Felipe Creek was the Ice Plant. The ice plant manufactured 50 pound blocks of ice for preserving food and cooling beer. The plant was built in 1883 on Academy Street. Ice was a very important commodity for South Texans, particularly in the hot summer months. However, the ice plant produced more than just ice. It was a gristmill, grinding grain from local farmers and from Mexico. Eventually, the ice plant became a power generating plant using coal from the mines in Eagle Pass to generate electricity for the town.

The oldest business near the San Felipe Creek in what is known as the San Felipe neighborhood was "La Constancia." Owned an operated by Don Jose Tagliabue and his wife, "La Constancia" opened its doors in 1881 as the first general store near San Felipe Creek. It catered to the people living in San Felipe along the creek who had to cross the creek to get any general goods prior to Don Jose opening his store. "La Constancia" became one of the many businesses that opened near the creek to serve the community along the creek.

San Felipe Creek saw the opening of a slaughterhouse and meat market in 1891. In 1893, the first of many Spanish language newspapers to serve the community opened. After the opening of this first newspaper, many followed in its place serving the needs of the Hispanic community living along the banks of the creek. Entertainment also became an important part along the Creek. The first Little Theater was organized in San Felipe in 1897 with its first production at the school house.

The early 1900s brought a growth in businesses along the San Felipe Creek. Many new grocery stores opened to provide the produce needed for the thriving population along the creek. The Villareal Grocery Store, "La Tienda Colorada," and Urby's Super Market all opened within a few years of each other near the creek.

Grocery stores were not the only businesses that opened. In 1909, Don Santos S. Garza opened Teatro Juarez, the first theater in San Felipe. Located on Cantu and Guillen Streets it was located along the creek. The theater offered celluloid films and live theater for the residents of the creek community. Many other theaters sprung up soon after Don Santos opened Teatro Juarez. Teatro Madero opened in 1913. The Casino opened in 1923 on the northeastern part of the Plaza Brown and served the community until 1938.

A café, bookstore, cleaners, hotel and filling station, funeral home, and pharmacy were all part of the development of the community along the San Felipe Creek in the early 1900's. The vibrant community supported all these businesses as they sprung up along the creek boundaries. The community continued to prosper, even after the flood of 1954. The businesses along the creek were tied to the community in San Felipe and as San Felipe grew, so did these businesses.

However, the growth of Del Rio soon impacted the community. HEB, Wal-Mart, and Plaza del Sol Mall all contributed to the decline of the local grocery and department stores by crippling the many merchants that survived in the community. San Felipe residents found themselves crossing the creek more and more to shop at these stores.

The 1998 flood also had a devastating effect on the San Felipe Creek community. Hundreds of homes were destroyed and those individuals relocated to other parts of town. The community changed as the creek waters changed the landscape.

Today, there are few businesses along the creek or in San Felipe. The ones that survived the flood, like Memo's Restaurant, continue to operate. Commercial Development along the creek is minimal. To date no new businesses are moving to the creek, most locate on the north side of Del Rio or in downtown ignoring the opportunity that the creek might bring.

CHAPTER III
Nature and the Environment

A. Natural Environment of the San Felipe Creek

1. Source and Use of the Creek

San Felipe Creek flows from the third largest spring system in Texas. Although there are several springs throughout the aquifer area, the City of Del Rio uses only the two main springs for its water supply. The aquifer derives its water from the Edwards and Trinity plateau, which lies above the Balcones fault zone. The underground aquifer is believed to cover over 6,500 square miles. The West Spring is classified as ground water; the East Spring is classified as ground water under the influence of surface water.

2. Development of Natural Vegetation
Natural vegetation needs encouragement by removing non-native vegetation and minimizing compaction of soil by pedestrians and automobiles and thru the reduction of mowing.

3. Habitat

A. Riparian- This zone is the area adjacent to and interactive with the stream. Riparian zones provide ecologic value by filtering pollutants, controlling soil erosion, and supplying habitat for vegetation and wildlife. Natural riparian areas are structurally diverse and more productive in plant and animal biomass than adjacent upland areas. Riparian areas supply food, cover, and water for many organisms, and serve as migration routes for a variety of wildlife. Because riparian ecosystems often are relatively small areas and occur in conjunction with waterways, they are vulnerable to alteration.

B. Stream- The steam consists of the flowing, aquatic habitat and its interactive organisms and physical elements. Organisms include plants, invertebrate, amphibians and fishes as well as terrestrial animals that depend on the stream. Physical elements include temperature, water chemistry, gradient current and substrate.

4. Conservation of Native Species
The Devils River Minnow (*Dionda diaboli*) is a small fish in the minnow family, *Cyprinidae*. It is recognized as a distinct species by the American Fisheries Society (Robins et al. 1991) based on morphology (Hubbs & Brown 1956), genetic markers (Mayden et al 1992), and chromosome differences (Gold et al 1992). Adult Devils River Minnows reach sizes of 25-53 mm (1.0-2.1in.) standard length. It is native to tributary streams of the Rio Grande in Val Verde and Kinney Counties, Texas and Coahuila, Mexico. This includes San Felipe Creek from headwater springs to springs in Del Rio and downstream.

The San Felipe Gambusia (*Gambusia clarkhubbsi*) is the first new fish discovered in Texas in over 30 years (Garret and Edwards 2004). Nine species of *Gambusia* are known to have occurred in Texas. Two are extinct and one is now extirpated from Texas waters. The majority of these species are (or were) adapted to specific spring environments, and most occurred sympatrically with other *Gambusia*. This new species also appears to be a spring specialist, occurring with the Mexican mosquito fish *(G. Speciosa)* in the head waters of San Felipe Creek. The new species belongs to group of fishes called mosquitofish, named because they consume vast quantities of mosquito larvae and are instrumental in the control of mosquito-borne disease vectors. The adults of this new species are typically one inch long and female adults are about and inch-and-a-half long. The color of San Felipe *gambusia* is light overall with caudal fins that are colorless to dusky except for a dark bar near the margin in mature specimen.

The discovery of this fish is thought to be linked to innovative work by the City of Del Rio and the San Felipe Country Club to improve and protect aquatic habitat along the San Felipe Creek. As enhanced vegetation and more environmentally friendly approaches to creek-side land management are instituted, aquatic habitat is improved, causing native fish populations to rebound and become more widespread and visible.

B. Environmental Issues

1. Water Quality

Water quality is of paramount importance. Urban and suburban runoff is the single biggest source of water pollution in most waterways. All existing and future activities and can have an impact on San Felipe Creek in terms of urban runoff, potential for accidental spills, and any other source of pollution. The use of pesticides and fertilizers should be minimized on city property and discouraged from use among private citizens along the creek. All possible sources of point and non-point source pollution should be investigated and eliminated.

The population of domestic ducks which reside near Highway 90 are a direct source of concentrated fecal pollution causing excessive growth of water plants and algae. In still waters, such as the Blue Hole area, these plants die in the summer and the decomposition process removes oxygen in the creek waters which may directly and negatively impact fish populations as well as other aquatic inhabitants. In addition, the presence of large amounts of feces and coliform bacteria may present a health hazard to the children and adults who swim at the Blue Hole.

Development along the creek is also a concern. Not only would it put these entities at risk in the event of a flood, but commercial development could also create other sources of pollution. The City has the ability to control and restrict inappropriate development in the drainage basin through zoning ordinances.

The construction of conventional-style parking lots should be especially discouraged. Rainfall runoff from parking lots can produce pollution, so, provisions should be made to construct a catchment (retention pond) to process the runoff or it should be directed to extensive areas of native vegetation to filter pollutants out.

The watershed consists of all the surrounding land area that conveys rainfall into the San Felipe Creek basin. It is made up of upland, undeveloped lots, highly developed residential and business areas. The status of the watershed can have a direct impact on the quality of water in San Felipe Creek and its ecosystem. Non-point and direct sources of pollution through runoff can especially have a damaging effect on the ecosystem. The upland zone is the area adjacent to the riparian zone. Natural upland areas in the San Felipe watershed contain many tree and shrub type plants, such as, huisache, cenizo, hackberry, and prickly pear cactus. These upland areas are key for providing food and habitat for maintaining the native fauna. Upland habitat provides additional benefit by reducing sediment loads, fertilizer runoff, and contaminants from flowing directly into the creek.

C. New Park Development

The damaged areas from the flood of 1998 along the San Felipe Creek that were bought out by FEMA have been cleared of debris and are now grass covered lots maintained and mowed by the City of Del Rio. Some of these areas have been turned over to various organizations in Del Rio to be used as parks. The city is currently designating areas along the creek as no mow zones (see attached map), these areas will help filter debris from entering the creek. The city is currently following procedures given to us by the Texas Parks and Wildlife to eradicate the non-native exotic river cane (Arundo Donax) along the creek; this is an on going process that will encourage the growth of native plants along the creek bank. We are also in the process of creating larger tracks of non-mowed areas with a walking path that will also serve as a habitat for the local birds. A hike and bike trail is also scheduled to be built along the creek to encourage wildlife viewing along the creek banks. San Felipe Creek has already been designated by Texas Parks and Wildlife Department as a nature viewing site for the Central Texas Nature Viewing Trail and will attract birdwatchers to the community.

CHAPTER IV
CHALLENGES

A. Event and Recreation Challenges

1. Attracting Audiences

Attracting audiences from around the region is a major challenge for San Felipe Creek Events. Many of the events on the creek are events that are also celebrated in the surrounding communities. Consequently, the surrounding communities will likely not attend the San Felipe Creek events. The challenge is to create events that are unique to San Felipe Creek and the surrounding communities. Events such as these have a potential for becoming tourist attractions for the City of Del Rio.

2. Mitigation of Environmental Impacts

Events and recreation areas on San Felipe Creek face the monumental challenge of mitigating the environmental impact– parking, trash, vehicle pollution – on the creek itself. The natural wonder that is the creek must be maintained free of contamination of all types. Events and recreation areas bring people and people most of the time bring trash. Consequently, this plan must educate the public about the importance of minimizing the environmental impact on the San Felipe Creek.

3. Marketing

Marketing is an important component of any event or recreation area. The San Felipe Creek is faced with a major challenge of marketing its natural, man-made, and event attractions. Developing a marketing strategy to attract tourists and locals to the creek on a consistent basis is important to the success of this Master Plan.

4. Safety
To ensure successful events and recreation facilities along the Creek, the City faces a safety challenge that can only be resolved with additional lighting and careful maintenance of vegetation. The creek must be a haven for individuals. They must feel safe before they venture into the creek. Consequently, safety becomes a major challenge.

B. Environmental Challenges

Preserving Natural Flow
1. The city relies on the San Felipe Springs for its drinking water, and the San Felipe Irrigation Company diverts water from the Creek into its irrigation canals. Although these users are essential to the community, and have never been shown to adversely affect the ecosystem, conservation measures could and should be considered.

2. San Felipe Springs are the only source of water for the City of Del Rio, as well as, Laughlin Air Force Base. Flow from San Felipe Springs typically ranges from 50 to 90 MGD (million gallons per day; 77-139 cfs). Its meandering creek provides for recreational use, outdoor experiences and excellent habitat for wildlife. Its serene flow allows for several passive parks and swimming areas. The surrounding vegetation and landscape allows for excellent bird watching.

3. With the San Felipe Springs being the sole source of water for Laughlin AFB, maintaining the water quality and quantity is imperative to their mission here in Del Rio. They have taken steps to help with water conservation as well by setting in place a lawn watering schedule for not only their offices but the residential units on base. Laughlin AFB also reserves the right to adjust the schedule through out the year should it be required. See attached.

4. The City of Del Rio, with local funds and grants (made possible by the NADBank/EPA), began construction of a water treatment plant in February, 2001. The plant was completed in August, 2002. The water treatment plant is located on the east side of the creek. However, in order to pump water from the West Spring the contractors designed a structure that will not disrupt the flow or ecology of the creek. In light of a $14 million dollar grant given to the City of Del Rio by the NADbank/EPA, we acknowledge the commitment to the conservation of the San Felipe Creek by both the City and federal government. With the anticipated growth of Del Rio, the water treatment plant also allows for expansion.

C. Economic Development Challenges

1. Floodway

Any development along San Felipe Creek faces the challenge of building in a flood zone. After the flood, the Federal Emergency Management Administration and the City of Del Rio recognized the need to regulate the building of structures along the San Felipe Creek. Consequently, a floodway map was created and regulations were adopted to ensure the safety of any structure that is built within this flood zone.

The zone extends outward from the banks of San Felipe Creek in three distinct intervals. First, the floodway which is currently designated as an area where residences cannot be constructed and any other buildings that are constructed require stringent elevation and safety features. Second, the 100 year floodway where residential buildings are allowed, but regulations require certain safety features and elevations. Finally, the 500 year floodway where construction is allowed under the regular building regulations with a few of the regulations found in the other two zones.

The challenge to developers wanting to develop along the San Felipe Creek is the expense of complying with the floodway regulations. In order to build any structure adjacent to the creek, developers must incur significant building costs to meet all regulations.

2. Existing Zoning

If development is to occur along the creek, land use and zoning must be modified to secure the appropriate level of development. Currently, there are few areas zoned for commercial use along the creek. Most commercial areas are along major crossings; none are along the edge of the creek path. Without appropriate zoning, developing the creek will prove to be a sizable challenge.

There are pockets of developable land along the creek that can be used to create multiuse master plan developments as seen in other communities. The land, however, is currently either the property of the City of Del Rio, occupied by longtime residents, or owned by absentee owners.

CHAPTER V
CITY of DEL RIO CODE OF ORDINANCES

A. Flood Damage Prevention

The City of Del Rio Code of Ordinances has various existing ordinances that pertain to protecting water quality. Chapter 11, Flood Damage Prevention, is designed to minimize flood losses. It provides for the restriction or prohibition of building floodplains, construction of stream channel or other natural barriers which accommodate floodwater, controls the filling, dredging, grading, or other developments that may increase flood damage, and prevents or regulates the construction of flood barriers. The areas of special flood hazard are identified by the Federal Emergency Management Administration to ensure conformance with this ordinance. This ordinance also designates the City Manager as the Floodplain Administrator.

B. Offenses – Miscellaneous

Another Ordinance is contained in Chapter 19, Parks, Recreation and Public Gathering Places. This provides for the conduct in public parks and in city activities, sanitation, park property, and enforcement. Specifically, Article IV, San Felipe Creek Walk, Sections 19.5-150 to 19.5-173 provides for the planning, management and coordination of the activities which are conducted in that area and this is accomplished by the designation of the San Felipe Creek Walk Association as the official agency of the city to accomplish this.

C. Sewers

Chapter 23, Sewers, regulates the discharge of wastes, provides rules for private sewage facilities and for licensing and regulation of the removal and disposition of private sewage facility wastes. Section 23.21 Same- To Public waters, states that no waste or wastewater may be discharged to public waters which contains acids, plating solutions. Fats, wax, grease, oils in excess of 100 milligrams per liter (mg/l) or which may solidify or become viscous at temperatures between 32°F and 150°F may not be discharged into public waters. Objectionable or toxic substances, liquids or gases are similarly restricted and disallowed. Permits for discharges are required.

D. Solid Waste

Chapter 24, Solid Waste, regulates the collection and disposal of solid wastes. This chapter provides for the residential garbage collection and for commercial disposal of wastes. The city landfill, permitted by TCEQ, is inspected periodically. Permit number for this facility is MSW 207A, as amended. Wastes are not allowed to collect in order to prevent such wastes from being carried or moved from the property by actions of the sun, wind, rain, or snow. Such wastes, if not collected and removed, could ultimately be deposited in public waters.

E. Water

Also, Chapter 29, Water, contains general provisions for the city as the water purveyor, for regulation of wells, and for water conservation and drought contingency plans. The city council or its designated agent, the City Engineer, shall inspect the wells, have made or make analysis of the well water, go onto private lands to inspect the wells, supervise and inspect the construction and require the owners to furnish all information on the well to include logs, geologic information and depth and size of well constructed. Further, the City is to monitor the daily water demand in case of emergency. The drought contingency plan provides for controls of water usage during droughts or emergency.

F. Drought Contingency Plan

The City of Del Rio via Ordinance No. O:2000-01 approved a revised Drought Contingency Plan and Water Management Plan on January 11, 2000.

1. The plans contain various aspects to determine what is drought condition, what triggers the drought contingency plan, enforcement and fines, in order to establish practices for the conservation of water.

2. The plan defines essential water use, non-essential water use and other such watering. The plans set three contingency triggers and severe water shortage. These trigger conditions set the plan in motion. Basically, this is a measurement of stored water quantities in the Bedell Reservoirs and others.

3. Once the plan is put into effect, notification is given to citizens via radio, television, and newspaper notices. Enforcement can be accomplished by fines and citations for non-compliance. The plan also can require a minimal use of water for watering purposes and establishes watering days based on locations and time of the year.

4. Since it was approved by the City Council, the plan has been put into use only on one occasion.

All ordinances above, or parts thereof, were briefly discussed and are pertinent to protecting the water quality in the San Felipe Creek and the two springs which provide the source of water for the city for domestic and industrial use, recreational use, and to maintain the quality of the public waters of the city.

CHAPTER V
RECOMMENDATIONS

A. Events and Recreation Action Items

1. Membership recruitment for planning activities.

2. Work with groups currently having events along the creek (San Felipe Creek Walk Association, The Brown Plaza Association).

3. Work with local organizations to encourage their events to take place along the creek.

4. Develop a group who can raise funds to help the City with costs associated with caring for San Felipe Creek.

5. Become a 501C3 non-profit to have the ability to apply for educational grants.

6. Continue to block vehicular traffic from areas too close to the creek. Access is by walking or biking down to the creek's edge.

7. Maintenance of the hike and bike trail.

8. Partnership with organizations to allow for some Eco-Tourism along or near the creek. Eco-tourism is the fastest growing segment of the tourism industry in Texas.

B. Proposed Future Events

1. Live music at the amphitheater encourages people to stay, play and picnic (summer).

2. Family Day with a variety of activities.

3. Clean-up events, working in conjunction with the City of Del Rio twice a year.

4. Arts and entertainment festivals, partnering with the local art community.

5. Duck Race.

6. Armored Catfish Festival.

7. Canoe race in the creek.

B. Economic Dev Action Items

1. Develop criteria and a proposed Land Use Map for development along the San Felipe Creek should be included in the San Felipe Creek Master Plan and be adopted by City Council.

It is the San Felipe Creek Commissioners belief that all proposed new development along the San Felipe Creek that does not meet the above mentioned development criteria and land use map should be presented to the Commissioners during a scheduled meeting for approval. If Commissioners believe that the proposed development will maintain the integrity of the creek and approve the development they will recommend approval to the Planning and Zoning Board and to City Council. Without the San Felipe Creek Commissioners approval of the proposed development it would be determined that proposed development would not maintain the natural integrity of the creek and its habitat and therefore not be allowed to proceed.

2. Develop Best Management Practices for development and/or the maintenance of the properties along the creek to be utilized by both governmental and private property owners.

C. Nature & Environment Action Items

1. Removal of non native species in conjunction with the Fish and Wildlife Service, local university and the City of Del Rio. We are currently working with the Fish and Wildlife Service Department to remove the exotic suckermouth catfish from the San Felipe Creek.

2. Pass ordinances to preserve the well being of the creek and its surrounding habitat, i.e., establish no parking zones under bridges and prohibit driving off designated roads. No driving and parking in natural and picnic areas along the creek bank.

3. Work with U.S. Fish and Wildlife Service to monitor steam flow, the Devils River minnow, and habitat health.

4. Signage and education for maintenance of natural areas and no-mow zones.

5. Work with the City's Water Department to test the water quality annually or as Commissioners feel needed.

6. Reduce pollutants: Both point and non point pollution sources to aquatic habitats throughout the range of Devils River minnow need to be detected and eliminated to the maximum extent practicable. Of special concern are inputs from urban environments in San Felipe Creek from Del Rio.

7. Restore and or enhance habitat: A habitat enhancement plan for San Felipe Creek in Del Rio (and other appropriate site) should be formulated and implemented aimed at improving and maintaining physical habitat for Devils River minnow. This may include the physical reconstruction of stream banks with native vegetation and natural stream morphology.

8. Only native plants should be used for landscaping; including planting more trees. (See Wasowski & Wasowski, "Native Plants of Texas") An approved native plant and tree list should be developed and included in the criteria for developing along the creek.

Native plants will be attractive to birds, butterflies and other forms of wildlife that nature tourists and local residents enjoy viewing.

9. As much as possible, stream banks are to be preserved in their natural state, or returned to their natural state as repair of existing sidewalks and retaining walls is performed.

> a. Stream bank retention, repair, and reinforcement, where needed, are to be done by the "most natural" method practicable. A return to a completely natural state with the use of native vegetation is preferred; following that, the use of fiber mats, gabions, etc., should be considered. Concrete, brick, stone, and mortar are to be the last resort.

10. Water diversion outside the immediate Del Rio area (such as regional water marketing), should not be allowed

11. Discourage pesticide use and encourage rejuvenation of natural vegetation. Work closely with the San Felipe Country Club Golf Course to ensure the proper maintenance involving the San Felipe Creek banks.

12. No watering using sprinkler systems.

13. New sidewalks or walking trails may be placed close enough to allow users a view of the waterway, but must be far enough away so as not to encourage erosion or to disrupt existing vegetation. As a general rule, sidewalks should be no closer to the stream bank than 10' and should meander up to 40' -50' from the stream. Occasional water-edge viewing areas may be constructed to look and function as part of the natural system.

14. The population of domestic ducks should be removed from the area.

15. The construction of conventional-style parking lots should be especially discouraged. Rainfall runoff from parking lots along the creek will end up polluting the creek with oils, gasoline and other pollutants. In the event that the construction of a parking lot is necessary, provisions should be made to construct a catchment (retention pond) to process the runoff or it should be directed to extensive areas of native vegetation to filter pollutants out. Other alternatives, such as porous cement ex. Ecocreto, can be looked into.

16. Continue working on the Devils River Minnow Recovery Plan by U.S. Fish and Wildlife Service page 2.4-7:

17. The parks should be developed with one major goal in mind, to create a people-friendly natural area. Areas such as bird watching sanctuaries and walking trails should be developed in conjunction with passive parks. For example, trails could be built 10 to 20 feet away from the creek, allowing natural vegetation to grow and act as a natural

buffer zone between the creek and the developed area. Because it is an urban park, other recreational opportunities will also be made available (e.g., baseball fields, playgrounds, etc.), but the City of Del Rio will take a precautionary stance in the development of San Felipe Creek. Wise planning, in conjunction with the Devils River Minnow Conservation Team, should allow a multi-functional greenbelt that protects the natural resources as well as provides the greatest benefit to the citizens of Del Rio.

18. Natural water flow is to be preserved to the greatest extent possible. There should be no new diversions of water into channels, canals, pools, fountains, etc. Fountains in the creek are not advisable. They reduce flow through evaporation and they communicate a "water waste" message to the community. Natural flow is not only important to the San Felipe Creek ecosystem but also affects the Rio Grande ecosystem and ultimately, fresh-water outflow to estuaries in the Gulf of Mexico.

19. Forge a partnership with Val Verde County, Laughlin AFB and local ranchers to ensure the protection of the San Felipe Creek.

D. No-mow Zones

1. No-mow zones should be designated in open space areas adjacent to the creek. Mosaic patterns should be used to make the resulting combination of open and closed areas pleasing to the eye by avoiding hard edges. As a practical guide, no mowing should take place within and under the drip line of existing trees. No-mow zones also serve to provide habitat for birds and other wildlife.

2. Map of no-mow zone is included. See attached.

3. Signs should be posted and fliers available to educate the public on the no-mow zones.

E. Removal of Noxious, Exotic Vegetation and the Restoration of Native Plants

River cane (Arundo donax) should be removed along the length of the creek with the cooperation and under the close supervision of personnel of the Texas Parks and Wildlife Department using EPA wetlands approved herbicide. This should be done only by prescription (due to the presence of a threatened fish species) and should be performed in the upper reaches of the creek first, to prevent re-establishment of the cane in lower areas through fragmentation. This should only be done after an agreement has been reached to allow re-vegetation of these areas with native vegetation through natural means. One year of experimentation with herbicides in lower reaches of the creek (where the Devils River Minnow is known not to occur) should first be performed to fully assess the effects of treatment to aquatic species and the surrounding ecosystem.

Exotic plant removal should ultimately be done in short stretches at a time in order to maintain the stability of existing banks in the event of a flood. Other introduced plant species (Chinese tallow, elephant ears) should also be selectively removed from creek side areas. As unwanted plants are removed, re-vegetation with native species is critical to success and system stability. Some segment-specific re-vegetation (e.g., butterfly gardens) may be desirable in some areas and passive re-vegetation may work best in others.

IV REPORTING

1. **The San Felipe Creek Master Plan Commissioners will create an annual report to be presented to City Council during the first quarter of the year. This report will include previous year goals met and/or revised along with current year goals.**
2. **The San Felipe Creek Master Plan Commissioners will report to City Council on an as needed basis to discuss amendments to the current Master Plan.**

APPENDIX D

U.S. Fish & Wildlife Service

Devils River Minnow
(Dionda diaboli)

Recovery Plan

September 2005

DEVILS RIVER MINNOW

(*Dionda diaboli*)

RECOVERY PLAN

Southwest Region

U.S. Fish and Wildlife Service

Albuquerque, New Mexico

Approved: Nancy J. Gloman 8/10/05
acting **Regional Director, Southwest Region** **Date**
U.S. Fish and Wildlife Service

Concur: [signature] 8/22/05
Executive Director **Date**
Texas Parks and Wildlife Department

DISCLAIMER

Recovery plans delineate actions that the best available science indicates are required to recover and protect listed species. The U.S. Fish and Wildlife Service, sometimes with the assistance of recovery teams, contractors, State agencies, and others, prepares and publishes recovery plans. Objectives will be attained and any necessary funds will be made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Nothing in this plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service **only** after they have been signed by the Regional Director as **approved**. Approved recovery plans are subject to modification as dictated by new information, changes in species status, and the completion of recovery actions. Please check for updates or revisions at the website below before using.

LITERATURE CITATION SHOULD READ AS FOLLOWS:

U.S. Fish and Wildlife Service. 2005. Devils River Minnow (*Dionda diaboli*) Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

ADDITIONAL COPIES OF THIS DOCUMENT MAY BE OBTAINED FROM:

U.S. Fish and Wildlife Service
Austin Ecological Services Office
10711 Burnet Road, Suite 200
Austin, TX 78758

U.S. Fish and Wildlife Service
Southwest Regional Office
500 Gold Street, SW
Albuquerque, NM 87102

Online at: http://www.fws.gov/endangered

Fees for plans vary depending on the number of pages in the plan.

ACKNOWLEDGEMENTS

The U.S. Fish and Wildlife Service gratefully acknowledges the commitment, dedication, and efforts of the Rio Grande Fishes Recovery Team in the preparation of this recovery plan. Dr. Gary Garrett, Texas Parks and Wildlife Department, and Dr. Robert Edwards, University of Texas-Pan American, provided particularly helpful assistance. In addition to the Team members, consultants to the Team provided significant additions to the plan. Dr. Kirk Winemiller, Texas A&M University, and Mr. John Karges, The Nature Conservancy, were especially helpful. Without the valuable expertise and assistance of these individuals, and others, this recovery plan would not have been possible. We sincerely appreciate the many other people who have provided assistance on this plan and the individuals and organizations who work for recovery of the Devils River minnow.

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EXECUTIVE SUMMARY

Devils River Minnow Recovery Plan

Current Species Status: The Devils River minnow (*Dionda diaboli*) was listed as a threatened species on October 20, 1999. It has a Recovery Priority of 2. It occurs in three streams in Val Verde and Kinney counties, Texas, all tributaries to the Rio Grande: Devils River, San Felipe Creek and Pinto Creek. The current status of the species in Sycamore Creek, Texas, and in the Río Salado drainage in Mexico is not known. The species is believed to be extirpated from the lower portions of the Devils River (now Amistad Reservoir in Val Verde County), Las Moras Creek (Kinney County), and from the Río San Carlos (Mexico).

Habitat Requirements and Limiting Factors: The Devils River minnow is found in small spring-fed streams of fast-flowing waters over gravel substrates often associated with emergent aquatic vegetation. Primary threats are habitat loss and non-native species introductions.

Recovery Strategy: The recovery strategy is to reduce threats to the species by securing adequate habitat conditions (clean, free-flowing springs and streams), allowing viable, self-sustaining populations to persist in the wild throughout its remaining range (includes controlling non-native species), and where feasible, to restore populations within the historic range. The primary focus is to protect naturally functioning spring and stream ecosystems within its current and potentially restorable historic range. See section 2.2 for the full recovery strategy for Devils River minnow.

Recovery Goal: Delisting.

Recovery Criteria: Delisting the Devils River minnow should be considered when threats have been removed or reduced as indicated by the following:

(1) Population monitoring verifies stable or increasing population trends for Devils River minnow for at least 10 years throughout its range including Devils River (middle portion), San Felipe Creek, Sycamore Creek, and Pinto Creek in Texas. If reestablishment is scientifically feasible, populations should be restored in Las Moras Creek. The status of populations in the Rio Salado drainage in Mexico should also be confirmed;

(2) Adequate flows in streams supporting Devils River minnow have been assured, including Las Moras Creek (if reestablishment is feasible), through State or local groundwater management plans, water conservation plans, drought contingency plans, regulations, or equivalent binding documents;

(3) Protection of surface water quality, including the protection of the quality of groundwater sources of surface water flows, is ensured throughout the range of Devils River minnow by demonstrated compliance with water quality standards and implementation of water quality controls, particularly in urban areas such as the cities of Del Rio and Brackettville; and

(4) Management and control of non-native species by local, regional, State, and Federal authorities are demonstrated to be successful.

Actions Needed:

(1) Maintain and enhance Devils River minnow populations and habitats range-wide.

(2) Establish additional Devils River minnow populations within the historic range.

(3) Maintain genetic reserves of the Devils River minnow through captive propagation until no longer needed.

(4) Disseminate information about Devils River minnow conservation.

Total Estimated Cost of Recovery by Recovery Action Priority: (Dollars x 1000)*:

Year	*Priority 1a	Priority 1b	Priority 2	Priority 3	Total
2005-6	$175	$470	$105	$10	**$760**
2007-8	$250	$450	$140	$70	**$910**
2009-10	$200	$230	$100	$0	**$530**
2011-12	$200	$170	$0	$50	**$420**
2013-14	$150	$120	$0	$30	**$300**
Total**	**$975**	**$1,440**	**$345**	**$160**	**$2,920**

* **Priority 1a** = An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future. **Priority 1b** = An action that by itself will not prevent extinction, but which is needed to carry out a Priority 1 action. **Priority 2** = An action that must be taken to prevent a substantial decline in species population/habitat quality or some other substantial negative effect short of extinction. **Priority 3** = All other actions necessary to meet the recovery objectives.

** Some costs for Recovery Actions were not determinable, such as costs for habitat restoration activities; therefore, total costs for recovery are likely higher than this estimate.

Date of Recovery: If recovery efforts are fully funded and carried out as outlined in this plan, recovery criteria could be met by 2014.

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1.0 BACKGROUND

1.1 Introduction

The Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) (ESA), established policies and procedures for identifying, listing, and protecting species of wildlife and plants endangered or threatened with extinction. The ESA defines an "endangered species" as "any species which is in danger of extinction throughout all or a significant portion of its range." A "threatened species" is defined as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range."

The U.S. Fish and Wildlife Service (Service), of the Department of Interior, is responsible for administering the ESA's provisions as they apply to the Devils River minnow (*Dionda diaboli*). Section 4(f) of the ESA directs the Service to develop and implement recovery plans for listed species or populations. The purpose of a recovery plan is to identify and guide species recovery efforts. It is intended to serve as a road map for recovery—laying out where we need to go and how best to get there. Recovery plans also ensure that we use sound science and logical decision-making throughout the recovery process. Recovery plans are strictly advisory documents developed to provide recovery recommendations based on resolving the threats to the species and ensuring self-sustaining populations in the wild. Such plans are to include:

(1) A description of site-specific management actions necessary to conserve the species or population;
(2) Objective, measurable criteria which, when met, will allow the species or populations to be removed from the list; and
(3) Estimates of the time and funding required to achieve the plan's goals and intermediate steps.

Section 4 of the ESA also describes the procedures for delisting species (removing them from the list). A species can be delisted if the Secretary determines that it no longer meets endangered or threatened status based upon any of the five listing factors in section 4(a)(1) of the ESA:

(A) The present or threatened destruction, modification, or curtailment of its habitat or range;
(B) Overutilization for commercial, recreational, scientific, or educational purposes;
(C) Disease or predation;
(D) The inadequacy of existing regulatory mechanisms; or
(E) Other natural or manmade factors affecting its continued existence.

The intent of this recovery plan is to guide the recovery of the Devils River minnow so the species can be delisted. The Background section of the plan outlines the basic biology, ecology, status of the fish and its habitats, threats to the species, and conservation actions that have already occurred. The Recovery section provides the actions needed to recover this species and specific criteria for measuring when recovery has occurred. The success of this plan depends upon the collaboration of many people and organizations to secure the future existence of this species.

1.2 Status of the Species

The Devils River minnow was initially proposed for listing as endangered in 1978. However, amendments to the ESA in 1978 delayed completion of the final rule to list the species for more than two years and the proposal was withdrawn in 1980. The species remained a concern to conservationists due to its rarity and limited distribution. The Service again proposed to list the Devils River minnow as endangered on March 27, 1998 (63 Federal Register 14885-14892). However, after publication of the proposed rule, the Service, the Texas Parks and Wildlife Department (TPWD), and the City of Del Rio signed a Conservation Agreement containing specific milestones for conservation actions to improve the status of the species. This agreement, in part, reduced threats so that the Devils River minnow was designated as threatened in the final rule.

On October 20, 1999, the Service listed the Devils River minnow as a threatened species (Final Rule: 64 Federal Register 56596-56609). Critical habitat has not been designated. The reasons for listing the species were threats from range reduction, habitat loss and fragmentation, spring dewatering and other stream modifications, and possible effects of introduced species.

The Devils River minnow is also considered a threatened species by the American Fisheries Society (Williams et al. 1989) and the former Texas Organization for Endangered Species (Hubbs et al. 1991). The fish is listed by TPWD as a threatened species (Texas Parks and Wildlife Code, Chapters 67 and 68; Texas Administrative Code, Title 31, Sections 65.171 - 65.184), and by Mexico as an endangered species (Secretaria del Medio Ambiente 2002). It was also described by Garrett et al. (2002) as a threatened fish.

The Service established a recovery priority of 2 for this species based on its taxonomy, degree of threats, and recovery potential (see 48 Federal Register 43098). A priority of 2 indicates that the species faces a high degree of threat with a high potential for recovery. The Service regularly reviews listed species with regard to threats and recoverability and may update the species' recovery priority as appropriate.

1.3 Description and Taxonomy

The Devils River minnow (*Dionda diaboli* Hubbs and Brown) is a small fish in the minnow family (Cyprinidae). It was first collected from Las Moras Creek, near Brackettville, Kinney County, Texas, on April 14, 1951. It was formally described by Hubbs and Brown (1956) from specimens taken in 1951 in the Devils River at Baker's Crossing (southernmost bridge crossing of State Highway 163). The Devils River minnow is recognized as a distinct species by the American Fisheries Society (Hubbs and Brown 1956, Robins et al. 1991). Taxonomic validity is based on morphology (Hubbs and Brown 1956), genetic markers (Mayden et al. 1992), and chromosome differences (Gold et al. 1992).

Figure 1. Devils River minnow photo (used with permission, Garold W. Sneegas).

Adult Devils River minnows reach sizes of 25-53 mm (1.0-2.1 in.) standard length. The fish has a wedge-shaped caudal spot (near the tail) and a pronounced lateral stripe extending through the eye to the snout but without reaching the lower lip (Figure 1). The lateral-line pores are marked above and below by small black spots of melanin, forming two parallel rows of "dashes." The species has a narrow head and prominent dark markings on the scale pockets of the body above the lateral line, producing a crosshatched appearance when viewed from above (Hubbs and Brown 1956). The species occurs with other minnows, such as the closely related manantial roundnose minnow (*Dionda argentosa*). It can be distinguished from manantial roundnose minnow by the parallel rows of dashes along the lateral line, the wedge-shaped caudal spot, and the prominent markings on the dorsal scale pockets (Hubbs et al. 1991).

1.4 Population Trends and Distribution

The Devils River minnow has been a species of conservation concern since it was discovered in the 1950s in Las Moras Creek in Brackettville, Texas (Hubbs and Brown 1956). Within two decades from the time of original description, the species had been eliminated from two known locations—Las Moras Creek and the lower Devils River.

The Devils River minnow is native to tributary streams of the Rio Grande in Val Verde and Kinney counties, Texas, and Coahuila, Mexico (Figure 2). The reported historic range of the species was based on collections from 1951 to 1989 and included the Devils River from Beaver Lake, near Juno, downstream to near its confluence with the Rio Grande; San Felipe Creek from headwater springs to springs in Del Rio and downstream; Sycamore Creek; Las Moras Creek near Brackettville; Río San Carlos, Mexico; and the Río Salado drainage, Mexico (Brown 1954a and 1954b; Dietz 1955a and 1955b; Hubbs and Brown 1956; TGFC 1956; Dietz 1959a and 1959b; Treviño-Robinson 1959; Stapleton 1974; Harrell 1978; Hubbs 1979; Smith and Miller 1986; Hubbs 1990b; Garrett et al. 1992). A comprehensive assessment of the distribution of Devils River minnow in Texas in 1989 documented a reduced range and showed the species to be rare compared to past collections (Garrett et al. 1992). In that survey, a total of seven specimens of Devils River minnow were collected from 5 of 24 sampling locations within the historic range of the species. Garrett et al. (1992) also observed a general shift in community structure toward fishes that tend to occupy quiet water or pool habitat, conditions that are often limited in flowing spring runs. The authors hypothesized that this shift was the result of reduced stream flows from drought, exacerbated by human modification of stream habitats. In 2001, a population of Devils River minnow was discovered in the headwaters of Pinto Creek, Kinney County (Garrett et al. 2004).

Appendix A lists the known collections of Devils River minnow throughout its range. Monitoring the species' distribution and abundance has been fairly limited in both time and the number of samples taken, but its range is well known. Despite many collection efforts (Hubbs et al. 1991), the species is unknown from nearby waters such as the mainstem Rio Grande, the Río Conchos drainage, or streams tributary to the Rio Grande, other than those listed above.

1.4.1 Devils River and Tributaries, Val Verde County, Texas

Collections during the 1950s found Devils River minnow in the Devils River from Baker's Crossing (the southernmost Highway 163 bridge), downstream to the former Devils Lake (now inundated by Amistad Reservoir) (Brown 1954a and 1954b; Dietz 1955a and 1955b; Hubbs and Brown 1956; TGFC 1956; Dietz 1959a and 1959b). Harrell (1978) collected Devils River minnow from the Beaver Lake area, upstream of Juno (Figure 2), in 1973 and 1974 (specimens in Strecker Museum, Baylor University). This indicates there was sufficient surface flow in the area during those years to support populations of the fish. In 1988-89, the species was taken from three sites in the Devils River: Baker's Crossing, Finegan Springs (about 1.5 km upstream of the Dolan Creek confluence), and Dolan Creek (Hubbs and Garrett 1990; Garrett et al. 1992). Recent surveys from 1997 to 2002 have shown Devils River minnow distributed from Pecan Springs, about 10 miles upstream of Baker's Crossing, downstream to below the confluence with

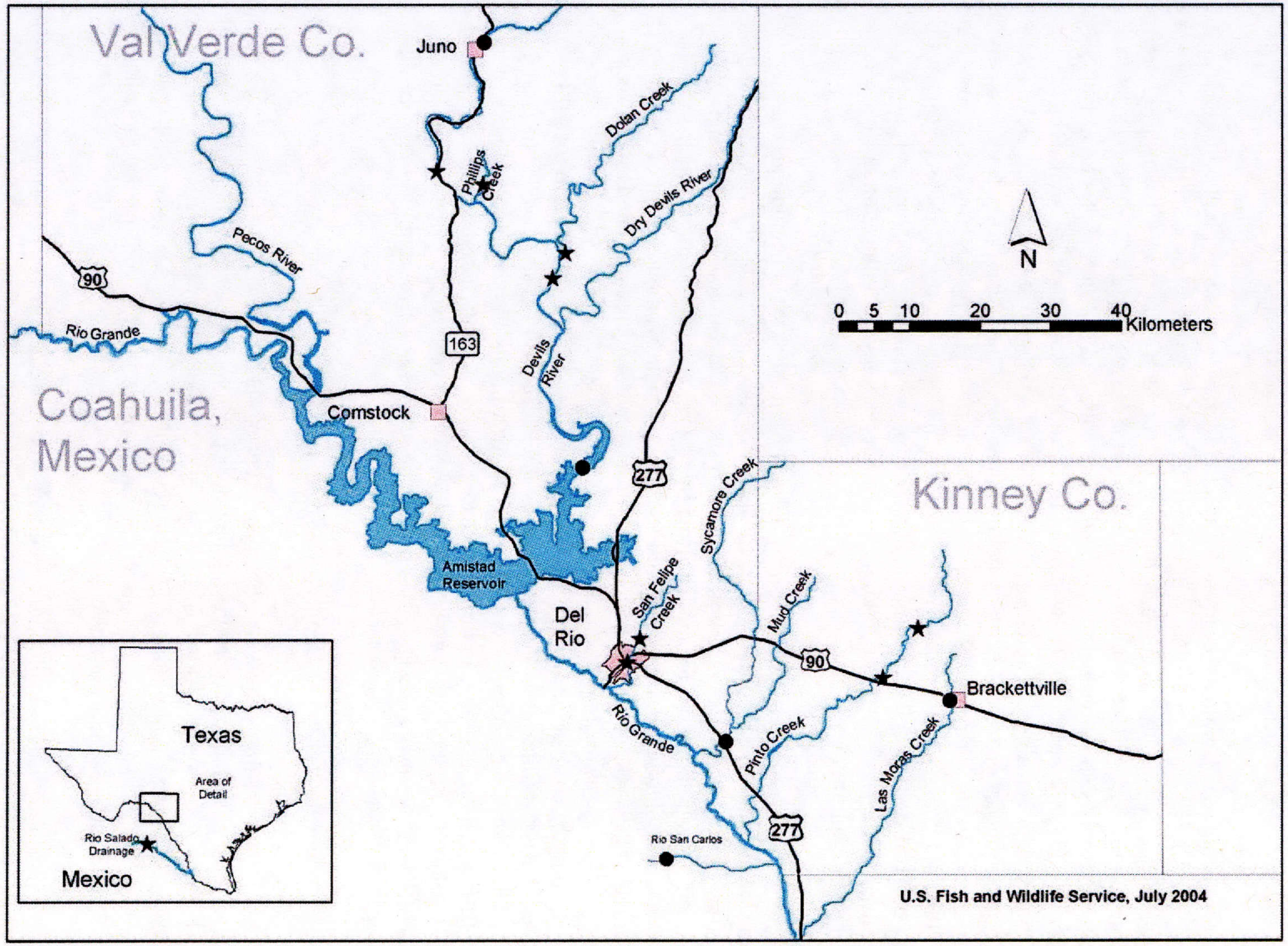

Figure 2. Devils River minnow range map. Stars indicate sites where the species has been collected since 1995 (distribution is presumed continuous between sites in the same creek). Filled circles indicate sites where the fish is either presumed or known to be extirpated.

Dolan Creek (G. Garrett, TPWD, pers. comm. 2003; Appendix C). The fish has also been collected recently in Phillips Creek and Dolan Creek, both tributaries to the Devils River (Figure 2). The species was eliminated from the lower portions of the Devils River when this area was inundated by construction of Amistad Reservoir (Garrett et al. 1992).

At Baker's Crossing, the Devils River minnow was the fifth most abundant fish collected (5 percent of 1,277 fish) in Brown's 1953 collection (Hubbs and Brown 1956). In Harrell's (1978) collections, the species was the sixth most abundant fish collected in the Devils River. Garrett et al. (1992) found the Devils River minnow to be one of the least abundant fish in the Devils River, collecting only two individuals out of 1,655 fish collected in 1989. Recent collections by G. Garrett (TPWD, pers. comm. 2004; Appendix C) document variations in Devils River minnow abundance over time. At some sites, collection efforts have resulted in no Devils River minnow being collected one year but many being collected another year. For example, based on several collections from 1997 to 2001, the species was common in Phillips Creek, but none were found in 2002. At another site, samples from upstream of Baker's Crossing to Pecan Springs in 1997 and 2000 had no Devils River minnow, but the fish was common from several sites in the same area in the summers of 2002 and 2003. We do not yet know why the abundance varies so much across years and between sites.

Annual summer surveys of the Devils River by TPWD from 2000 to 2003 entailed comprehensive collections of representatives of the entire fish fauna of the Devils River and its tributaries (G. Garrett, TPWD, pers. comm. 2003; Appendix C). Some sites between previously sampled locations were accessed for the first time by canoe and many of these yielded Devils River minnow. The 2000 survey revealed no Devils River minnow downstream of Dolan Falls (which is a large waterfall on the Devils River about 100 m downstream of the Dolan Creek confluence), and only the area upstream of Dolan Falls was sampled in 2001. In both years, no Devils River minnow were collected upstream of Baker's Crossing. However, in the 2002 surveys, Devils River minnow were collected upstream of Baker's Crossing to Pecan Springs, the current headwaters of the Devils River. Devils River minnow were also collected several miles downstream of Dolan Falls, an important extension of the known range of the fish from this local population. In 2003, no Devils River minnow were collected downstream of Dolan Falls. Devils River minnow were again taken upstream of Baker's Crossing to Pecan Springs, but in reduced numbers.

1.4.2 San Felipe Creek, Val Verde County, Texas

In 1979, Devils River minnow made up about 2 percent of all collections (total of 3,458 fish) and was the sixth most abundant of 16 species in the upper portion of the permanent flowing part of San Felipe Creek, upstream of Del Rio (Figure 2). No Devils River minnow were found in 1989 surveys in San Felipe Creek upstream of Del Rio (Garrett et al. 1992). No known collections have been made there since 1989. This area is privately owned and no information is available for insight into the species status in this area.

In 1989, only three Devils River minnow specimens were obtained in a collection of 1,651 fishes in San Felipe Creek in the City of Del Rio (Garrett et al. 1992). Data from 1997-2003 suggest that the Devils River minnow was common in the San Felipe Creek downstream of the East and

West San Felipe Springs in the urban section of the creek (G. Garrett, TPWD, unpublished data 2002, Winemiller 2003, Lopez-Fernandez and Winemiller 2005). Recent collections on San Felipe Creek in Del Rio (1999 - 2003) have yielded Devils River minnow (G. Garrett, TPWD, unpublished data 2002, Winemiller 2003) and suggest the population increased in abundance compared to what was reported from 1989 surveys (Garrett et al. 1992). No surveys have been conducted upsteam of the City of Del Rio due to limited private access. Quarterly surveys of aquatic habitat and aquatic organisms in San Felipe Creek in Del Rio have been conducted (2001 to 2003) by the Texas Agriculture Experiment Station at Texas A&M University (Winemiller 2003, Lopez-Fernandez and Winemiller 2005). The species never was collected or observed within the two spring outflow channels located on the municipal golf course. The species appears to be broadly distributed in low to moderate numbers within the mainstem San Felipe Creek, at least from the northern limit of the city golf course downstream along the length of the city greenway. The species was present in at least two of three mainstem channel sampling locations during each survey. Seasonal fluctuations in abundance were largely associated with recruitment dynamics of juveniles, which peaked in late summer and fall. Surveys in the summer and fall of 2004 found the Devils River minnow abundance very low (G. Garrett, TPWD, pers. comm. 2004).

1.4.3 Sycamore and Mud Creeks, Kinney County, Texas

Sycamore Creek constitutes a small portion of the range of Devils River minnow (Figure 2). The only known accounts of the species from this stream are an anecdotal mention of its occurrence in the 1970s (Harrell 1980) and collection of two individuals at the Highway 277 bridge crossing near the Rio Grande in 1988 and 1989 (Garrett et al. 1992). Collections in 1999 and 2002 from that site and the State Highway 90 bridge crossing of Sycamore Creek did not yield Devils River minnow (G. Garrett, TPWD, unpublished data 2002). Garrett et al. (1992) surveyed portions of Mud Creek (a tributary to Sycamore Creek) in 1989 but found no Devils River minnow. Due to limited access on private lands, few other locations in the Sycamore Creek watershed have been sampled. Additional surveys are needed to determine the current status of the fish in this watershed.

1.4.4 Pinto Creek, Kinney County, Texas

Pinto Creek (Figure 2) contains a newly discovered and important addition to the known range of Devils River minnow (Garrett et al. 2004). Garrett et al. (1992) surveyed portions of Pinto Creek downstream of the Highway 90 bridge and did not collect Devils River minnow. Upstream areas were on private land and access was unavailable until recently. Prior to collections in 2001 and 2002, most of Pinto Creek (located in Kinney County) had not been surveyed for fishes. The only previous collections were primarily at bridge crossings (Highways 277 and 90), due to limited access to private lands; but no Devils River minnow had been collected. During 2002 surveys throughout Pinto Creek, a Devils River minnow population was discovered at sites upstream of State Highway 90. The Devils River minnow was one of the more abundant fishes at these locations (Garrett et al. 2004). None were found at or below Highway 90. At sites from Highway 90 downstream, the most abundant fish was red shiner (*Cyprinella lutrensis*). At one site, just upstream of Highway 90, both species were obtained in the same location. Preliminary evaluations suggest natural changes in water chemistry of Pinto Creek occur at about the Highway 90 Bridge, and may result in changes in the fish community (Garrett et al. 2004).

The species is found only in the relatively pristine headwaters of Pinto Creek upstream of Highway 90, despite searches downstream to Highway 277 (Garrett et al. 2004). Due to its isolation in the headwaters of Pinto Creek, this population could represent a genetically unique Devils River minnow population (Garrett et al. 2004). This population of Devils River minnow may provide important biological data on the species' habitat needs because of the sharp changes in both water quality and Devils River minnow distribution at the Highway 90 bridge (Garrett et al. 2004).

1.4.5 Las Moras Creek, Kinney County, Texas

Las Moras Creek represents the eastern extent of the historic range of the species (Figure 2). Historically, the population may have been restricted to the headspring area of Las Moras Creek in Brackettville, where 39 individuals were collected in 1951 (Hubbs and Brown 1956). The species has not been collected from this site since the 1950s and apparently has been extirpated from the Las Moras Creek drainage. This conclusion is based on the absence of the species in sampling efforts from the late 1970s to 2002 (Smith and Miller 1986; Hubbs et al. 1991; Garrett et al. 1992; G. Garrett, unpublished data 2002). The species may have been eliminated from Las Moras Creek as a result of periodic chlorination of the spring outflow for swimming pool maintenance (Garrett et al. 1992) or from drying of the spring in the 1960s (Eckhardt 2004).

1.4.6 Río San Carlos, Coahuila, Mexico

The Río San Carlos (Figure 2) is a small tributary of the Rio Grande that flows through Ciudad Acuña (Mexican city across the Rio Grande from Del Rio). Only a few individuals have been collected from this location, once in 1968 and again in 1974 (Appendix A). We are not aware of any collections of Devils River minnow from this site since 1974, and the species is presumed extirpated from this location (S. Contreras-Balderas, University of Nuevo Leon, in litt. 1997; S. Contreras-Balderas, pers. comm. 2003).

1.4.7 Río Salado Drainage, Coahuila, Mexico

The population of Devils River minnow in the Río Salado drainage of northern Mexico represents a critical portion of the southernmost extent of the range. The Río Salado is distant from the Rio Grande tributaries supporting the species in Texas. Collections of the species from the Río Salado drainage are limited to the Río Sabinas (=Río San Juan) and Río Alamo (Appendix A) from about 8 km (5 mi) northwest of Muzquiz to about 12 km (7 mi) west of Nueva Rosita (S. Contreras-Balderas, University of Nuevo Leon, in litt. 1997). Contreras-Balderas et al. (2001) reviewed the fishes of this area and reported the Devils River minnow was historically found in these two locations. In 1994, 18 Devils River minnow were collected from a site in the Río San Juan, near Muzquiz; in 2001 none were found there (Contreras-Balderas et al. 2001). In 1985, 16 Devils River minnow were collected from the Río Alamo, near Nueva Rosita; in 2001, only one individual was found there (Contreras-Balderas et al. 2001). Contreras-Balderas et al. (2001) concluded, "The Río Sabinas is highly impacted upon, due to a combination of mining and urban/municipal pollution, garbage, deforestation, channelization, gravel pits, siltation, and damming. River quality has been lost at an average of 50 percent from original. Water runoff has been lost approximately 80 percent from original."

1.5 Life History, Ecology, and Habitat

Little information is available on life history characteristics, feeding patterns, or reproductive behaviors of this species. However, based on their long coiled intestinal tract, species of the genus *Dionda* are considered to feed primarily on algae, although larval stages may prey on invertebrates (Balon 1985; Gerking 1994). Other closely related species of *Dionda* occurring in the Edwards Plateau of central Texas and the Pecos River drainage of New Mexico and Texas spawn from January through August, laying demersal (deposited near the stream bottom), non-adhesive eggs, sometimes beneath several millimeters of gravel (Hubbs 1951; Wayne and Whiteside 1985; Johnston and Page 1992). In captivity, Devils River minnow eggs were slightly adhesive and adults preferred gravel as a spawning substrate over rocks, sand, or a manufactured spawning substrate (Gibson et al. 2004). The life expectancy of the fish has not been studied, but based on similar minnows it can be estimated at one to two years (C. Hubbs, University of Texas at Austin, pers. comm. 2003). Some fish in captivity have survived for more than 4.8 years (J. N. Fries, Service, pers. comm. 2005).

General habitat associations for Devils River minnow have been described as channels of fast-flowing, spring-fed waters over gravel substrates (Harrell 1978; Cantu and Winemiller 1997). Although the species is closely associated with spring systems, the fish most often occurs where spring flow enters a stream, rather than in the spring outflow itself (Hubbs and Garrett 1990). The species probably evolved in environmental conditions of large hydrologic variations inherent in desert river systems (Harrell 1978) that are characterized by extended droughts and extreme flash floods (USGS 1989).

The Devils River minnow is part of a unique fish fauna, which includes Mexican peripherals, local endemics, and widespread North American fishes (Hubbs 1957; Miller 1978; Garrett 1997; Edwards et al. 2004). This diversity is remarkable and just recently a new fish species was described as an endemic to San Felipe Creek (Garrett and Edwards 2003). The Devils River minnow occurs in an area where the Chihuahuan Desert, Edwards Plateau, and South Texas Brush ecoregions join. Fishes in arid regions, such as those of the Chihuahuan Desert, have been particularly affected by human development and use of water resources. Hubbs (1990a) stated that half the native fishes of the Chihuahuan Desert of Mexico and Texas are considered threatened and at least four species have been documented to be extinct (Miller et al. 1989), primarily due to habitat destruction and introduced species.

1.6 Hydrology and Geohydrology

The region of Texas within the historic range of the Devils River minnow is semi-arid, receiving a range of annual rainfall from 30 to 51 cm (12 to 20 in.). Spring-fed streams of this portion of the southwestern Edwards Plateau flow southerly into the Rio Grande. The rocky, limestone soils and shrubby vegetation are characteristic of the more arid western reaches of the Edwards Plateau. This area is underlain by the Edwards-Trinity aquifer system. This aquifer system produces the largest number of springs in Texas, including some of the largest spring systems (for example, San Felipe Springs in Del Rio and Goodenough Spring now submerged below Amistad Reservoir) (Brune 1975, 1981). Brune (1981) identified at least 48 springs occurring in Val Verde County. The principal water-bearing rock formations of the Lower Cretaceous Comanchean series dip toward the southeast and are relatively permeable, with high transmissivity values (Barker et al. 1994). The thickness of the Comanchean strata ranges from less than 1,000 feet in the area of outcropping to more than 10,000 feet (Barker et al. 1994).

Barker and Ardis (1996) divided the Edwards-Trinity aquifer system into the following four subgroups (Figure 3): Balcones fault zone, Hill Country, Edwards Plateau, and Trans-Pecos. The Devils River minnow range in Texas is within the southern portion of the Edwards Plateau subgroup. The Edwards-Trinity aquifer system that underlies the Edwards Plateau extends over about 24,000 square miles of central Texas (Barker and Ardis 1996).

The contributing and recharge area for springs on the Devils River and San Felipe Creek is suspected to include a large region, extending as far north as Sheffield in Pecos County and Eldorado in Schleicher County and eastward into Edwards County (Brune 1981). Recharge to the aquifer is mostly from infiltration of precipitation through the land surface and seepage loss through stream beds (Barker and Ardis 1996). "Discharge from the aquifer mainly occurs through (1) springs in the stream-dissected northeastern and southeastern fringes of the Edwards Plateau; (2) base flow to gaining reaches of the Concho, Llano, and Pecos Rivers; and (3) wells pumped for domestic, irrigation, and stock water" (Barker and Ardis 1996). Recharge and discharge of the aquifer, in general, are estimated to average less than 2.54 cm (1 in.) per year over the Edwards Plateau (Barker and Ardis 1996). However, the flow from springs, and the resulting surface flow in streams, fluctuates considerably, depending on the amount of rainfall, recharge, and water in storage in the aquifer. Conservation of the quality and quantity of this groundwater supply is essential for the continued existence of the Devils River minnow.

The middle and upper parts of the Devils River Formation, considered the principal water-producing zone for southern Edwards County and central Val Verde County, probably support surface flow in the Devils River (Barker and Ardis 1996). The Del Rio area, where major springs support surface flows in San Felipe Creek, is within an isolated depositional area called the Maverick basin (LBG-Guyton Associates 2001). The primary water bearing stratum within this basin is the Salmon Peak Formation, the uppermost unit in the Edwards Group. In this area the Edwards-Trinity (Plateau) is in very deep strata, underlying the Edwards Group. As a result, the local aquifer around Del Rio that supports surface spring flows is actually an isolated part of the Edwards aquifer (Balcones Fault Zone) (LBG-Guyton Associates 2001).

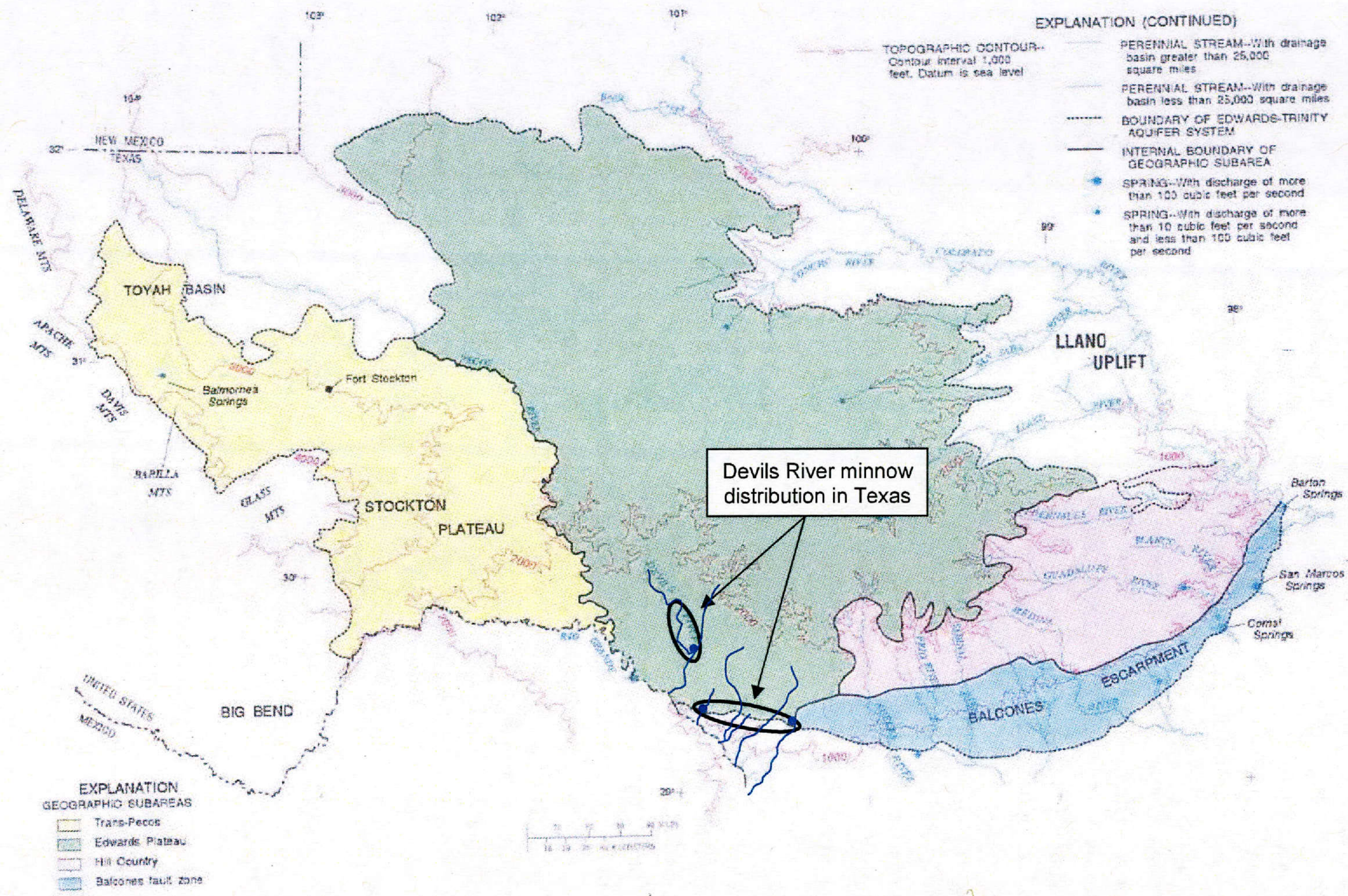

Figure 3. Location of geographic subareas of the Edwards-Trinity aquifer system, the major springs and perennial streams (*adapted from* Barker and Ardis 1996), and general distribution of the Devils River minnow in Texas.

The groundwater in Kinney County that contributes to spring flows in Las Moras, Pinto, and Sycamore creeks is from the northern part of the county in the Edwards and associated limestones (Bennett and Sayer 1962). In general, the groundwater in Kinney County from Brackettville east moves to the southeast and east into Uvalde County. Groundwater west of Brackettville moves southwestward toward the Rio Grande and Val Verde County (Bennett and Sayer 1962).

1.7 Reasons for Listing and Threats Assessment

The following discussion summarizes the reasons that the Devils River minnow was listed as a threatened species, based on consideration of the five listing factors. In addition, an updated assessment is included under each factor of the current understanding of threats to the species and its habitat.

1.7.1 Listing Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Devils River Minnow Habitat or Range

1.7.1.1 Range Reduction and Habitat Loss

One of the primary reasons for listing the Devils River minnow was the considerable habitat loss that previously occurred and resulted in a reduction in both the distribution and abundance of the species. Habitat loss and modification throughout a large portion of the range of the Devils River minnow has resulted in the fragmentation and contraction of the species' range. The distribution of the minnow in the Devils River was reduced by the impoundment of Amistad Reservoir in 1968. The inundation of the lower portion of the river by Amistad Reservoir eliminated important habitat for Devils River minnow, changing a lotic environment (fast flowing water) to a lentic environment (non-flowing or slow flowing water). These alterations resulted in the elimination of Devils River minnow in the lower portions of the Devils River.

In addition, the species has not been found upstream of Pecan Springs since the early 1970s and likely no longer occurs in the upper portions of the Devils River due to lack of stream flow. There are no historical flow data in the upper part of the Devils River to verify changes in stream flows over time. Brune (1975) believed the river originated farther upstream in historic times, referring to accounts of the river in the area of Juno (Figure 2), which was described in 1916 as a beautiful stream with large live oaks. However, local landowners suggest that the river has been intermittent in this reach, at least since 1916.

The species also has been extirpated from Las Moras Creek; the exact reason is not known. However, the natural habitat of the spring was extensively altered when the outflow was dammed and stream bank vegetation was removed to create a recreational swimming pool. Water for the swimming pool comes directly from the spring and has been treated regularly with chlorine (a toxin to fish and other organisms) before being discharged into Las Moras Creek. Garrett et al. (1992) also indicated that spring flow also has been drastically reduced by drought and diversion of surface water and withdrawal of groundwater for human use. The springs are reported to have ceased flowing in the 1960s (Brune 1981; Eckhardt 2004) and then again in the 1980s (Garrett et al. 1992). Las Moras Creek downstream from the spring is degraded from pollution and channelization (Garrett et al. 1992). This combination of habitat alteration (periodic loss of spring flow and channel modification) and water quality degradation (from chlorination) is the most likely cause for the extirpation of the species from Las Moras Creek.

We believe the Devils River minnow has been extirpated from the Río San Carlos drainage in Mexico and has declined in distribution and abundance from the Río Salado drainage, primarily due to changes in habitat from loss of stream flow, pollution, and channel manipulation (Contreras-Balderas and Lozano-Vilano 1994).

1.7.1.2 Spring Flow Declines (Water Quantity)

Groundwater discharge declines from springs and seeps are major threats to the Devils River minnow throughout its range (Garrett et al. 1992, Contreras-Balderas and Lozano-Vilano 1994). Groundwater levels in the Edwards-Trinity (Plateau) fluctuate based on the cyclical amount of precipitation for recharge and variations in discharge from well withdrawals (Barker et al. 1994). Declines have been documented where natural recharge rates have not offset the increase in withdrawal from pumping (Barker et al. 1994). As an example, the following is quoted from Barker et al. (1994), p. 40:

> During the last 50 years, water levels have declined more than 50 ft in northwestern parts of the Edwards Plateau, including parts of Ector, Glasscock, Midland, Reagan, Sterling, and Schleicher Counties (Walker, 1979, p. 96-100)...The nearly continuous, long-term nature of water-level decline in many wells reflects the direct relation to a rapid increase in the number of irrigation wells that began about 1946 and continued through the 1960s. Since the late 1970s, water levels in most parts of the Edwards Plateau have stabilized or begun to recover, reflecting the results of recent efforts to reduce the need for irrigation and to conserve water.

Historical data on stream flows in the upper portion of the Devils River are not available to confidently assess changes in habitat in this reach. However, noted declines in the northwest part of the aquifer may account for the current lack of long-term flow in the uppermost parts of the Devils River, from Beaver Lake, near Juno, to Pecan Springs (Brune 1975). Increases in groundwater withdrawal from the Edwards-Trinity (Plateau) aquifer could result in further declines in stream flow on the Devils River and affect the quantity and quality of available stream fish habitat. The downstream portion of the Devils River from the Pecan Springs area and below Baker's Crossing continues to flow naturally and has been referred to as one of the most pristine rivers in Texas. Because of groundwater reservoirs that support the remaining spring systems, the river has maintained a perennial flow since 1960 in the range of 3 to 10 cubic-meters-per-second (cms) [106 to 353 cubic-feet-per-second (cfs)] at the inflow to Amistad Reservoir (IBWC 2003).

The population of the City of Del Rio (City) and Laughlin Air Force Base was estimated to be 38,964 in 2000. Over the next 50 years, the human population and the municipal water supply demand of the City are expected to grow 46 percent and 30 percent, respectively (LBG-Guyton Associates 2001). Del Rio draws water directly from San Felipe Springs, the sole source of municipal water supply for the City and for nearby Laughlin Air Force Base. These springs typically discharge at 3.4 to 4.0 cms (120 to 140 cfs); however, during drought years in the late 1990s spring discharge fell below 1.4 cms (50 cfs) (LBG-Guyton Associates 2001). During 1995 and 1996, the average water use by the City varied seasonally from about 8 to 19 million gallons per day (about 12 to 29 cfs, 0.3 to 0.8 cms). The City recently upgraded the water treatment facility to provide a maximum of 16 million gallons per day (about 25 cfs, 0.7 cms) for municipal use (LBG-Guyton Associates 2001). This new treatment plant and associated storage and transmission facility allows for important water conservation, as the previous water system had substantial losses due to outdated inefficiencies. With additional water conservation measures in place to reduce per capita water use, the City could decrease its water consumption from San Felipe Creek.

The City of Del Rio recently evaluated several alternatives to activate groundwater wells around the city to account for possible future water shortfalls and to decrease dependence on the San Felipe Springs (LBG-Guyton Associates 2001). These additional groundwater withdrawals from the Salmon Peak formation of the Edwards Aquifer could affect the quantity of spring flow from the San Felipe springs complex. The report recommended investigating the effects of pumping from the aquifer on the spring flow.

Increases of water withdrawals from aquifers that support spring flows in the range of the Devils River minnow (including the Devils River, San Felipe Creek, Sycamore Creek, Pinto Creek, and Las Moras Creek) could result in reduction of critical spring flows or the drying of streams that support the species. As spring flows decline due to drought or groundwater lowering from pumping, habitat for the Devils River minnow is reduced and could eventually cease to exist. The relationship of declining spring flows and habitat loss is unknown. However, when streams cease flowing, the habitat is lost and the fish populations will no longer exist. In some reaches, such as Pinto Creek, natural repopulation of streams is not possible due to the fragmented range of the species.

A number of metropolitan areas surrounding the range of the Devils River minnow (for example, San Antonio, San Angelo, Eagle Pass, and Laredo) are seeking additional water sources to support growing water consumption needs (Upper Guadalupe River Authority 2002, Khorzad 2002). Because Texas groundwater use is under the "Rule of Capture," which means that with few exceptions, landowners have the right to take all the water that can be captured under their land, there are currently few, if any, limits to the amount of groundwater that can be withdrawn from aquifers and exported to other locations. Several private water development projects are planned for pumping large amounts of groundwater from within Kinney County and piping it eastward toward San Antonio. It is unknown what effect, if any, these projects could have on the spring flows that support the stream habitat of the Devils River minnow. However, the location of these projects is close to Pinto and Las Moras creeks and they may pose a high magnitude and imminent threat to maintaining habitat for that population (Garrett et al. 2004).

Other factors also affect the level of groundwater available to support spring flows. For example, the amount of recharge to aquifers is directly related to precipitation patterns. Therefore, localized drought can result in reduced stream flows for Devils River minnow. Land management practices and watershed health also influence recharge rates. The relationship of landscape vegetation to spring flow rates is dependent on a number of factors, such as vegetation characteristics, precipitation, soils, and geology (Wilcox 2002). Loss of grasses on the landscape can alter runoff patterns to increase the rate of surface water storm flows and reduce the rates of aquifer recharge (Brune 1981).

1.7.1.3 Water Quality Degradation

Water quality degradation and contamination are inherent threats to the population in San Felipe Creek because of its urban location. Studies by the Texas Commission on Environmental Quality (TCEQ), formerly the Texas Natural Resource Conservation Commission, (TNRCC 1994, 1996) and the International Boundary and Water Commission (IBWC 1994) found elevated levels of nitrates, phosphates, and orthophosphate in San Felipe Creek, indicating potential water quality problems. Land uses in the immediate area of the springs, such as runoff from the municipal golf course, may have contributed to these conditions. Catastrophic events, such as a large contaminant spill from a transportation vehicle at a bridge crossing, also threaten the species in San Felipe Creek. Continued swimming pool maintenance practices may be negatively affecting the water quality in Las Moras Creek and degrading the stream habitat.

1.7.1.4 Stream Channel Modifications

The stream channels in San Felipe Creek in Del Rio and Las Moras Creek in Brackettville have been modified for bank stabilization, flood control, public access, road bridges, and diversion of irrigation water. Non-native vegetation dominates much of the riparian corridors. In some areas, these changes may alter the habitat for the Devils River minnow, but the extent of this threat is not known.

1.7.1.5 Habitat Degradation in Mexico

Aquatic ecosystems in the northern regions of Chihuahua and Coahuila, Mexico, are undergoing changes from increasing use of groundwater and surface water (Contreras and Lozano 1994). Watersheds throughout the Río Salado Basin have been degraded from agricultural land uses and industrial development resulting in channelization and pollution of the creeks that provide habitat for the Devils River minnow (Contreras-Balderas et al. 2001). The Río Sabinas, in particular, has been noted for decreasing stream flows (Contreras and Lozano 1994).

1.7.2 Listing Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization is not considered a threat to the Devils River minnow at this time.

1.7.3 Listing Factor C. Disease or Predation

The Devils River minnow is threatened by the presence of introduced fishes. Fish collections by G. Garrett in 1997 from San Felipe Creek revealed for the first time the presence of armored catfish (*Hypostomus* sp.). Collections in 2001 to 2003 have confirmed that armored catfish are reproducing and are abundant in San Felipe Creek (Lopez-Fernandez and Winemiller 2005). This fish is an exotic species with an established breeding population in the San Antonio River, Texas, and was cited as potentially competing with *Dionda episcopa* in the San Antonio River due to its food habits (Hubbs et al. 1978, Edwards 2001, Hoover et al. 2004). Although *Dionda* species are common in spring runs in Central Texas, they are now absent from these habitats in the San Antonio River, further suggesting possible displacement by the armored catfish (Hubbs et al. 1978). Lopez-Fernandez and Winemiller (2005) suggested that declining trends of Devils

River minnow at some monitoring sites might be a consequence of expanding populations of the armored catfish.

In 1999, a Raphael catfish (*Platydorus costatus*) was collected from San Felipe Creek but the species does not appear to have persisted (Howells 2001, Lopez-Fernandez and Winemiller 2005). Lopez-Fernandez and Winemiller (2005) also reported a reproducing population of blue tilapia (*Oreochromis aureus*) in San Felipe Creek. This species is known to occur in the Devils River (Garrett et al. 1992). Any of these non-native fishes could pose a major threat to the Devils River minnow population in San Felipe Creek by degrading physical habitat (eating algal cover and uprooting aquatic plants), competing for food (Lopez-Fernandez and Winemiller 2005), and preying on eggs by incidental ingestion (Hoover et al. 2004).

The smallmouth bass (*Micropterus dolomieu*), a game fish introduced to Amistad Reservoir in about 1975, is native to eastern North America but has been widely introduced as a sport fish to reservoirs and streams outside its natural range. It is believed smallmouth bass gained access to the middle and upper portions of the Devils River (upstream of Dolan Falls) from Amistad Reservoir by the early to mid-1980s but is unknown how they were moved upstream of Dolan Falls (G. Garrett, TPWD, pers. comm. 1997). The Devils River is currently managed by TPWD as a trophy smallmouth bass fishery with an 18-inch (46-cm) length minimum and a catch limit of three fish per day to maintain a healthy population of large-sized bass for anglers (Baxter 1993; Gough 1993; TPWD 2004-2005 Exceptions to Statewide Fish Harvest Regulations). TPWD has not stocked smallmouth bass in Amistad Reservoir, or any other nearby waters, since the early 1980s. Smallmouth bass do not co-occur with any other population of the Devils River minnow, other than in the Devils River.

The Devils River minnow evolved in the presence of native fishes that consume other fishes, such as largemouth bass (*Micropterus salmoides*). However, the smallmouth bass is an aggressive, non-native predator, and it is known to affect other native fish communities (Taylor et al. 1984, Moyle 1994). The Devils River minnow is within the size class of small fishes that are susceptible to predation by smallmouth bass. Robertson and Winemiller (2001) studied smallmouth bass in the Devils River near Dolan Falls. They found that the bass consumed mostly insects, but also preyed heavily on fish, with 8 of the 12 small fish species occurring in the Devils River being found in smallmouth bass stomachs. Devils River minnow were too rare in the study (and not identified in bass stomach analysis) to draw any conclusions regarding effects of the bass; however, manantial roundnose minnow (a closely-related species) was preyed upon in a proportion greater than its relative abundance in the river (Robertson and Winemiller 2001).

Ongoing studies by TPWD are investigating the potential effects of smallmouth bass on fishes of the Devils River through controlled experiments in an outdoor simulated stream environment at the Heart of the Hills Fisheries Science Center (HHFSC) in Ingram, Texas. Results have not shown that sub-adult smallmouth bass preferentially prey on Devils River minnow. Devils River minnow seem to be less susceptible to smallmouth bass predation than other minnows from the Devils River in this simulated setting (G. Garrett, TPWD, pers. comm. 2003).

The future intentional or unintentional release of non-native fishes into areas inhabited by Devils River minnow is a constant potential threat. Live bait fish are commonly discarded into nearby waters by anglers, resulting in introductions of non-native species (Taylor et al. 1984). This situation has occurred in many streams in the southwestern U.S. to the detriment of native fish communities (Moyle 1994). In addition, exotic fishes from aquaria could be introduced into local waters. Currently, only a small number of introduced fishes occur within the range of the Devils River minnow, but the potential for unintentional introductions is high because of the number of anglers on Amistad Reservoir and the urban setting of San Felipe Creek. Threats to Devils River minnow from possible introduction and establishment of non-native fishes include diseases, parasites, competition for food and space, predation, and hybridization.

Another aquatic animal introduced into San Felipe Creek is the Asian snail, *Melanoides tuberculata*. This snail serves as an intermediate host of a gill fluke that has been documented to harm other fishes in San Felipe Creek (McDermott 2000). The effects this parasite may have on Devils River minnow are unknown.

1.7.4 Listing Factor D. The Inadequacy of Existing Regulatory Mechanisms

The State of Texas lists the Devils River minnow as a threatened species; however, the State provides no protection for the habitats of listed species. Changes to the State's baitfish regulations (see Section 1.8, below) have made it illegal to use most exotic fish for bait in this area. However, few, if any, other regulations exist that prevent the introduction of non-native species to habitats of the Devils River minnow.

Limited State regulations administered by the TCEQ can protect instream flows from some changes caused by surface water right permits and can protect water quality for wildlife and human uses. However, the instream flow requirements do not apply to most existing surface water permits and no such requirements provide protection for instream flows for the streams where the Devils River minnow occurs. TCEQ's water quality regulations, as currently implemented, apply primarily to point source discharges of pollutants and, generally, have not been applied to protect individual fish species, except in very limited circumstances.

Groundwater pumping that could affect stream flows within the Devils River minnow's range is subject to limited regulation. State agencies do not control groundwater. Texas courts have held that, with few exceptions, landowners have the right to take all the water that can be captured under their land (Rule of Capture), regardless of effects on neighbors or natural resources. Individual groundwater conservation districts, specifically authorized by the Texas legislature, have varying amounts of authority and capacity to limit groundwater pumping. Under this legal framework, the authorities for protection of groundwater aquifers for the benefit of the Devils River minnow are uncertain.

The Kinney County Groundwater Conservation District is a local authority with some regulatory control over the pumping and use of groundwater resources in Kinney County. However, the relatively new district is facing many challenges in its efforts to manage groundwater pumping. It is unknown what benefits the groundwater district may provide for the conservation of spring flows and instream flows in the creeks in Kinney County. Val Verde County is not within the jurisdiction of a groundwater conservation district.

1.7.5 Listing Factor E. Other Natural or Manmade Factors Affecting Its Continued Existence

1.7.5.1 Small, Fragmented Populations

Populations of Devils River minnow are restricted to small reaches of streams that are disconnected from one another. Amistad Reservoir has fragmented the population of the fish in the Devils River from other populations to the east. Hydrologically there are connections between San Felipe, Sycamore, Pinto, and Las Moras creeks via the Rio Grande. However, because the fish are (or were) restricted to upstream portions of these streams, and the Rio Grande is being reduced in water quality and quantity, it is highly unlikely that any genetic exchange is occurring between these populations. There is also likely no genetic exchange between U.S. and any extant Mexican populations of Devils River minnow, since they are separated by a large distance. These populations are highly vulnerable to events that could cause substantial loss of natural genetic diversity or local extirpations (such as stream desiccation or contamination). The current distribution would not allow natural recolonization from other populations. The overall risk of extinction is elevated due to such factors as the small number of fragmented populations in relative close proximity, the small fluctuating population sizes, and the short species life span (for a sample of discussions on extinction risk see Davies et al. 2004, Fagan et al. 2002, Ogrady et al. 2004, and Pimm et al. 1988).

1.7.5.2 Cumulative Threats

The cumulative nature of these threats could exacerbate their effects on Devils River minnow populations (Davies et al. 2004). For example, subtle reductions in stream flows could produce small shifts in habitat use that make the species more vulnerable to competition and predation by native and non-native fishes. Reduced stream flows often further degrade poor water quality conditions. In addition, long-term drought could affect habitat of the species, especially with increased human water use (municipal and agricultural). This species has adapted to historical natural climatic variations (such as large floods and prolonged droughts). However, in conjunction with other threats to the species (primarily habitat loss and exotic competitors/predators), drought would add to the threat of extinction.

1.8 Conservation Efforts to Date

1.8.1 Conservation Agreement

In September 1998, a Conservation Agreement (Agreement) for the Devils River minnow was signed by the Service, TPWD (in cooperation with local landowners), and the City of Del Rio to expedite conservation measures needed to ensure the continued existence of the species and facilitate recovery of the species (Appendix B). The Agreement and implementation were important steps in the conservation of Devils River minnow and its environment (Garrett 2003). The objectives of the Agreement are to reduce potential threats to the species and to stabilize and improve the species populations and the ecosystems upon which they depend. The Agreement includes a Conservation Strategy (Strategy) describing specific actions needed for conservation of the Devils River minnow. In most cases, this Recovery Plan includes, and is consistent with, these provisions.

Actions identified in the 1998 Strategy, and their status, are provided below (see Appendix B for full explanation of the Conservation Actions):

(1) Determine the current status [range wide] of the Devils River minnow and monitor changes

Annual surveys of the Devils River, San Felipe Creek, and Pinto Creek were conducted by TPWD from 2000 through 2004. Refer to sections 1.4.1 to 1.4.4 of this document for a discussion of these surveys. No new information has been collected thus far on the status of Devils River minnow in Mexico.

(2) Maintain genetically representative, captive populations of Devils River minnow at the TPWD Heart of the Hills Fisheries Science Center (HHFSC) and at one or more alternate facilities deemed appropriate by the Service for reintroduction propagation and as insurance against extinction

As part of ongoing experimental studies by TPWD, Devils River minnow have been maintained at the HHFSC since 1999 and at the San Marcos National Fish Hatchery and Technology Center (SMNFH&TC) since 2000. These captive stocks are being maintained for research purposes and not specifically as refugia populations. That is, these stocks are not yet being maintained under strict controls and in sufficient sizes to be suitable as a source for reintroduction in the wild. However, both efforts are increasing our knowledge of the life history and reproductive characteristics of the species, which will assist in future captive population maintenance.

Since August 2000, the SMNFH&TC has maintained a small captive stock of Devils River minnow to investigate potential techniques needed for captive propagation (Gibson et al. 2004). Two recirculating systems with several spawning substrates and riverine habitats (riffle, pool, "canopied" pool) were used and both systems were stocked with 19 Devils River minnows on September 5, 2001. By late November 2001, 1,152 eggs and 1,118 larvae had been recorded and about 450 fry had been produced (20 percent survival). Work is continuing to improve survival from eggs to fry and to develop information on early life history, fecundity, growth, life span, and food requirements. Additionally, research is continuing to determine mechanisms controlling reproduction, refine culture techniques to improve efficiency, and determine fish gender. As of April 2005, the SMNFH&TC housed 121 wild stock of Devils River minnow (J. N. Fries, Service, pers. comm. 2005). Offspring from the wild stock of various ages are being used to describe the developmental process of the species. Morphometrics, meristics, and melanophore characteristics of Devils River minnow early life stages were described for individuals ranging in age from time of hatch to Day 128 (Hulbert 2005).

(3) Reintroduce Devils River minnow reared from captive populations to reestablish populations in the wild

At the time the Conservation Agreement was developed, there was concern that Devils River minnow populations in the Devils River were extirpated, or nearly so. Therefore, the conservation action to reestablish populations was focused on reintroducing fish only in the Devils River. Reintroductions of Devils River minnow into the Devils River are not anticipated as part of this Recovery Plan because the species' status in the river is better than previously documented. Future reintroductions may prove feasible in currently unoccupied areas, such as Las Moras Creek. Efforts have been made to work with the local community through the Fort Clark Springs Association (Association) to develop a restoration plan for reestablishing Devils River minnow in Las Moras Creek. The Association manages the upper few miles of Las Moras Creek, including the spring head and the connected swimming pool. The Association has shown some interest in the past in pursuing a restoration project; however, thus far the Association has declined to participate in restoration efforts for Devils River minnow in Las Moras Creek.

(4) Continue and enhance protection of the San Felipe Creek watershed

In 2003, the City of Del Rio and San Felipe Country Club (local golf course) signed management plans for the protection, preservation, restoration, and management of San Felipe Creek (Appendix C). These plans will provide important conservation benefits to the population of Devils River minnow in San Felipe Creek. The City also has adopted a Water Conservation Plan to direct future water use activities during drought times and has taken several additional steps to enhance water conservation within the City (City of Del Rio 2002).

(5) Provide technical assistance to landowners on riparian protection and management

To date, TPWD has provided technical assistance to the City of Del Rio and the San Felipe Country Club for golf course management. In response, the golf course has changed mowing and fertilizing procedures and has instituted a minimum 10 to 15 feet no-mow buffer along the creek to improve the health of San Felipe Creek (City of Del Rio 2002).

(6) Review live bait harvest and selling practices in the Devils River area to develop methods and take appropriate actions (for example, regulation, education) to prevent further establishment of exotic, aquatic species within the historic range of Devils River minnow.

In 1998, TPWD modified its bait fish regulations to allow only native bait fish, exotics that are already well established (carp), or exotics that have historically been used but never established viable populations (golden shiner & goldfish). The remaining approved species are common native fishes. The modified bait fish regulations state:

"In Brewster, Crane, Crockett, Culberson, Ector, El Paso, Jeff Davis, Hudspeth, Loving, Pecos, Presidio, Reeves, Terrell, Upton, Val Verde, Ward and Winkler counties, the only fishes that may be used or possessed for bait while fishing are common carp, fathead minnows, gizzard and threadfin shad, golden shiners, goldfish, Mexican tetra, Rio Grande cichlid, silversides and sunfish."

(7) Document abundance and range of exotic fish species in the Devils River, San Felipe, Las Moras and Sycamore creeks using methods described in [Conservation Action] #1

See results of Conservation Action #1 above. A complete report of the results of these collections (2000-2004) will be available in the future from TPWD.

(8) Obtain and analyze changes in flow data for the Devils River, San Felipe, Las Moras, and Sycamore creeks

We are not aware of any specific action that has been taken on this task.

(9) With progeny of the captive population, use a simulated environment to determine ecological and life history requirements of Devils River minnow

Since September 1999, predation and competition experiments have been conducted in artificial streams by TPWD. Predation experiments used various sizes of sub-adult smallmouth bass as the predator and observed effects on different fish communities found in the Devils River. Results suggest that the Devils River minnow may be less susceptible to bass predation than other minnows from the Devils River (G. Garrett, TPWD, pers. comm. 2002). Since 2001, experiments on competitive interactions of native fishes have been conducted. In 2002, two additional artificial streams were constructed, bringing the total to four artificial streams. Additional replication will enhance statistical inferences drawn from the data.

(10) Determine *in situ* predator/prey interactions [in the natural environment] between smallmouth bass and Devils River minnow

A study by Robertson (1998) suggested that smallmouth bass may be affecting the native fish assemblages in the Devils River (Robertson and Winemiller 2001). However, few Devils River minnow were found in the study, and no conclusions could be reached for the effects of smallmouth bass on this species.

1.8.2 Land Conservation

Much of the land along the Devils River has been placed in conservation management during recent years, including the purchase of the 7,689-ha (19,988-acre) Devils River State Natural Area in the 1980s (Karges 2003). Since then, The Nature Conservancy (TNC) has been active in working with local landowners to conserve the lands along the Devils River by direct purchase and establishing conservation easements (Karges 2003). In all, TNC currently has about 51,592 ha (127, 458 acres) under conservation management within the Devils River watershed, with approximately 25 miles of riverfront and riparian habitat. Although land ownership and management can not address all the threats to the Devils River minnow, they do benefit the aquatic habitat for the species.

2.0 RECOVERY

2.1 Goals, Objectives, and Criteria

2.1.1 Recovery Goal

The recovery goal for the Devils River minnow is to reduce or remove threats to the species and its habitat such that its long-term survival is secured, so that the species is no longer threatened and can be delisted. The recovery plan outlines necessary actions to conserve the species and the ecosystem upon which it depends. Conservation of this species in the wild is dependent upon conservation of stream and spring flows of appropriate quantity and quality to support the species and its habitat. The goal includes protection and maintenance of the native biological aquatic communities in which the Devils River minnow occurs.

2.1.2 Recovery Objectives

Recovery objectives collectively describe the specific conditions by which the Devils River minnow recovery goals will be met. Recovery objectives for Devils River minnow include:

(1) Ensure self-sustaining populations of Devils River minnow in Devils River, San Felipe Creek, Sycamore Creek, Pinto Creek, and Las Moras Creek in Texas and in the Río Salado drainage in Coahuila, Mexico;

(2) Secure protection of adequate stream and spring flows for long-term maintenance of aquatic ecosystems upon which Devils River minnow rely;

(3) Reduce pollutants from point and non-point sources affecting areas with existing water quality problems and avoid degradation of water quality of surface water and groundwater throughout the range of the Devils River minnow;

(4) Reduce the opportunities for introduction and establishment of non-native species, and manage all current aquatic non-native species for the benefit of native biological aquatic communities throughout the range of the Devils River minnow.

2.1.3 Recovery Criteria

The ESA requires recovery plans to include "objective, measurable criteria which, when met, would result in the determination…that the species be removed from the list." Recovery criteria describe discrete targets with standards for measurement to determine that species have achieved recovery objectives and may be delisted. Developing precise measurable criteria for recovery of Devils River minnow is challenging because of information gaps about the species and its habitat. As a result, many of the recovery actions are intended to fill these gaps and will allow future development of more specific criteria. Based on the best available scientific information, Devils River minnow should be considered for delisting when:

(1) Population monitoring verifies stable or increasing population trends for Devils River minnow for at least 10 years throughout its range including Devils River (middle portion), San Felipe Creek, Sycamore Creek, and Pinto Creek in Texas. If reestablishment is scientifically feasible, populations should be restored in Las Moras Creek. The status of populations in the Rio Salado drainage in Mexico should also be confirmed.

(2) Adequate flows in streams supporting Devils River minnow have been ensured, including Las Moras Creek (if reestablishment is feasible), through State or local groundwater management plans, water conservation plans, drought contingency plans, regulations, or equivalent binding documents;

(3) Protection of surface water quality, including the protection of the quality of groundwater sources of surface water flows, is ensured throughout the range of Devils River minnow by demonstrated compliance with water quality standards and implementation of water quality controls, particularly in urban areas such as the cities of Del Rio and Brackettville; and

(4) Management and control of non-native species by local, regional, State, and Federal authorities are demonstrated to be successful.

2.2 Recovery Strategy

The general recovery strategy for the Devils River minnow is to reduce threats to the species, secure adequate habitat conditions (clean, free-flowing springs and streams), and allow viable, self-sustaining populations to persist in the wild throughout its remaining range, and where feasible to restore populations within the historic range. Many of the necessary actions for habitat protection are predicated on an increased understanding of the relationship of the Devils River minnow to its physical, chemical, and ecological environment. Several recovery actions are designed to collect information on the species and its habitat to provide for better future science-based management decisions and conservation actions. For example, an increased understanding of the species' genetics, life history, population dynamics, and responses to identified threats are needed. Implementation of the recovery plan will require adaptive management strategies to use the most up-to-date information as it becomes available.

2.2.1 Conserve Habitat

The primary focus of the recovery strategy for the Devils River minnow is the protection of naturally functioning spring and stream ecosystems within its current and potentially restorable historic range. The first priority is to ensure sufficient stream and spring flows (that is, water quantity) to maintain viable populations of native fauna and flora. Protection of underground water reservoirs (aquifers) from non-sustainable use is essential because all streams in the Devils River minnow's range are supported by these aquifers (Brune 1981; see *Section F. Hydrology and Geohydrology*). Current State of Texas regulations require that this be accomplished through local groundwater management. At this time, insufficient information is available to recommend specific flows for streams where Devils River minnow occur. Future analysis of preferred habitat use of the fish and historic stream hydrology are needed to develop specific stream flow targets; when completed these targets will be incorporated into the plan.

Water quality protection also is important to ensure that adequate habitat is available throughout the Devils River minnow's range. Based on current information, focus is placed on protection of water quality in the urban settings of Del Rio and Brackettville. However, additional research may warrant considerations for water quality protection in rural settings as well. Current information is not available to determine specific water quality needs of the Devils River minnow. Initially, water quality analysis of currently occupied habitats can be used to describe the water quality conditions needed for the species.

In some situations, restoring the natural physical stream conditions from previous stream channel modifications (small dams, stream bank changes, channelization, etc.) may be needed to allow the microhabitat conditions necessary for feeding, breeding, and sheltering of Devils River minnows. These physical components of streams work together to support the natural aquatic ecosystem upon which the species and all associated native species depend.

2.2.2 Control Non-native Species

Non-native competitors, predators, and carriers of parasites and/or diseases need to be restricted. Introduced species within the range of the Devils River minnow are a constant threat and alleviating this threat will require ongoing enforcement of State regulations and public education. The influences of introduced species may be difficult to measure, due to the complex nature of the interactions. Potential problems could include not only non-native fishes, but also other animals or plants that could introduce a parasite or disease or alter the natural habitat.

2.2.3 Preserve Genetic Diversity

All of the remaining populations of Devils River minnow are included in the recovery criteria because of the small number of total populations remaining. To achieve recovery, threats must be reduced and populations stabilized throughout the species' range. The different populations of the Devils River minnow are considered management units. The recovery criteria use six management units, based on the streams where the fish occur, or could be restored. These six units are:

1. Devils River, Texas;
2. San Felipe Creek, Texas;
3. Sycamore Creek, Texas;
4. Pinto Creek, Texas;
5. Las Moras Creek, Texas; and
6. Río Salado drainage, Mexico.

Verifying or establishing viable populations in all six of these management units is considered necessary (if scientifically feasible) for recovery to be achieved, since they are all now isolated, vulnerable to threats, and not likely to be naturally recolonized if extirpated. Until new information is available on the genetics of these populations, they should be treated and managed as separate units. Surveys are especially needed in Sycamore Creek and in the Río Salado drainage in Mexico to assess the current status of the species and its habitat there. In the absence of more information on the feasibility of conserving Devils River minnow in these areas, both were included in the recovery criteria to decrease the risk of species extinction over the long-term. Although the Devils River minnow does not presently occur there, Las Moras Creek is believed to be "recoverable" habitat and is included as a necessary population in the recovery criteria.

2.2.4 Maintain Captive Populations

Because of the small and isolated nature of these populations, captive propagation (culture of fish in a hatchery or zoo setting) likely will be needed for the foreseeable future. Implementation of a captive propagation plan is aimed at maintaining natural genetic diversity among and within the different management units. This will help ensure conservation of genetic diversity in the event that wild populations are extirpated. Captive populations should be maintained until species' threats are sufficiently reduced that extinction in the wild is no longer likely.

2.2.5 Monitor Population Status

Once the identified threats have been sufficiently reduced, viable populations should be confirmed throughout the historic range of Devils River minnow, with the exception of upper and lower sections of the Devils River in Texas and the Río San Carlos in Mexico, where it may not be feasible to restore habitat. Due to the species' limited distribution, it is prudent to maintain or reestablish populations in all available and restorable habitats. The lowest sections of the Devils River are excluded from the recovery criteria because the habitat is believed to be permanently lost due to the impoundment of Amistad Reservoir. Similarly, the upper section of the Devils River appears to no longer support continual stream flows, and restoration of Devils River minnow habitat there is not considered feasible. The status of the habitat in the Río San Carlos in Mexico is unknown but is presumed degraded to the extent that the species is extirpated.

Assuming a life expectancy of about 2 years, the recommended 10 years of monitoring represents at least five generations. Additional research may be necessary to evaluate the magnitude of hydrologic variations likely to occur that were not experienced during the 10 years (such as unusually large, infrequent floods or droughts) and the effects of these variations on Devils River minnow.

2.2.6 Conserve Mexican Populations

Determining an appropriate strategy for conservation of Devils River minnow in Mexico is particularly challenging because of the scarcity of information on the species there. Developing a strategy for the species in Mexico can only be adequately addressed with documented surveys and a complete assessment of threats. In addition, a thorough evaluation of the phylogenetic relationship of Devils River minnow populations in Mexico to populations in Texas also is needed. Mechanisms for interagency coordination with the appropriate personnel in Mexico are vitally needed to develop an appropriate strategy there. The recovery plan and criteria may be revised to include additional recovery actions for populations in Mexico, as the understanding of the species and its needs in Mexico increases.

2.2.7 Apply Adaptive Management

The strategy of this recovery plan is based on the best available science; however, we recognize there are considerable knowledge gaps regarding the species and the ecosystem upon which it depends. As a result of this uncertainty, the process of Devils River minnow recovery will necessitate adaptive management—that is, "we will learn by doing." Throughout the implementation of recovery actions outlined below, new information and technologies will become available. New information should be evaluated and used to modify the strategy for recovery of Devils River minnow, as appropriate. With increasing knowledge, some recovery actions will likely become obsolete and other actions will be proposed that cannot be envisioned now. Likewise, the objectives and criteria of this recovery plan may be adjusted in the future as our understanding improves. Through a continual process of planning, doing, monitoring, research and evaluation, and adjusting management, we will learn how to effectively conserve this species. The knowledge we gain from implementation of this recovery plan will be incorporated in the future recovery process.

The Service periodically reviews approved recovery plans to determine the need for modifications. This recovery plan should be considered a living document that is flexible and consistent with the available, contemporary, scientific information. This may require periodic updates to the plan without full revisions being completed. This flexibility will maximize the usefulness of the recovery plan. The adaptive management concept ensures that all parties who choose to participate will have opportunities to contribute to the Devils River minnow recovery process. The work to accomplish the species' recovery is too large and too complex for any entity to accomplish alone. Only by working together with diverse groups of people with different knowledge and expertise can recovery objectives and criteria be achieved.

2.3 Recovery Action Outline

1. Maintain and enhance existing Devils River minnow populations and habitats.
   - 1.1 Monitor status of Devils River minnow.
     - 1.1.1 Monitor distribution and abundance in Texas.
     - 1.1.2 Assess distribution and abundance in Mexico.
     - 1.1.3 Assess and monitor threats to Texas and Mexico populations.
     - 1.1.4 Evaluate geographic variation in the species' genetic structure.
   - 1.2 Determine biological and life history requirements.
     - 1.2.1 Study competition with coexisting species.
     - 1.2.2 Study reproductive variables.
     - 1.2.3 Investigate predation by other species.
     - 1.2.4 Determine early life history characteristics and survivorship.
     - 1.2.5 Investigate disease and parasites.
     - 1.2.6 Study effects of aquatic non-native species.
   - 1.3 Identify specific habitat requirements.
     - 1.3.1 Determine physical habitat preferences.
     - 1.3.2 Determine chemical habitat preferences and tolerances (water quality).
     - 1.3.3 Determine relationships of stream flow and habitat availability.
     - 1.3.4 Determine stream flows needed for habitat maintenance.
     - 1.3.5 Study effects of riparian management strategies.
     - 1.3.6 Investigate regional hydrogeology.
   - 1.4 Manage Devils River minnow habitat.
     - 1.4.1 Seek and maintain the cooperation of landowners and government agencies.
     - 1.4.2 Ensure protection for certain stream segments and their watersheds.
     - 1.4.3 Develop and implement groundwater management plans for stream flow protection.
     - 1.4.4 Monitor stream flows.
     - 1.4.5 Monitor existing physical and chemical habitats.
     - 1.4.6 Restore and enhance habitat conditions.
     - 1.4.7 Reduce pollutants.
   - 1.5 Establish and implement procedures to prevent introduction of exotic species and control problem exotic species.
   - 1.6 Develop a recovery strategy for Mexican populations.
   - 1.7 Assess effectiveness of recovery management actions.

2. Establish additional viable Devils River minnow populations within the historic range.
   2.1 Develop landowner agreements to reintroduce in former site(s) of occurrence.
   2.2 Restore habitat conditions at former site(s) of occurrence.
      2.2.1 Assess future spring flows at reintroduction site(s).
      2.2.2 Ensure adequate water quality protection at reintroduction site(s).
      2.2.3 Develop and implement stream channel restoration projects at reintroduction site(s), if necessary.
   2.3 Develop and implement a reintroduction plan.

3. Maintain genetic reserves of Devils River minnow in captivity until no longer needed.
   3.1 Develop and implement a genetics management plan.
   3.2 Maintain captive populations in at least two appropriate facilities.

4. Disseminate information about Devils River minnow conservation.
   4.1 Develop an outreach strategy.
   4.2 Prepare and distribute an information pamphlet.
   4.3 Produce and maintain an outreach website.
   4.4 Construct an informational kiosk in Del Rio on San Felipe Creek.

5. Post-delisting monitoring.
   5.1 Develop a post-delisting monitoring plan for the Devils River minnow.

2.4 Recovery Action Narrative

Each recovery action is described below. An explanation of priority numbers is given in *Section 3.2 Recovery Action Priorities and Abbreviations.* For each individual recovery action, the estimates of cost, list of responsible parties, and a cross-reference to recovery criteria and the listing factor is given in *Section 3.3 Implementation Schedule.*

1. <u>Maintain and enhance existing Devils River minnow populations and habitats</u>. Recovery actions 1.1 to 1.3 are designed to collect the necessary updated information to manage Devils River minnow populations and their habitat for natural ecosystem functions. The knowledge gained in monitoring and research studies should be used in an adaptive management approach to provide new strategies for Devils River minnow recovery.

   1.1 <u>Monitor status of Devils River minnow</u>. Range-wide up-to-date information on the distribution, abundance, and threats to the species is needed to inform species conservation and management decisions. The last published comprehensive analysis of the fish's status in the U.S. was from data collected in 1989 (Garrett et al. 1992). TPWD has conducted numerous survey efforts over the last five years. Once published, this will provide the latest summary of the status of the species.

      1.1.1 <u>Monitor distribution and abundance in Texas **(Priority 1b)**</u>. Multiple years of fish surveys need to be conducted in all stream habitats ranging from Las Moras Creek watershed to the Devils River watershed to determine and monitor the current distribution and abundance of Devils River minnow in Texas. The success of this action is directly dependent on the voluntary permission of private landowners allowing biologists access to creeks on private property for surveys.

      1.1.2 <u>Assess distribution and abundance in Mexico **(Priority 1b)**</u>. Fish surveys are needed in the Río Salado and Río San Carlos drainages and intervening watersheds to determine the current distribution and abundance of Devils River minnow in Mexico. Cooperation of private landowners and Federal and local Mexican governments is needed to conduct research in Mexico.

      1.1.3 <u>Assess and monitor threats to Texas and Mexico populations **(Priority 1b)**</u>. An updated evaluation of threats to the Devils River minnow in Texas and Mexico needs to be completed. Threat evaluation should include a study of the past physical habitat changes (water quantity, water quality, substrates, stream channel geometry, stream bank) and changes in ecological factors (non-native species introductions, food sources, predators, competitors). The results will allow for high-priority recovery actions to be directed at reducing the most immediate threats. Approval and support of Mexican and U.S. governmental agencies and private landowners are needed.

      1.1.4 <u>Evaluate geographic variation in the species' genetic structure **(Priority 2)**</u>. The results should help in the management of populations in different watersheds, possibly as separate units. One consideration is the possible effects of Amistad Reservoir eliminating the movement of fish and, therefore, gene flow, between the Devils River and other streams. This information will be essential for establishment of captive populations or reintroduction plans.

1.2 Determine biological and life history requirements. Management for long-term survival of the species depends on knowledge of its ecological needs. Studies aimed at developing such knowledge should be conducted, with sensitivity toward problems of over-collecting, transportation of exotics, and any other actions that may adversely affect the fish.

1.2.1 Study competition with coexisting species **(Priority 2)**. Investigations of competition will require additional knowledge of reproduction, life history, habitat use, and food preference. The Devils River minnow is thought to eat algae; however, virtually nothing is known of food preferences. Overlap in food preferences with coexisting species (for example, exotic armored catfish) could adversely affect Devils River minnow at times when resources are limited. Competition for space (for example, breeding areas) could also be a problem. One potential area of investigation is how niche separation occurs with the manantial roundnose minnow, a closely related species often found in the same habitat but at greater abundances.

1.2.2 Study reproductive variables **(Priority 1b)**. Comprehensive studies in laboratory and field settings are needed to determine reproductive traits such as timing, duration, frequency, behavior, fecundity, and habitats (including water velocities, depths, and substrate). This information can be used to assist in developing captive breeding techniques for maintaining captive populations and assessing potential competition with other fishes. The information could also be critical to management of the ecosystem to benefit reproduction of the species. For example, if a particular flow rate were needed in San Felipe Creek to provide the habitat needed to ensure egg or fry survival during a particular season, it would be important for the City of Del Rio to proactively manage water withdrawals to ensure the appropriate conditions are not compromised. Other important factors could be discovered that are currently limiting the reproduction and early survival of Devils River minnow.

1.2.3 Investigate predation by other species **(Priority 2)**. Predation levels by native and non-native fishes, including smallmouth bass, should be determined for different Devils River minnow populations through field and laboratory study. Additional investigations in the wild may need to be conducted to determine what effect, if any, predation by smallmouth bass may have on Devils River minnow. Results could direct future management actions for the smallmouth bass fishery in the Devils River, particularly in critical river segments.

1.2.4 Determine early life history characteristics and survivorship **(Priority 2)**. Nothing is known of Devils River minnow survivorship or longevity. Seasonal mortality rates for each life history stage should be determined and could be incorporated into future management actions for Devils River minnow conservation.

1.2.5 Investigate disease and parasites **(Priority 3)**. Except for McDermott's (2000) survey for gill flukes in San Felipe Creek, no data are available on the diseases and parasites of the Devils River minnow. Advancing knowledge of the diseases and parasites of the fish could help contain any potential future epidemic.

1.2.6 Study effects of aquatic non-native species **(Priority 1b)**. Exotic species currently occurring within the range of the Devils River minnow (as well as potential future releases and establishment of other non-native organisms) are a potential threat to its survival. Effects of non-native species often are manifested through competition, predation, disease, parasitism, or hybridization—all of which are difficult to quantify. The best approach to this problem is to reduce the possibility of any releases of non-native species into the wild (see Action 1.5). A study is needed on the effects of the exotic *Melanoides* snails in San Felipe Creek (McDermott 2000) and the potential for the associated gill parasite to infect Devils River minnow. Research also is needed in San Felipe Creek to determine how the recently introduced exotic armored catfish affect the Devils River minnow. In both cases, measures should be developed to control the exotic species because of the probable negative effects.

1.3 Identify specific habitat requirements. Valuable data for protection and enhancement of the Devils River minnow would be gained from a survey of physical, chemical, and biotic features in relation to presence and abundance of the species.

1.3.1 Determine physical habitat preferences **(Priority 2)**. The specific physical characteristics (for example, water depth, velocity, substrate, vegetation) associated with stream habitats should be quantified for Devils River minnow preference. The information should be analyzed by season, age class, and stream reaches. To date, only qualitative assessments of habitat preferences have been made, suggesting the fish (adults) occupy areas with moderate depths and velocities, and gravel substrates near aquatic vegetation. This research should identify high quality habitat for Devils River minnow maintenance, restoration, or reintroduction.

1.3.2 Determine chemical habitat preferences and tolerances (water quality) **(Priority 2)**. Through both field and laboratory investigations, preferences and tolerances of Devils River minnow should be determined for a range of chemical properties (for example, water temperature, dissolved oxygen, pH, salinity, suspended sediments, total dissolved solids, nitrates, phosphates, petroleum hydrocarbons) of waters that may be found within the species range.

1.3.3 Determine relationship of stream flow and habitat availability **(Priority 1b)**. Hydrological analysis should be completed for streams known to be occupied by Devils River minnow and correlated to physical habitat availability for the fish. A range of flows should be evaluated for the various effects on overall available habitat for Devils River minnow.

1.3.4 Determine stream flows needed for habitat maintenance **(Priority 1b)**. Where stream flows may be directly influenced by human actions, optimum stream flows should be established to maintain adequate Devils River minnow populations. A specific need where a target flow regime may be useful is on San Felipe Creek, where the City of Del Rio removes water directly from the springs that supply water to the creek. This flow analysis should be based on extensive field data collection and state-of-the-art modeling techniques. This information could be used as a guide for water users, like the City of Del Rio, to develop and implement water management strategies and drought contingency plans, while still sustaining biotic integrity and conservation values of surface streams.

1.3.5 Study effects of riparian management strategies **(Priority 3)**. Conduct research to determine the effects on Devils River minnow of various land management methods (related to grazing practices in rural areas and related to bank modifications in urban settings) in riparian areas where Devils River minnow occurs.

1.3.6 Investigate regional hydrogeology **(Priority 1b)**. Determining the source and recharge zones of the aquifers that support stream flows in Devils River minnow habitat in Texas is paramount in protecting these flows. Only through comprehensive investigation, mapping, and modeling can effective groundwater management and conservation be ensured.

1.4 Manage Devils River minnow habitat. Ensuring maintenance and conservation of habitat currently supporting Devils River minnow populations is critical to recovery. Effective management should include groundwater conservation in the contributing aquifer(s); stream flow protection; physical habitat improvement in some stream reaches; pollution prevention; and cultivation of cooperative relationships with and among landowners, public agencies, and other interested parties in the area. Information gained from actions 1.1, 1.2, and 1.3 (described above) will be helpful in meeting actions 1.4 and 2.0.

1.4.1 Seek and maintain the cooperation of landowners and government agencies **(Priority 1a)**. Private landowners should be recognized for past land management actions that have allowed the species to persist in the streams on or adjacent to their property. Private landowners should be involved in recovery action planning and implementation for the Devils River minnow. Local government agencies, such as the cities of Del Rio and Brackettville, Val Verde and Kinney counties, and local water districts, should also be involved in planning and conducting recovery implementation for the species.

1.4.2 Ensure protection for certain stream segments and their watersheds **(Priority 1a)**. Stream flow, water quality, and channel morphology should be maintained in natural conditions to provide for ecosystem functions to support Devils River minnow. Areas in Texas where the Devils River minnow currently occurs should be the focus of conservation efforts. (Areas include Devils River and tributaries from Pecan Springs to Dolan Falls; San Felipe Creek in Del Rio; upper segments of San Felipe Creek; Sycamore Creek; and upper segments of Pinto Creek). Protection should be initiated and documented in commitments by individual landowners, local governmental agencies (cities and counties) and non-governmental organizations (such as water conservation districts, landowner associations, and regional water planning groups). Land management plans that serve to improve watershed health should be developed and implemented throughout the watersheds supporting Devils River minnow.

1.4.3 Develop and implement groundwater management plans for stream flow protection **(Priority 1a)**. State and local governmental entities (for example, groundwater districts, regional water planning groups, cities, and counties) should work with landowners and other water users to develop and implement specific plans for sustainable groundwater use to ensure that surface water flow from springs and creeks are maintained for the benefit of natural ecosystems upon which the Devils River minnow depends.

1.4.4 Monitor stream flows **(Priority 1b)**. A comprehensive network of stream discharge gages should be installed and maintained for streams within the range of the Devils River minnow. The data should be readily available through online sources on the Internet. This information would provide historic flow data and current stream flow conditions to assist in management of Devils River minnow habitat. This would be especially necessary during critical low flow periods when physical habitat may be limited by lack of adequate stream flow and conservation actions may need to be triggered based on flow rates.

1.4.5 Monitor existing physical and chemical habitats **(Priority 1b)**. The status of habitat conditions at locations of all extant Devils River minnow populations needs to be monitored, at least annually, to detect changes in habitat availability. A monitoring plan should be developed to ensure uniform methods of field work over time and location to evaluate habitat trends.

1.4.6 Restore and enhance habitat conditions **(Priority 2)**. A habitat enhancement plan for San Felipe Creek in Del Rio (and any other appropriate site) aimed at improving and maintaining physical habitat for Devils River minnow should be formulated and implemented. This may include the physical reconstruction of stream banks with native vegetation and natural stream morphology.

1.4.7 Reduce pollutants **(Priority 1a)**. Pollution sources to aquatic habitats throughout the range of the Devils River minnow need to be detected and the pollutants eliminated to the maximum extent practicable. Of special concern are inputs from urban environments in San Felipe Creek from Del Rio.

1.5 Establish and implement procedures to prevent introductions of exotic species and control problem exotic species **(Priority 1a)**. Because of the dangers of predation, competition, diseases, parasites, and hybridization, further introductions of all exotic organisms that could affect the aquatic environment, should be prevented within the range of the Devils River minnow. Methods for control should be developed and implemented for existing exotic species found to be degrading Devils River minnow populations or their habitats.

1.6 Develop a recovery strategy for Mexican populations **(Priority 1b)**. As new information is gained on the status and threats to Devils River minnow populations in Mexico, collaboration between U.S. and Mexico to address transboundary conservation needs may be warranted. The strategy may or may not include similar actions necessary to achieve recovery in the U.S. and needs to be compatible with local culture and government policies.

1.7 Assess effectiveness of recovery management actions **(Priority 1b)**. Ongoing evaluations of the results of management actions should be conducted to allow for adaptive management so that changes can be made as new information becomes available.

2. Establish additional viable Devils River minnow populations within the historic range. Adequate spring flows, spring outlet restoration, alteration of swimming pool maintenance activities, and elimination of any non-native fishes may allow repatriation of the Devils River minnow in the Las Moras Creek watershed in Brackettville and downstream. Other sites within the historic range may be considered for reintroductions (Sycamore Creek, for example, if future surveys do not confirm its presence there) if determined appropriate and habitat restoration actions can be undertaken. Support of private landowners will be necessary to plan and implement the reestablishment of the Devils River minnow. There is uncertainty regarding the feasibility of reestablishing the Devils River minnow in its former range. Therefore, adaptive management principles will be essential in planning and implementing reintroduction efforts.

2.1 Develop landowner agreements in former site(s) of occurrence **(Priority 1b)**. Agreements would need to be documented to show landowner cooperation in restoration efforts and commitments to future conservation measures to ensure successful repatriation of Devils River minnow in any formerly occupied areas.

2.2 Restore habitat conditions at former site(s) of occurrence. Prior to any reintroduction of Devils River minnow in Las Moras Creek (or any other site), the following minimum conditions, should be considered to ensure habitat availability.

2.2.1 Assess future spring flows at reintroduction site(s) **(Priority 1b)**. The probability of maintaining future adequate spring flows should be considered. Ideally, documented and enforceable groundwater management (based on detailed hydrogeology studies) would be in place to provide for permanent flow at adequate levels in Las Moras Creek. This may require establishing target stream flows based on species' requirements and making those flow levels part of groundwater management goals.

2.2.2 Ensure adequate water quality protection at reintroduction site(s) **(Priority 1b)**. A comprehensive study of water quality and contaminants is needed to determine survival potential for Devils River minnow in any reintroduction site. Concerns for water quality should be addressed prior to development of reintroduction plans. For example, in Las Moras Creek, chlorination of the swimming pool fed by Las Moras Creek is suspected to limit all biota in the creek downstream (Garrett et al. 1992). These maintenance practices may need to be replaced with a less detrimental form of pool cleaning to support Devils River minnow populations. Other pollution sources need to be evaluated in Brackettville, as well. Written agreements with local landowners (including Fort Clark Springs Association) and the City of Brackettville should be developed that provide for adequate water quality in the spring outflow and downstream.

2.2.3 Develop and implement stream channel restoration projects at reintroduction site(s), if necessary **(Priority 1b)**. An analysis of the physical habitat of the spring outflow area of Las Moras Creek needs to be completed, including documentation of past changes (for example, any dredging or channelization that occurred). If substantial degradation has occurred, a stream channel restoration plan may need to be developed and implemented.

2.3 Develop and implement a reintroduction plan **(Priority 1a)**. Prior to any reintroduction efforts, a comprehensive reintroduction plan should be developed in accordance with the Service's Captive Propagation Policy (Policy Regarding Controlled Propagation of Species Listed Under the Endangered Species Act, 65 FR 56916, September 20, 2000). This plan would include, but not be limited to, a consideration of population genetics, an assessment of reintroduction effects on other native species, and a specific monitoring component to measure reintroduction results. In developing this plan the results of Recovery Actions associated with 2.1 and 2.2 should be taken into account.

3. Maintain genetic reserves of Devils River minnow in captivity until no longer needed. Captive populations should be representative of the total genetic variation and maintained in a way that is most useful for reintroduction purposes (per actions under 2, above). Maintaining captive stock also is important should a loss of natural populations ever occur. Captive-held fish also can be used to provide live or preserved specimens for scientific study and deposition in fish museums for future reference and study.

3.1 <u>Develop and implement a genetics management plan **(Priority 1b)**</u>. A genetics management plan should be completed in accordance with the Service's Captive Propagation Policy. The purpose of the plan is to ensure that: (1) the genetic makeup of propagated individuals is, to the extent practicable, representative of the wild populations; (2) propagated individuals are behaviorally and physiologically suitable for introduction; and, (3) this genetic make-up is maintained in captivity over generations. Until a genetics study can be completed (Action 1.1.4), each population of Devils River minnow should be separately maintained. Individuals from the Devils River drainage, San Felipe Creek drainage, Pinto Creek, Sycamore Creek, and Mexico should not be allowed to interbreed in captivity. The genetics management plan should include adaptive management provisions to incorporate biological information gained during the research and early implementation of captive propagation.

3.2 <u>Maintain captive populations in at least two appropriate facilities **(Priority 1a)**</u>. Develop culture techniques, incorporating reproductive ecology (as outlined in 1.2.2) and genetics considerations (as outlined in 3.1), to maintain genetically representative, captive populations of Devils River minnow. Establish and maintain these populations at HHFSC and SMNFH&TC (in accordance with the Service's Captive Propagation Policy). If one or both of these facilities is unable to maintain a captive population, alternative facilities should be used such that captive populations are maintained in at least two separate locations.

4. <u>Disseminate information about Devils River minnow conservation.</u> A good public information program solicits and encourages support for protection of imperiled species. Information on Devils River minnow should be disseminated to a wide audience, while focusing on the local communities within the species range.

4.1 <u>Develop an outreach strategy **(Priority 3)**</u>. A plan to describe the basic message and the audience should be prepared to guide public outreach efforts.

4.2 <u>Prepare and distribute an information pamphlet **(Priority 3)**</u>. A pamphlet on Devils River minnow ecology, life history, status, and general aspects of recovery efforts should be prepared and distributed. Content of the pamphlet should include information on how local landowners can participate in conservation efforts for the Devils River minnow. The pamphlet also could discourage introduction of bait fishes and be distributed at bait and tackle shops.

4.3 <u>Produce and maintain an outreach website **(Priority 3)**</u>. A website describing the Devils River minnow and threats to it and conservation efforts for it should be produced and made available to the public.

4.4 <u>Construct an informational kiosk in the City of Del Rio on San Felipe Creek **(Priority 3)**</u>. The largest community within the range of the Devils River minnow is the City of Del Rio. The City has several public parks along San Felipe Creek where the public can recreate (swim, fish, picnic, etc.). One or more kiosks should be constructed in areas frequented by the public to provide information on Devils River minnow and San Felipe Creek and encourage environmental conservation of the creek.

5. Post-delisting monitoring.

5.1 Develop a post-delisting monitoring plan for the Devils River minnow **(Priority 3)**. Section 4 (g) (1) of the ESA requires that the Service monitor the status of all recovered species for at least five years following delisting. In keeping with this mandate, a post-delisting monitoring plan should be developed by the Service in cooperation with TPWD, the Rio Grande Fishes Recovery Team, Federal agencies, academic institutions, and other appropriate entities. This plan should outline the indicators that will be used to assess the population status of the Devils River minnow, develop monitoring protocols for those indicators, and evaluate factors that may trigger consideration for relisting.

2.5 Control of Threats

The following summarizes the recovery actions for the Devils River minnow that are intended to control the threats to the species. References to specific recovery actions (abbreviated RA in this section) can be reviewed in *Sections 2.3, 2.4* and *3.3* of this plan. For a review of the threats, see *Section 1.7 Reasons for Listing and Threats Assessment.* Recovery criteria refer to those listed in *Section 2.1 Goals, Objectives, and Criteria.* A summary relating threats associated with the five listing factors to the recovery criteria and recovery actions is provided in Table 1.

2.5.1 Listing Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Devils River minnow Habitat or Range

2.5.1.1 Range Reduction and Habitat Loss

Some of the habitat lost in the Devils River is considered permanent and not recoverable due to stream flow loss and reservoir inundation in the upstream and downstream portions of the river, respectively. It is uncertain whether habitat losses in Mexico are recoverable. However, it appears likely that the Las Moras Creek population of Devils River minnow could be restored if the local community decided to take the necessary actions to do so. Recovery Actions (RAs) 1.4.1, 2.1, 2.2.1, 2.2.2, 2.2.3, and 2.3 guide the necessary process for restoring this population. Initiating any action to restore the population is predicated on having the support of the local community and landowners, preferably documented by written agreements. Some assurance must be demonstrated that the appropriate water quantity, water quality, and stream channel habitat conditions are present and will be maintained at any potential reintroduction site, such as Las Moras Creek. Specific measures and actions to carry out restoring and monitoring the population should be guided by a reintroduction plan. Monitoring efforts are needed throughout the Devils River minnow range to gauge population status and the threats it faces, as well as to determine when the recovery criteria might be met (RAs 1.1.1-1.1.4, 1.3.1 1.4.5, 1.7, and others).

An effective monitoring program is a key component to implement and document success of this recovery plan and providing opportunities for adaptive management (RAs 1.1.1, 1.1.2, 1.1.3, 1.1.4, and 3.1). Ongoing evaluation of the abundance and distribution of the Devils River minnow across its range will allow for the verification of the completion of Recovery Criterion 1. To properly manage the different Devils River minnow populations, information on the intraspecific genetic relationships is needed (RAs 1.1.4 and 3.1). Monitoring threats to Devils River minnow and the status of its habitat is necessary to document the fulfillment of Recovery Criteria 2, 3, and 4.

2.5.1.2 Spring Flow Declines (Water Quantity)

This recovery plan envisions protections for maintaining appropriate water quantity (Recovery Criterion 2) in streams inhabited by the Devils River minnow to be protected by local authorities. The conservation of instream flows should be demonstrated by written management plans of local and State entities with the authority and responsibility for managing groundwater and surface water resources, such as groundwater districts, cities and counties (RAs 1.4.1, 1.4.2, and 1.4.3). Additional science on the biology and ecology of the Devils River minnow (RAs 1.2.2, 1.2.4, 1.3.1, 1.3.2, 1.3.3, 1.3.4, and 1.4.5) and on hydrology and geohydrology (RAs 1.3.6 and 1.4.4) in the geographic areas supporting the species would be useful when formulating conservation measures to provide appropriate stream flows. Watershed management plans that strive for balanced, natural vegetation communities may benefit aquatic habitats depending on the site conditions and the landscape scale under management. The relationship of spring flows and vegetation management is a developing science in Texas (for example, see Ball and Taylor 2003, Hart 2004, White 2000, and Wilcox 2002).

2.5.1.3 Water Quality Degradation

Conservation of surface water quality (Recovery Criterion 3) in Texas streams primarily is regulated by the TCEQ. However, many implementing measures that will reduce pollution (RA 1.4.7) in waters that provide habitat for Devils River minnow are accomplished at the local level of private landowners and municipalities (RA 1.4.1). Only through the commitment to conservation of water quality through land management and wastewater treatment by the local communities will the needed level of protection be accomplished (RAs 1.3.5 and 1.4.2). In addition, research is needed on the specific tolerances and effects of various contaminants or water quality conditions on both individuals of Devils River minnow and on populations of the species (RA 1.3.2 and 1.4.5).

2.5.1.4 Stream Channel Modifications

Streams occupied by Devils River minnow have undergone various levels of change over time, including the establishment of non-native riparian vegetation, the modification of stream banks for erosion and flood control, and the construction of small dams and water crossing structures. Investigations on the specific microhabitats used by Devils River minnow (RAs 1.3.1, 1.3.2, and 1.4.5) and specific life history traits (RAs 1.2.2 and 1.2.4) will determine the need for future management and restoration (RAs 1.3.5 and 1.4.6) of the physical stream environments of Devils River minnow. This issue is related to Recovery Criterion 1 because providing the necessary habitat conditions is vital to ensuring stable populations. Additional information will allow for the determination as to the importance of controlling this threat for Devils River minnow recovery. Implementation of any habitat restoration or enhancement measures will need the consent of and close coordination with private landowners and/or local authorities (RA 1.4.1).

2.5.2 Listing Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization is not considered a threat to the Devils River minnow at this time.

2.5.3 Listing Factor C. Disease or Predation

To reduce the threat to the Devils River minnow posed by non-native species (RA 1.5), an effective outreach campaign would educate the public about the risks of releasing plants and animals into the wild (RAs 4.1, 4.2, 4.3, and 4.4). Even though specific regulations can be imposed to make importation or release of exotic species illegal, enforcement of such measures can be difficult. Preventing the establishment of non-native species requires ongoing and intense field monitoring of the stream and riparian biota and a quick response to the information gained (RAs 1.1.3 and 1.7). Research on the specific effects of exotic species on the Devils River minnow, particularly potential problems from competition, predation, diseases, and parasites (RAs 1.2.1, 1.2.3, and 1.2.5, respectively), also is needed to identify control needs and design priority actions (RA 1.2.6).

2.5.4 Listing Factor D. The Inadequacy of Existing Regulatory Mechanisms

Reducing the threats to the Devils River minnow and its habitat will be accomplished primarily at the local level. The "regulatory mechanisms" to ensure safeguards are in place will depend on local communities and individual landowners (RAs 1.4.1-1.4.4, 1.4.7, and 1.5). Because most Devils River minnow habitat is on private land or within the cities of Del Rio and Brackettville, individual landowners and local municipalities have the best opportunity to implement conservation measures for the species. The State, through TCEQ, has some authority to protect surface water quantity and quality. However, the surface water quantity protections provide limited benefit for the Devils River minnow. Similarly, to date, the surface water quality protections have been aimed primarily at point source discharges, which are not the principal concern for the Devils River minnow. In addition, TCEQ's implementation of surface water quality protection generally has focused on protection of overall aquatic communities without knowledge of the needs of individual rare species. State and Federal agencies can play a large role in providing the expertise and financial resources to collect and disseminate the information needed at the local level to implement the various conservation measures outlined in this recovery plan.

2.5.5 Listing Factor E. Other Natural or Manmade Factors Affecting Its Continued Existence

2.5.5.1 Small, Fragmented Populations

To provide a safeguard against the extinction of Devils River minnow and to provide important opportunities for biological research (for example, RAs 1.2.1, 1.2.2, 1.2.3, 1.2.4, 1.2.5, and 1.3.2), captive populations of the species should be established and maintained (RA 3.2). To establish appropriate captive stocks (2.1, 2.2.1-3, 2.3), based on sound science of conservation genetics, additional research on genetics is required (RA 1.1.4) and a genetics management plan needs to be developed (RA 3.1). If appropriate, captive propagation efforts could provide large numbers of individuals to assist in future reintroduction efforts (RA 2.3).

2.5.5.2 Cumulative Threats

As previously emphasized in this plan, the recovery of the Devils River minnow will likely entail a flexible process of continuing to collect additional information, while modifying the recovery actions to take advantage of new information and circumstances. Therefore, it is important that this plan, including the Recovery Objectives, Criteria, and Actions, be evaluated and revised as necessary (RAs 1.1.3 and 1.7). Where particular knowledge gaps now exist, future data collection may allow for further specific plans and strategies. For example, genetic studies (RA 1.1.4) will provide the information needed to develop a genetics management plan for Devils River minnow (RA 3.1). Also, additional research on the status of the fish and its environment in Mexico (RAs 1.1.2 and 1.1.3) could lead to a conservation strategy for Mexican populations (RA 1.6).

Implementation of most of the recovery actions needed to reduce the threats to the species will need the support of the local community (RA 1.4.1). Therefore, informing the local public about the issues and conservation needs is important to the success of this plan (RAs 4.1, 4.2, 4.3, and 4.4).

Table 1. Summary of Devils River minnow listing factors and threats, and the recovery actions intended to control those threats.

Listing Factor	Threats	Recovery Criteria	Recovery Actions
ALL (except Factor B)	ALL	ALL	1.1.3 Monitoring threats 1.4.1 Maintain landowner cooperation 1.6 Recovery strategy for Mexico 1.7 Assess recovery progress 4.1 – 4.4 Outreach 5.1 Post-delisting monitoring plan
Factor A	Population and Habitat Loss	(1)	1.1.1, 1.1.2 Monitoring populations 1.3.1 Study physical habitat 1.4.3 Groundwater management plans 2.1, 2.2.1-3, 2.3 Reestablish populations
	Spring Flow Declines (Water Quantity)	(2)	1.2.2 Study reproduction 1.2.4 Study early life history 1.3.1 Study physical habitat 1.3.3 Study stream flow and habitat 1.3.4 Determine stream flow needs 1.3.6 Investigate regional hydrogeology 1.4.2 Protect streams 1.4.3 Groundwater management plans 1.4.5 Monitor habitats
	Water Quality Degradation	(3)	1.3.2 Determine chemical preferences 1.4.2 Protect streams 1.4.5 Monitor habitats 1.4.7 Reduce pollutants
	Stream Channel Modifications	(1)	1.2.2 Study reproduction 1.2.4 Study early life history 1.3.1, 1.3.2 Study habitat 1.3.5 Study riparian management 1.4.5 Monitor habitats 1.4.6 Restore habitats
Factor B	None	None	None
Factor C	Non-native species	(4)	1.2.1 Study competitors 1.2.3 Study predators 1.2.5 Study disease and parasites 1.2.6 Study effects of exotics 1.5 Prevent introduction of exotics
Factor D	No Habitat Protection by State	(2), (3)	1.4.3 Groundwater management plans 1.4.4 Monitor stream flows
	Rule of Capture	(2)	
	Inadequate Water Quality Protection	(3)	1.4.2 Protect streams 1.4.5 Monitor habitats 1.4.7 Reduce pollutants
Factor E	Small, Fragmented Populations	(1)	1.1.4 Study genetics 3.1 Genetics management plan 2.1, 2.2.1-3, 2.3 Reestablish populations 3.2 Captive populations
	Cumulative Threats	ALL	ALL

3.0 IMPLEMENTATION SCHEDULE

The following implementation schedule outlines priorities, potential or responsible parties, and estimated costs for the specific actions for recovering the Devils River minnow. It is a guide to meeting the goals, objectives, and criteria from *Section 2 RECOVERY* of this recovery plan. The schedule: (a) lists the specific recovery actions, corresponding outline numbers, the action priorities, and the expected duration of actions ("Continuous" denotes an action that once begun should continue on a regular basis); (b) recommends agencies, groups, or individuals for carrying out these actions; and (c) estimates the financial costs for implementing the actions. These actions, when complete, should accomplish the goal of this plan -- recovery of the Devils River minnow.

3.1 Responsible Parties and Cost Estimates

The value of this plan depends on the extent to which it is implemented; the Service has neither the authority nor the resources to implement many of the proposed recovery actions. The recovery of the Devils River minnow is dependent upon the voluntary cooperation of many other organizations and individuals who are willing to implement the recovery actions. The implementation schedule identifies agencies and other potential "responsible parties" (private and public) to help implement the recovery of this species. <u>This plan does not commit any "responsible party" to carry out a particular recovery action or to expend the estimated funds.</u> It is only recognition that particular groups may possess the expertise, resources, and opportunity to assist in the implementation of recovery actions. Although collaboration with private landowners and others is called for in the recovery plan, no one is obligated by this plan to any recovery action or expenditure of funds. Likewise, this schedule is not intended to preclude or limit others from participating in this recovery program.

The cost estimates provided are not intended to be a specific budget but are provided solely to assist in planning. Costs designated "ND" (not determined) were not estimated at this time due to the uncertainty associated with the actions proposed. Costs with "- -" indicates no costs are expected. The total estimated cost of recovery, by priority, is provided in the Executive Summary. The schedule provides cost estimates for each action on a biannual basis. Estimated funds for agencies include only project-specific contract, staff, or operations costs in excess of base budgets. They do not include ordinary operating costs (such as staff) for existing responsibilities.

3.2 Recovery Action Priorities and Abbreviations

Priorities in column 1 of the following implementation schedule are assigned using the following guidelines:

Priority 1a = An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 1b = An action that by itself will not prevent extinction, but which is needed to carry out a Priority 1 action.

Priority 2 = An action that must be taken to prevent a substantial decline in species population/habitat quality or some other substantial negative effect short of extinction.

Priority 3 = All other actions necessary to meet the recovery objectives.

The assignment of these priorities does not imply that some recovery actions are of low importance, but instead implies that lower priority items may be deferred while higher priority items are being implemented.

The following abbreviations are used in the Implementation Schedule:

AGEX	Texas A&M Agricultural Extension Service
ALL	All interested parties share responsibility
BRD	Biological Resources Division, U.S. Geological Survey
EPA	U.S. Environmental Protection Agency
FWS	U.S. Fish and Wildlife Service
IBWC	International Boundary and Water Commission, U.S. Section
LOCAL	local entities, including private landowners and local government
MEX	Mexican governmental agencies
NGO	Nongovernmental organizations
NRCS	Natural Resource Conservation Service, U.S. Dept. of Agriculture
TDA	Texas Department of Agriculture
TNC	The Nature Conservancy of Texas
TCEQ	Texas Commission on Environmental Quality
TPWD	Texas Parks and Wildlife Department
TWDB	Texas Water Development Board
UNIV	Academic institutions (colleges and universities)
USGS	U.S. Geological Survey, Water Resources Division

3.3 Implementation Schedule.

Table is sorted by priority, then recovery action number. *Section 2.4 Recovery Action Narrative* has recovery action descriptions.

PRIORITY	RECOVERY ACTION #	RECOVERY ACTION DESCRIPTION	ACTION DURATION (YEARS)[a]	RESPONSIBLE PARTIES	Cost Estimates ($000) YEARS 1-2	YEARS 3-4	YEARS 5-6	YEARS 7-8	YEARS 9-10	CRITERIA[b]-CONTROL OF THREATS[c]
1a	1.4.1	Seek and maintain the cooperation of landowners and government agencies.	Cont.	ALL	--[d]	--	--	--	--	ALL
1a	1.4.2	Ensure protection for certain stream segments and their watersheds.	Cont.	LOCAL, TCEQ, TNC, TPWD	50	50	50	50	50	(2), (3) – A, D
1a	1.4.3	Develop and implement groundwater management plans for stream flow protection.	5-10	LOCAL, TWDB	50	50	50	50	50	(2) - A, D
1a	1.4.7	Reduce pollutants.	Cont.	EPA, LOCAL, TDA, TCEQ	ND[4]	ND	ND	ND	ND	(3) - A
1a	1.5	Establish and implement procedures to prevent introduction of exotic species and control problem exotic species.	Cont.	LOCAL, TPWD	ND	ND	ND	ND	ND	(4) - C
1a	2.3	Develop and implement a reintroduction plan.	6	LOCAL, FWS, TPWD, UNIV, NGO	--	100	50	50		(1) - A
1a	3.2	Maintain captive populations in at least two appropriate facilities.	Cont.	FWS, TPWD, NGO	75	50	50	50	50	(1) – A, E
1b	1.1.1	Monitor distribution and abundance in Texas.	Cont.	BRD, FWS, TPWD, UNIV	30	30	30	30	30	(1) - E
1b	1.1.2	Assess distribution and abundance in Mexico.	2	BRD, IBWC, FWS, MEX, TPWD, UNIV	40	--	--	--	--	(1) - A

[a] "Cont." denotes recovery actions that require continuous activities.
[b] CRITERIA cross-references recovery actions to recovery criteria, as numbered and described on Page 2.1-2.
[c] CONTROL OF THREATS cross-references recovery actions to the five listing factors (A-E), as discussed on Page 2.5-1.
[d] -- indicates no costs are anticipated, ND indicates costs are not determinable.

PRIORITY	RECOVERY ACTION #	RECOVERY ACTION DESCRIPTION	ACTION DURATION (YEARS)[a]	RESPONSIBLE PARTIES	Cost Estimates ($000) YEARS 1-2	YEARS 3-4	YEARS 5-6	YEARS 7-8	YEARS 9-10	CRITERIA[b]- CONTROL OF THREATS[c]
1b	1.1.3	Assess and monitor threats to Texas and Mexico populations.	Cont.	BRD, FWS, MEX, TPWD, UNIV	40	40	20	20	20	ALL
1b	1.2.2	Study reproductive variables.	2	BRD, FWS, TPWD, UNIV	--	30	--	--	--	(1) - A
1b	1.2.6	Study effects of aquatic non-native species.	2	BRD, FWS, TPWD, UNIV	--	40				(4) - C
1b	1.3.3	Determine relationships of stream flow and habitat availability.	4	BRD, EPA, FWS, TPWD, UNIV	50	50	--	--	--	(2) - A
1b	1.3.4	Determine stream flows needed for habitat maintenance.	4	BRD, FWS, TPWD, UNIV	50	50	--	--	--	(2) - A
1b	1.3.6	Investigate regional hydrogeology.	6	TWDB, UNIV, USGS, TNC	100	50	50			(2) - A
1b	1.4.4	Monitor stream flows.	Cont.	IBWC, TWDB, TCEQ, USGS	50	50	20	20	20	(2) - A
1b	1.4.5	Monitor existing physical and chemical habitats.	Cont.	BRD, FWS, MEX, TPWD, UNIV	25	25	25	25	25	(2), (3) - A
1b	1.6	Develop a recovery strategy for Mexican populations.	4	IBWC, MEX, FWS	--	--	50	50	--	ALL
1b	1.7	Assess effectiveness of recovery management actions.	Cont.	FWS, MEX, TPWD, UNIV	25	25	25	25	25	ALL
1b	2.1	Develop landowner agreements to reintroduce in former site(s) of occurrence.	4	LOCAL, FWS, TPWD	--	10	10	--	--	ALL
1b	2.2.1	Assess future spring flows at reintroduction site(s).	1	TWDB, UNIV, USGS	10	ND	ND	ND	ND	(1), (2) - A
1b	2.2.2	Ensure adequate water quality protection at reintroduction site(s).	Cont.	EPA, LOCAL, TCEQ	ND	ND	ND	ND	ND	(3) - A
1b	2.2.3	Develop and implement stream channel restoration projects at reintroduction site(s), if necessary.	5-8	LOCAL, FWS, TPWD	ND	ND	ND	ND	ND	(1) - A

PRIORITY	RECOVERY ACTION #	RECOVERY ACTION DESCRIPTION	ACTION DURATION (YEARS)[a]	RESPONSIBLE PARTIES	Cost Estimates ($000) YEARS 1-2	YEARS 3-4	YEARS 5-6	YEARS 7-8	YEARS 9-10	CRITERIA[b]- CONTROL OF THREATS[c]
1b	3.1	Develop and implement a genetics management plan.	4	FWS, TPWD, UNIV	50	50				(1) - E
2	1.1.4	Evaluate geographic variation in the species' genetic structure.	2	BRD, FWS, TPWD, UNIV	75					(1) - A
2	1.2.1	Study competition with coexisting species.	2	BRD, FWS, TPWD, UNIV	--	--	40	--	--	(4) - C
2	1.2.3	Investigate predation by other species.	2	BRD, FWS, TPWD, UNIV	--	50	--	--	--	(4) - C
2	1.2.4	Determine early life history characteristics and survivorship.	2	BRD, FWS, TPWD, UNIV	--	30	--	--	--	(1) - A
2	1.3.1	Determine physical habitat preferences.	4	BRD, FWS, TPWD, UNIV	--	60	60	--	--	(1), (2) - A
2	1.3.2	Determine chemical habitat preferences and tolerances (water quality).	2	BRD, EPA, FWS, TCEQ, TPWD, UNIV	30	--	--	--	--	(1), (3) - A
2	1.4.6	Restore and enhance habitat conditions.	6	FWS, LOCAL, MEX, NRCS, TDA, TNC, TPWD	ND	ND	ND	ND	ND	(1), (2), (3) - A
3	1.2.5	Investigate disease and parasites.	2	BRD, FWS, TPWD, UNIV	--	--	--	50	--	(4) - C
3	1.3.5	Study effects of riparian management strategies.	2	AGEX, FWS, LOCAL, NRCS, TDA, TPWD	--	25	--	--	--	(1) - A
3	4.1	Develop an outreach strategy.	1	FWS, TPWD	10	--	--	--	--	ALL - A, C, E
3	4.2	Prepare and distribute information pamphlet.	2	FWS, TPWD	--	20	--	--	--	ALL - A, C, E
3	4.3	Produce and maintain an outreach website.	1	NGO, TPWD,	--	10	--	--	--	ALL - A, C, E
3	4.4	Construct an informational kiosk for the City of Del Rio on San Felipe Creek.	1	LOCAL, FWS, TPWD	--	15	--	--	--	ALL - A, C, E
3	5.1	Develop a post-delisting monitoring plan for the Devils River minnow	1	FWS, TPWD, LOCAL	--	--	--	--	30	ALL

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Appendix A

Collections of Devils River minnow

Appendix A. Table of collections of Devils River minnow.

Devils River Minnow Collections

Stream Segment[1]	Country, St., Co.	Date	*D. diaboli* N (collected)[2]	Location of collection	Collection No.[3]	Holding[4]
Devils River (upper)	US, TX, Val Verde	9-Sep-1953	36	2 miles south of Pecan Springs	UMMZ 168973	University of Michigan Museum
Devils River (upper)	US, TX, Val Verde	7-Oct-1953	10	Pecan Springs (30°03'N 101°11'W)	USNM 00164251	National Museum of Natural History, Smithsonian Institution
Devils River (upper)	US, TX, Val Verde	17-Nov-1953	0	1.5 miles south of Pecan Springs		
Devils River (upper)	US, TX, Val Verde	7-Mar-1970	215	31 miles north of Comstock; Hwy 163; at #3 bridge north of Juno	BU 123	Strecker Museum, Baylor University
Devils River (upper)	US, TX, Val Verde	15-Sep-1973	14	2 miles north of Juno, right side of road	BU 1448	Strecker Museum, Baylor University
Devils River (upper)	US, TX, Val Verde	15-Sep-1973	6	20 miles north of Comstock, Hwy 163; left side of road about 2 miles on Hudspeth Ranch	BU 1442	Strecker Museum, Baylor University
Devils River (upper)	US, TX, Val Verde	10-Nov-1973	17	20 miles north of Comstock, Hwy 163; 0.5 miles north of Baker's Crossing	BU 1756	Strecker Museum, Baylor University
Devils River (upper)	US, TX, Val Verde	16-Mar-1974	13	2 miles north of Juno, Beaver Lake	BU 1786	Strecker Museum, Baylor University
Devils River (upper)	US, TX, Val Verde	17-Mar-1974	3	28 miles north of Comstock; Hudspeth Spring, Hudspeth River Ranch	BU 1817	Strecker Museum, Baylor University
Devils River (upper)	US, TX, Val Verde	17-Mar-1974	11	25 miles north of Comstock, Hwy 163; 0.25 north of Baker's Crossing	BU 1804	Strecker Museum, Baylor University
Devils River (upper)	US, TX, Val Verde	13-Jul-1981	47	5.8 miles south of Juno, turn right just before highway water crossing	TCWC 7416.02	Texas A&M Univerisity
Devils River (upper)	US, TX, Val Verde	4-Nov-1997	0	Hudspeth River Ranch; 4 sites, Pecan Springs to Hudspeth Spring		
Devils River (upper)	US, TX, Val Verde	25-Nov-1997	0	400 meters upstream from Baker's Crossing		
Devils River (upper)	US, TX, Val Verde	31-Jul-2001	0	Hudspeth River Ranch; 2 sites		
Devils River (upper)	US, TX, Val Verde	30-Jul-2002	93	Hudspeth River Ranch to Baker's Crossing	TBD[5]	Texas Natural History Collections, University of Texas at Austin
Devils River (Baker's Crossing)	US, TX, Val Verde	29-Jul-1953	58	Baker's Crossing (State Highway 163 bridge)	TNHC 4214	Texas Natural History Collections, University of Texas at Austin
Devils River (Baker's Crossing)	US, TX, Val Verde	18-May-1954	4	Baker's Crossing (29°57'N 101°09'W)	UMMZ 168971 & UMMZ168972	University of Michigan Museum of Zoology
Devils River (Baker's Crossing)	US, TX, Val Verde	27-Mar-1968	16	20 miles north of Comstock, Hwy 163	BU 44	Strecker Museum, Baylor University
Devils River (Baker's Crossing)	US, TX, Val Verde	15-Sep-1973	6	20 miles north of Comstock, Hwy 163, upstream of Bakers Crossing	BU 1436	Strecker Museum, Baylor University
Devils River (Baker's Crossing)	US, TX, Val Verde	15-Sep-1973	7	20 miles north of Comstock, Hwy 163, downstream of Bakers Crossing	BU 1425	Strecker Museum, Baylor University
Devils River (Baker's Crossing)	US, TX, Val Verde	10-Nov-1973	2	25 miles north of Comstock, Hwy 163; at Baker's Crossing	BU 1829	Strecker Museum, Baylor University
Devils River (Baker's Crossing)	US, TX, Val Verde	15-Mar-1975	1	Fort Hudson Crossing	TCWC 298.04	Texas A&M Univerisity

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Stream Segment[1]	Country, St., Co.	Date	*D. diaboli* N (collected)[2]	Location of collection	Collection No.[3]	Holding[4]
Devils River (Baker's Crossing)	US, TX, Val Verde	25-Mar-1988	8	Baker's Crossing (State Highway 163 bridge)	UAIC 8354.04	University of Alabama Museum
Devils River (Baker's Crossing)	US, TX, Val Verde	10-Jul-1989	1	Baker's Crossing (State Highway 163 bridge)		
Devils River (Baker's Crossing)	US, TX, Val Verde	25-Nov-1997	0	Baker's Crossing (State Highway 163 bridge)		
Devils River (Baker's Crossing)	US, TX, Val Verde	28-May-1998	0	Baker's Crossing (State Highway 163 bridge)		
Devils River (Baker's Crossing)	US, TX, Val Verde	1-Aug-2001	54	Baker's Crossing (State Highway 163 bridge)	TBD[5]	Texas Natural History Collections, University of Texas at Austin
Devils River (middle)	US, TX, Val Verde	29-May-1953	1	0.25 miles north of Dolan Falls	TNHC 3421	Texas Natural History Collections, University of Texas at Austin
Devils River (middle)	US, TX, Val Verde	9-Jul-1966	0	at Dolan Falls		
Devils River (middle)	US, TX, Val Verde	16-Mar-1974	3	22 miles north of Comstock, Rocker U Ranch	BU 1809	Strecker Museum, Baylor University
Devils River (middle)	US, TX, Val Verde	22-Jul-1974	4	Dolan Creek Ranch	TNHC 21793	Texas Natural History Collections, University of Texas at Austin
Devils River (middle)	US, TX, Val Verde	3-Nov-1988	17	at spring (DR#3)	TNHC 16046	Texas Natural History Collections, University of Texas at Austin
Devils River (middle)	US, TX, Val Verde	3-Nov-1988	14	just below spring (DR#2)	TNHC 16028	Texas Natural History Collections, University of Texas at Austin
Devils River (middle)	US, TX, Val Verde	8-Apr-1989	0	near Blue Hole		
Devils River (middle)	US, TX, Val Verde	4-Nov-1997	0	Rocker U Ranch crossing; approx 3 RM downstream of Baker's Crossing		
Devils River (middle)	US, TX, Val Verde	25-Nov-1997	0	Finegan Springs		
Devils River (middle)	US, TX, Val Verde	27-May-1998	1	Finegan Springs	TBD[5]	Texas Natural History Collections, University of Texas at Austin
Devils River (middle)	US, TX, Val Verde	11-Jul-2000	86	Baker's Crossing to Jarrett Ranch (7 RM downstream); 51 collection sites	TNHC 29392	Texas Natural History Collections, University of Texas at Austin
Devils River (middle)	US, TX, Val Verde	12-Jul-2000	147	Jarrett Ranch to Dolan Falls (approx. 8 RM); 54 collection sites	TNHC 29393	Texas Natural History Collections, University of Texas at Austin
Devils River (middle)	US, TX, Val Verde	9-Aug-2000	0	Rocker U Ranch crossing; approx 3 RM downstream of Baker's Crossing		
Devils River (middle)	US, TX, Val Verde	31-Jul-2001	66	Jarrett Ranch to Dolan Falls (approx. 8 RM); 20 collection sites	TNHC 29355	Texas Natural History Collections, University of Texas at Austin
Devils River (middle)	US, TX, Val Verde	30-Jul-2002	562	Baker's Crossing to Jarrett Ranch (7 RM downstream); 21 collection sites	TBD[5]	Texas Natural History Collections, University of Texas at Austin
Devils River (middle)	US, TX, Val Verde	31-Jul-2002	165	Jarrett Ranch to Dolan Falls (approx. 8 RM); 29 collection sites	TBD[5]	
Devils River (lower)	US, TX, Val Verde	22-Jul-1953	1	Devils Lake, head of lake, spring on west side	TNHC 5657	Texas Natural History Collections, University of Texas at Austin

Appendix A. Table of collections of Devils River minnow.

Devils River Minnow Collections

Stream Segment[1]	Country, St., Co.	Date	*D. diaboli* N (collected)[2]	Location of collection	Collection No.[3]	Holding[4]
Devils River (lower)	US, TX, Val Verde	29-Jul-1953	0	Devil's River at Hwy 90 bridge		
Devils River (lower)	US, TX, Val Verde	9-Sep-1953	0	Devil's River 1 mile above mouth of river		
Devils River (lower)	US, TX, Val Verde	27-Mar-1954	2	Devils Lake, head of lake, spring on west side	CNHM 61606	Chicago Natural History Museum
Devils River (lower)	US, TX, Val Verde	6-Oct-1954	0	Devil's River, 300 yards above confluence with Rio Grande		
Devils River (lower)	US, TX, Val Verde	17-Feb-1955	1	springs in Devil's Lake (29°36'N 100°57'W)	TNHC 4234	Texas Natural History Collections, University of Texas at Austin
Devils River (lower)	US, TX, Val Verde	6-Nov-1970	45	12 miles north of mouth with Rio Grande	BU 761	Strecker Museum, Baylor University
Devils River (lower)	US, TX, Val Verde	13-Mar-1979	0	Oak Tree Campsite to Pafford's Crossing to Little Satan Creek		
Devils River (lower)	US, TX, Val Verde	8-May-1979	0	downstream from weir dam		
Devils River (lower)	US, TX, Val Verde	13-Jul-2000	0	Dolan Falls to Blue Sage (approx. 8 RM); 27 collection sites		
Devils River (lower)	US, TX, Val Verde	1-Aug-2002	6	Dolan Falls to Blue Sage (approx. 8 RM); 24 collection sites	TBD[5]	Texas Natural History Collections, University of Texas at Austin
Devils River (lower)	US, TX, Val Verde	1-Aug-2002	0	Pafford's Crossing	TBD[5]	Texas Natural History Collections, University of Texas at Austin
Devils River (location unknown)	US, TX, Val Verde	26-Mar-1954	2	at H. Meadows	FMNH 61606	Field Museum of Natural History (Chicago)
Devils River (location unknown)	US, TX, Val Verde	26-Nov-1964	1	Devils River	TCWC 1087.01	Texas A&M Univeristy
Phillips Creek	US, TX, Val Verde	22-Apr-1998	4	headspring to ranch road crossing	TBD[5]	Texas Natural History Collections, University of Texas at Austin
Phillips Creek	US, TX, Val Verde	28-May-1998	142	entire creek	TBD[5]	Texas Natural History Collections, University of Texas at Austin
Phillips Creek	US, TX, Val Verde	9-Aug-2000	41	entire creek	TBD[5]	Texas Natural History Collections, University of Texas at Austin
Phillips Creek	US, TX, Val Verde	31-Jul-2001	0	ranch road crossing		
Phillips Creek	US, TX, Val Verde	30-Jul-2002	2	headspring to ranch road crossing	TBD[5]	Texas Natural History Collections, University of Texas at Austin
Dolan Creek	US, TX, Val Verde	8-May-1979	0			
Dolan Creek	US, TX, Val Verde	14-Mar-1980	0	Dolan Springs and creek		
Dolan Creek	US, TX, Val Verde	8-Apr-1989	1	Dolan Springs and creek		

Appendix A. Table of collections of Devils River minnow.

Devils River Minnow Collections

Stream Segment[1]	Country, St., Co.	Date	*D. diaboli* N (collected)[2]	Location of collection	Collection No.[3]	Holding[4]
Dolan Creek	US, TX, Val Verde	27-May-1998	3	side springs and pool	TBD[5]	Texas Natural History Collections, University of Texas at Austin
Dolan Creek	US, TX, Val Verde	6-Apr-2000	26	at main pool	TBD[5]	Texas Natural History Collections, University of Texas at Austin
Dolan Creek	US, TX, Val Verde	24-May-2000	11	at main pool	TBD[5]	Texas Natural History Collections, University of Texas at Austin
Dolan Creek	US, TX, Val Verde	31-Jul-2001	14	at main pool	TBD[5]	Texas Natural History Collections, University of Texas at Austin
Dolan Creek	US, TX, Val Verde	31-Jul-2002	1	at main pool	TBD[5]	Texas Natural History Collections, University of Texas at Austin
San Felipe Creek (upper)	US, TX, Val Verde	14-Mar-1979	1	Lowe Ranch	TNHC 9382	Texas Natural History Collections, University of Texas at Austin
San Felipe Creek (upper)	US, TX, Val Verde	14-Mar-1979	21	tributary, east side, Lowe Ranch	TNCH 9472	Texas Natural History Collections, University of Texas at Austin
San Felipe Creek (upper)	US, TX, Val Verde	14-Mar-1979	8	tributary, Hinds Ranch (joins slightly below new headspring	TNHC 9336	Texas Natural History Collections, University of Texas at Austin
San Felipe Creek (upper)	US, TX, Val Verde	14-Mar-1979	22	new headsprings, Hinds Ranch	TNHC 9420	Texas Natural History Collections, University of Texas at Austin
San Felipe Creek (upper)	US, TX, Val Verde	14-Mar-1979	16	far upstream of Lowe Ranch	TNHC 9370	Texas Natural History Collections, University of Texas at Austin
San Felipe Creek (upper)	US, TX, Val Verde	11-Jul-1989	0	Hinds Ranch		
San Felipe Creek (Del Rio)	US, TX, Val Verde	22-Jun-1955	5	Del Rio	TU 10413	Tulane University Museum
San Felipe Creek (Del Rio)	US, TX, Val Verde	10-Jul-1965	131	eastern edge of Del Rio, Hwy 90	TU 38795	Tulane University Museum
San Felipe Creek (Del Rio)	US, TX, Val Verde	15-May-1966	6	Del Rio, at hwy 90 crossing	TU 41237	Tulane University Museum
San Felipe Creek (Del Rio)	US, TX, Val Verde	13-Aug-1968	3	eastern edge of Del Rio, Hwy 90	TU 54423	Tulane University Museum
San Felipe Creek (Del Rio)	US, TX, Val Verde	23-Aug-1974	2	Del Rio	TU 90661	Tulane University Museum
San Felipe Creek (Del Rio)	US, TX, Val Verde	24-Nov-1977	6	1-2 km north of San Felipe Springs	TNHC 8827	Texas Natural History Collections, University of Texas at Austin
San Felipe Creek (Del Rio)	US, TX, Val Verde	14-Mar-1979	0	spring run at golf course		
San Felipe Creek (Del Rio)	US, TX, Val Verde	14-Mar-1979	3	Golf Course, not spring run	TNHC 9459	Texas Natural History Collections, University of Texas at Austin
San Felipe Creek (Del Rio)	US, TX, Val Verde	11-Jul-1989	3	at Hwy 277, downstream to Canal Street		
San Felipe Creek (Del Rio)	US, TX, Val Verde	11-Jul-1989	0	4.5 km upstream of mouth, downstream of sewage treatment plant		
San Felipe Creek (Del Rio)	US, TX, Val Verde	3-Nov-1997	54	at Hwy 277, downstream	TNHC 25184	Texas Natural History Collections, University of Texas at Austin

Appendix A. Table of collections of Devils River minnow.

Devils River Minnow Collections

Stream Segment[1]	Country, St., Co.	Date	*D. diaboli* N (collected)[2]	Location of collection	Collection No.[3]	Holding[4]
San Felipe Creek (Del Rio)	US, TX, Val Verde	3-Nov-1997	1	at Canal St.	TNHC 25191	Texas Natural History Collections, University of Texas at Austin
San Felipe Creek (Del Rio)	US, TX, Val Verde	3-Nov-1997	57	Spring outflow to Hwy 90	TNHC 25203	Texas Natural History Collections, University of Texas at Austin
San Felipe Creek (Del Rio)	US, TX, Val Verde	8-Apr-1999	0	at Hwy 90, downstream		
San Felipe Creek (Del Rio)	US, TX, Val Verde	11-Jul-1999	16	at Hwy 90, downstream	TBD[5]	Texas Natural History Collections, University of Texas at Austin
San Felipe Creek (Del Rio)	US, TX, Val Verde	22-Sep-1999	16	Hwy 90 to Canal Street; 4 collection sites	TBD[5]	Texas Natural History Collections, University of Texas at Austin
San Felipe Creek (Del Rio)	US, TX, Val Verde	25-Feb-2000	23	Hwy 90 to Canal Street; 4 collection sites	TBD[5]	Texas Natural History Collections, University of Texas at Austin
San Felipe Creek (Del Rio)	US, TX, Val Verde	28-Apr-01	18	east and west channels to 200 m below confluence	TBD[5]	Texas Natural History Collections, University of Texas at Austin
San Felipe Creek (Del Rio)	US, TX, Val Verde	3-Aug-2001	30	east and west channels to 200 m below confluence	TBD[5]	Texas Natural History Collections, University of Texas at Austin
San Felipe Creek (Del Rio)	US, TX, Val Verde	30-Oct-2001	0	at Hwy 277, downstream		
San Felipe Creek (Del Rio)	US, TX, Val Verde	3-Nov-2001	45	east and west channels to 200 m below confluence	TBD[5]	Texas Natural History Collections, University of Texas at Austin
San Felipe Creek (Del Rio)	US, TX, Val Verde	23-Mar-2002	24	east and west channels to 200 m below confluence	TBD[5]	Texas Natural History Collections, University of Texas at Austin
Cienegas Creek	US, TX, Val Verde	12-Mar-1979	0	at headwaters, Cantu Spring		
Cienegas Creek	US, TX, Val Verde	11-Jul-1989	0	upstream and downstream of sewage treatment plant		
Salt Creek	US, TX, Val Verde	12-Mar-1979	0	from Sulphur Springs to railroad crossing (approx. 2 km)		
Sacatosa Creek	US, TX, Val Verde	14-Mar-1979	0	at headsprings		
Sacatosa Creek	US, TX, Val Verde	13-Jul-1989	0	at impounded headspring		
Sycamore Creek	US, TX, Val Verde	10-May-1979	0	at Hwy 277 crossing		
Sycamore Creek	US, TX, Val Verde	12-Jul-1989	0	throughout the tributary, Mud Creek		
Sycamore Creek	US, TX, Val Verde	28-Oct-1989	0	throughout the tributary, Mud Creek		
Sycamore Creek	US, TX, Val Verde	12-Jul-1989	2	at Hwy 277 crossing		
Sycamore Creek	US, TX, Val Verde	10-Jul-1999	0	at Hwy 277 crossing		

Appendix A. Table of collections of Devils River minnow.

Devils River Minnow Collections

Stream Segment[1]	Country, St., Co.	Date	*D. diaboli* N (collected)[2]	Location of collection	Collection No.[3]	Holding[4]
Sycamore Creek	US, TX, Val Verde	6-Jun-2002	0	at Hwy 277 and Hwy 90 crossings		
Pinto Creek	US, TX, Kinney	12-Jul-1989	0	from Hwy 277 crossing upstream to FM 2804		
Pinto Creek	US, TX, Kinney	17-Dec-2001	80	headwaters on Shahan Ranch	TBD[5]	Texas Natural History Collections, University of Texas at Austin
Pinto Creek	US, TX, Kinney	5-Jun-2003	457	headwaters on Shahan Ranch to Hwy. 90. 24 collection sites	TNHC 29354	Texas Natural History Collections, University of Texas at Austin
Las Moras Creek	US, TX, Kinney	14-Apr-1951	39	Brackettville (Fort Clark Springs)	TNHC 1852	Texas Natural History Collections, University of Texas at Austin
Las Moras Creek	US, TX, Kinney	1-May-1955	1	Brackettville (Fort Clark Springs)		
Las Moras Creek	US, TX, Kinney	11-Mar-1979	0	Brackettville (Fort Clark Springs)		
Las Moras Creek	US, TX, Kinney	10-May-1979	0	road crossing off FM 1908		
Las Moras Creek	US, TX, Kinney	13-Jul-1989	0	Fort Clark Springs to approx. 7 RM downstream, near FM 1572		
Las Moras Creek	US, TX, Kinney	17-Dec-2001	0	Fort Clark Springs to approx. 2 RM downstream		
Rio San Carlos	Mexico, Coahuila	7-Aug-1968	1	27 km S of Acuna	UANL 1023	Universidad Autonoma de Nuevo Leon
Rio San Carlos	Mexico, Coahuila	31-Mar-1974	4	27 km south of Ciudad Acuna, just below highway bridge (28-40 N; 100-35 W)	UMMZ 196744	Univeristy of Michigan Museum
Rio Alamo	Mexico, Coahuila	28-Aug-1964	23	4.4 km west of Nueva Rosita, San Juan de Sabinas	UANL	Universidad Autonoma de Nuevo Leon
Rio Alamo	Mexico, Coahuila	13-Oct-1966	9	4.4 km west of Nueva Rosita	TU 95979	Tulane University Museum
Rio Alamo	Mexico, Coahuila	1985	16	Nueva Rosita, 4 km Carr. Muzquiz (27-56-53N, 101-15-23W)		
Rio Alamo	Mexico, Coahuila	2001	1	Nueva Rosita, 4 km Carr. Muzquiz (27-56-53N, 101-15-23W)		
Rio Sabinas	Mexico, Coahuila	3-Apr-1961	23	abut 2 miles west of Rosita	TU 43870	Tulane University Museum
Rio Sabinas	Mexico, Coahuila	28-Aug-1964	4	11.7 km WSW Nueva Rosita (27-52 N; 101-22 W)	UANL 753	Universidad Autonoma de Nuevo Leon
Rio Sabinas (=Rio San Juan)	Mexico, Coahuila	1978	0	Muzquiz, Carr. Boquillas (27-58-09N, 101-24-51W)		
Rio Sabinas (=Rio San Juan)	Mexico, Coahuila	21-Jul-1985	3	at bridge, 14km Carr. Muzquiz - Boquillas del Carmen, Muzquiz (27-58-09N, 101-24-51W)	UANL 9174	Universidad Autonoma de Nuevo Leon
Rio Sabinas (=Rio San Juan)	Mexico, Coahuila	8-Aug-1994	13	8 km NW of Muzquiz and 200m upstream from bridge (27-58-09N, 101-24-51W)	UANL 11598	Universidad Autonoma de Nuevo Leon

Appendix A. Table of collections of Devils River minnow.

Devils River Minnow Collections

Stream Segment[1]	Country, St., Co.	Date	*D. diaboli* N (collected)[2]	Location of collection	Collection No.[3]	Holding[4]
Rio Sabinas (=Rio San Juan)	Mexico, Coahuila	8-Aug-1994	18	8 km NW of Muzquiz and 3km downstream from bridge (27-58-09N, 101-24-51W)	UANL 11588	Universidad Autonoma de Nuevo Leon
Rio Sabinas (=Rio San Juan)	Mexico, Coahuila	2001	0	8 km NW of Muzquiz and 3km downstream from bridge (27-58-09N, 101-24-51W)		
Rio San Juan	Mexico, Coahuila	1-Jan-1985	16	at bridge, 14km Carr. Muzquiz - Boquillas del Carmen, Muzquiz	UANL 9134	Universidad Autonoma de Nuevo Leon
Rio San Juan	Mexico, Coahuila	1984	0	Nacimento Kikapoo (28-02-28N, 101-47-31W)		
Rio San Juan	Mexico, Coahuila	1985	0	Nacimento Kikapoo (28-02-28N, 101-47-31W)		
Rio San Juan	Mexico, Coahuila	2001	0	Nacimento Kikapoo (28-02-28N, 101-47-31W)		
Rio San Juan (=Sabinas)	Mexico, Coahuila	1985	0	Parque Los Ojitos		
Rio San Juan (=Sabinas)	Mexico, Coahuila	2001	0	Parque Los Ojitos		
Rio Sabinas	Mexico, Coahuila	1964	0	Sabinas (27-50-38N, 101-07-20W)		
Rio Sabinas	Mexico, Coahuila	1985	0	Sabinas (27-50-38N, 101-07-20W)		
Rio Sabinas	Mexico, Coahuila	2001	0	Sabinas (27-50-38N, 101-07-20W)		

FOOTNOTES:

1 - Devils River (upper) = Devils River upstream of Baker's Crossing (Highway 163 Bridge)
Devils River (Baker's Crossing) = Devils River at or near Highway 163 Bridge
Devils River (middle) = Devils River downstream of Baker's Crossing, upstream of Dolan Falls
Devils River (lower) = Devils River downstream of Dolan Falls

2 - Total number of Devils River minnow collected as documented in a report or in museum collection

3 - Collection No. is the museum reference number for this collection

4 - Holding is the museum or facility where collection is being curated; NA indicates no museum specimens known

5 - Collection numbers are yet To Be Determined

Appendix B

Devils River Minnow Conservation Agreement, September 1998

CONSERVATION AGREEMENT
DEVILS RIVER MINNOW
Dionda diaboli

I. INTRODUCTION

This voluntary Conservation Agreement (Agreement) for the Devils River minnow (*Dionda diaboli*) has been developed in order to expedite conservation measures needed to ensure the continued existence and facilitate recovery of the species. These measures are taken in accordance with the Endangered Species Act of 1973, as amended (ESA). The objective of the Agreement is to reduce the potential threats to the species and to stabilize and improve the species populations and the ecosystems upon which they depend. The specific conservation actions to be undertaken to make progress toward this objective are outlined in detail in the Conservation Strategy for Devils River minnow (Attachment A).

The Devils River minnow has been proposed for listing as an endangered species under the ESA by the U.S. Fish and Wildlife Service (Service). The Service is responsible for reviewing the status of the species and determining whether it warrants inclusion on the list. The full implementation of this Agreement and the associated Strategy is intended to identify and reduce potential threats to the species. If the Strategy is successful, the need for listing the species as threatened or endangered may be removed. Also, threats to the species could be reduced to only require listing as threatened rather than endangered. If the expected outcome of the Strategy is not realized, or other circumstances change, the Service is required to proceed with listing the species as threatened or endangered.

II. ADDITIONAL BENEFITS

The purpose of this Agreement is the conservation of the Devils River minnow and its unique habitat, the Devils River, San Felipe, Las Moras and Sycamore creeks. The conservation actions, however, also assure that these ecosystems will continue to provide habitat for other indigenous species (e.g., proserpine shiner, Conchos pupfish, blotched gambusia and Rio Grande darter) as well as provide a valuable resource for the citizens of Texas (e.g., Attachment B).

III. INVOLVED PARTIES

Texas Parks & Wildlife Department
4200 Smith School Road
Austin, Texas 78744

City of Del Rio
P.O. Box 4239
109 W. Broadway
Del Rio, TX 78840

United States Department of the Interior
Fish and Wildlife Service
500 Gold Avenue SW
Albuquerque, NM 87102

The Texas Parks and Wildlife Department (TPWD) has worked closely with local landowners and other stakeholders to keep them informed and aware of the intention of the TPWD to enter into this agreement for the conservation of the Devils River minnow and its habitat

IV. AUTHORITY

The signatory parties enter into this Conservation Agreement and the attached Conservation Strategy under Federal and State law, as applicable, including but not limited to Fish and Wildlife Coordination Act (as amended) 16 U.S.C. 16 et seq. and Section 2(c)(2) of the Endangered Species Act (ESA) of 1973 (as amended) which states that "the policy of Congress is that Federal agencies shall cooperate with State and local agencies to resolve water resource issues in concert with conservation of endangered species."

All parties to this Agreement recognize that they each have specific statutory responsibilities that cannot be delegated, particularly with respect to the management and conservation of wildlife and aquatic resources. Nothing in this Agreement or the Strategy is intended to abrogate any of the parties' respective responsibilities.

This agreement is subject to and is intended to be consistent with all applicable Federal and State laws.

V. STATUS AND DISTRIBUTION OF THE DEVILS RIVER MINNOW

The study by Garrett et al. (1992) revealed that Devils River minnow was very rare throughout its range in 1988-1989 and substantiated the species' extirpation reported for Las Moras Creek (Smith and Miller 1986). In 25 sampling locations within the historic range, a total of only 7 individuals were collected (Devils River = 2; San Felipe Creek = 3; Sycamore Creek = 2). The data indicate the species has decreased in both absolute numbers and relative abundance. Devils River minnow was the fifth most abundant species in 1953 at Bakers Crossing on the Devils River (Garrett et al. 1992); sixth most abundant species in the river in 1974 (Harrell 1978); and one of the least abundant species in 1989 (Garrett et al. 1992). In 1979, Devils River minnow made up 10% of the *Dionda* in the headwater springs of San Felipe Creek; in 1989 none were collected from this site (Garrett et al. 1992). In the creek below San Felipe Springs (in Del Rio), the fish was very rare in collections in 1989 (Garrett et al. 1992).

Little published information is available on the status of the species in Mexico. The most recent collections indicate the species only occurs in two localities in Mexico. The status of the populations there appear to be very depressed and face significant threats from industrial development (Contreras-B. and Lozano-V. 1994).

The most recent information on the distribution and abundance of Devils River minnow in Devils River and San Felipe Creek was obtained during status surveys conducted in November 1997 and May 1998. Personnel from the Texas Parks and Wildlife Department sampled the fish community at sites on the upper Devils River and San Felipe Creek. No Devils River minnow were collected from locations on the Devils River but they were very common (more than 100 fish collected) from San Felipe Creek, downstream of San Felipe Springs, Dolan Creek (14 specimens) and Phillips Creek (142 specimens). Valdes Cantu and Winemiller (1997) reported that the species was still present in the Devils River at the confluence with Dolan Falls in 1994, but only in low numbers. No specimens were retained to confirm identification.

The Devils River minnow is currently listed as a threatened species by the State of Texas and as an endangered species by Mexico. The species is also included as threatened species by the Endangered Species Committee of the American Fisheries Society and listed as threatened by the Texas Organization for Endangered Species.

VI. PROBLEMS FACING THE SPECIES

Very little is known of the Devils River minnow, but some problem areas are apparent. The Las Moras Creek population has been extirpated. Habitat loss has occurred through minimal flows in Sycamore Creek and inundation of the lower Devils River by lakes Walk and Devils and ultimately Amistad Reservoir. The river originally flowed approximately 50 miles, from Pecan Springs to its confluence with the Rio Grande (Taylor 1904). Many springs in the area have diminished flows, some (e.g., Beaver Springs, Juno Springs and Dead Man's Hole) have totally stopped (Brune 1981). Many of the perennial streams (Gray 1919) of the area no longer flow. USGS data from the Pafford Crossing gauging station reveals a general decrease in daily mean discharge for the period between the study by Harrell (1978) and that of Garrett et al. (1992). In the early 1950's, Dietz (1955) noted that pumping from irrigation wells was lowering the aquifer. Brune (1981) asserts (but provides no data) that the reduction in spring flows in this area is due to heavy pumping from wells and overgrazed soils with lowered capacity to absorb water and thus recharge aquifers. Local ranchers dispute Brune's (1981) assertions, stating that there has been no irrigation since 1987 and prior to that (1950's - 1960's) only 200 - 500 acres were ever in irrigation (Byron Hodge, pers. com.). Decreases in aquifer storage and discharge may be due to a variety of factors, but are almost certainly related to an overabundance of juniper (*Juniperus* spp.) and mesquite (*Prosopis glandulosa*). Improvements in aquifer recharge may be accomplished by addressing this problem through range management (Thurow and Carlson 1994; Smeins et al. 1997; Thurow and Hester 1997).

In a study on water quality of the Devils River and San Felipe Creek, the Texas Natural Resources Conservation Commission (TNRCC 1994) listed a number of parameters indicative of reduced water quality and perhaps important in understanding changes in fish community structure. Substances found in concentrations high enough to be considered as "concerns" or "possible concerns" for aquatic life or human health were nitrate-nitrogen, nitrite+nitrate, TDS, chloride, phosphate, orthophosphate, sulfates, phosphate, cadmium, lead and mercury. These substances exceeded levels established by the Texas Surface Water Quality Standards. In the case of nitrate-nitrogen and nitrite+nitrate in the Devils River, the standards were exceeded by 82% and 100% of the samples, respectively. In San Felipe Creek, the standards for nitrate-nitrogen, phosphate and orthosphosphate were exceeded by 98%, 100% and 100% of the samples, respectively.

Although some aspects of water quality and quantity may be less than ideal, the Devils River is still one of the most pristine rivers in southwestern North America. It remains relatively unpolluted, undammed and although flows have diminished, they are still substantial

The aquifer that sustains spring flows within the range of Devils River minnow is the Edwards-Trinity (Plateau) of the Georgetown and associated limestones. This major aquifer produces the largest number of springs in Texas (Brune 1975). The contributing recharge area of springs on the Devils River and San Felipe Creek is thought to include a large area to the north from near the towns of Sheffield to Eldorado (Brune 1975), although the subsurface hydrogeomorphology of the region is not well defined. The flow from springs tend to fluctuate considerably, depending on the amount of rainfall, recharge, and water in storage in the underground reservoirs. The conservation of this groundwater supply is imperative to the existence of the Devils River minnow.

Exotic species that have become established within the range of Devils River minnow are: common carp (*Cyprinus carpio*), black bullhead (*Ameiurus melas*), gulf killifish (*Fundulus grandis*), sailfin molly (*Poecilia latipinna*), inland silverside (*Menidia beryllina*), redbreast sunfish (*Lepomis auritus*), redear sunfish (*Lepomis microlophus*), smallmouth bass (*Micropterus dolomieu*) and blue tilapia (*Tilapia aurea*). Although fishes throughout the Chihuahuan Desert have been negatively impacted by introduced species (Hubbs 1990) and such factors as predation by smallmouth bass may cause negative impacts, specific effects on Devils River minnow are not known.

The Strategy is designed to assess the potential threats to the species and determine the necessary management actions the signatories to this Agreement will undertake to address those threats. This Agreement and the Strategy attempt to establish a baseline understanding of the Devils River minnow and its habitat for the purpose of providing a framework for implementation of the conservation measures.

VII. CONSERVATION ACTIONS TO BE IMPLEMENTED

In order to meet the objectives of this Agreement, ten conservation actions are being implemented. These actions, as described in the Strategy, include: 1) Determine the current status of the Devils River minnow and monitor changes; 2) Maintain genetically representative, captive populations of Devils River minnow at TPWD Heart of the Hills Research Station and at one or more alternate facilities (e.g., Dexter National Fish Hatchery) for breeding and as insurance against extinction; 3) Reintroduce Devils River minnows reared from captive populations in order to reestablish populations; 4) Continue and enhance protection of the San Felipe Creek watershed; 5) Provide technical assistance to landowners on riparian protection and management; 6) Review bait harvest/selling in the Devils River area and investigate methods (e.g., regulation, education) to prevent the further establishment of exotic, aquatic species within the historic range of Devils River minnow; 7) Document abundance and range of exotic fish species in the Devils River, San Felipe, Las Moras and Sycamore creeks; 8) Obtain and analyze changes in flow data for the Devils River, San Felipe, Las Moras and Sycamore creeks; 9) With progeny of the captive population, use a simulated environment to determine ecological and life history requirements of Devils River minnow; 10) Determine *in situ* predator/prey interactions between smallmouth bass and Devils River minnow. In addition, four general administrative actions, as outlined below, will be implemented: coordinate conservation activities; implement the conservation schedule; fund conservation actions; and assess conservation progress.

Coordinating Conservation Activities

Administration of the Conservation Agreement and information distribution will be conducted by the Devils River Minnow Conservation Team (DRMCT). The team will consist of representatives of: 1) TPWD, 2) USFWS, 3) Del Rio, 4) one or more private landowners, 5) native fish population biologist (academia), 6) hydrogeologist (state/federal agency). The DRMCT may also include technical and legal advisors and other members as deemed necessary by the signatories. Because the State of Texas presently has primary jurisdiction over Devils River minnow, the designated DRMCT leader will be the TPWD representative. Authority of the DRMCT shall be limited to developing and making recommendations for the conservation of Devils River minnow to the Agreement signatories. The DRMCT will meet annually to develop recommended yearly conservation schedules, review the Strategy and make recommendations to modify the Strategy as necessary. The DRMCT will meet as often as necessary to report on the progress of implementing the Strategy. DRMCT meeting will be open to the public. Minutes of the meetings will be kept and distributed to any interested party.

Implementing Conservation Schedule

A total of five (5) years is anticipated for full implementation of actions identified and specified in the Strategy (Table 1). Nevertheless, the parties agree that significant actions to benefit the Devils River minnow will be implemented within the first year (1998).

The DRMCT will coordinate conservation activities and monitor conservation actions taken by the signatories to this Agreement.

Funding Conservation Actions

Funding for the Conservation Agreement will be provided by a variety of sources, including, but not limited to:

1) State funding sources, including but not limited to, TPWD
2) Federal sources including but not limited to, the FWS through Section 6 Funds under the ESA
3) Private funding sources

In-kind contributions in the form of personnel, field equipment, supplies, etc., will be provided by participating agencies as necessary. In addition, each agency will have specific task responsibilities and proposed actions/commitments related to its in-kind contributions.

It is understood that all funding commitments made under this Agreement are subject to approval by the appropriate State and Federal entities. Failure to fund needed actions will result in the dissolution of the Agreement, however, this Agreement does not commit a state or federal agency to spend resources beyond its authority.

Assessing Conservation Progress

A semiannual assessment of progress towards implementing actions identified in this Agreement will be provided to the signatories of the Agreement by DRMCT. This assessment will be based on updates and evaluations by DRMCT members.

The DRMCT will produce an annual written report documenting the status of accomplishments under the Strategy. This assessment will determine the effectiveness of the Agreement and whether revisions are warranted and will be provided to the signatories of the Agreement by DRMCT.

If threats to the survival of the Devils River minnow become known that are not or cannot be resolved through this or any Conservation Agreement, the DRMCT will promptly notify all signatories. If this situation occurs, the Service may be required to take appropriate listing action under Section 4 of the ESA.

VIII. DURATION AND AMENDMENT OF AGREEMENT

The initial term of this Agreement shall be five (5) years. This Agreement shall be extended for an additional five (5) years upon agreement by the parties. Any party may withdraw from this Agreement upon sixty (60) days written notice to the other parties. Changes to the Agreement may be made upon agreement in writing of all the signatories.

IX. NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) COMPLIANCE

Signing of this Agreement is covered under authorities outlined in Section IV listed above. We anticipate that any survey, collection or research activities for implementation and maintenance of the Agreement will not entail significant Federal action under the NEPA and will be given a categorical exclusion designation. All other actions will be evaluated prior to implementation and will comply with NEPA regulations.

X. SIGNATURES

TEXAS PARKS AND WILDLIFE DEPARTMENT
4200 Smith School Road
Austin, Texas 78744

Andrew Sansom date
Executive Director

CITY OF DEL RIO
P.O. Box 4239
109 W. Broadway
Del Rio, TX 78840

Robert Chavira date
Mayor

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
10711 Burnet Rd, Suite 200
Hartland Bank Bldg
Austin, TX 78758

8/17/98

Dave Frederick date
State Director

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
500 Gold Avenue SW
Albuquerque, New Mexico 87102

for Nancy Kaufman date 9/1/98
Regional Director

ATTACHMENT A

CONSERVATION STRATEGY
Devils River minnow
Dionda diaboli

PURPOSE

The purpose of this document is to describe specific procedures and strategies required for conservation of the Devils River minnow, *Dionda diaboli*. The general conservation goal is to eliminate or significantly reduce the probability that potential threats to the minnow will actually harm this species and to recover populations of the minnow to viable levels. Though the primary focus of this Conservation Strategy is conservation of the Devils River minnow, it will also reduce or eliminate threats to the associated ecosystems and thereby provide additional benefits to the citizens of Texas.

BACKGROUND

The geographic location and historic stability of the Devils River has sustained a number of indigenous organisms. Due to limited access, the river has not been well studied. However, collections in the past decade by Garrett et al. (1992) and others indicate a diminution in abundance of several flowing-water species, particularly the Devils River minnow. In 1953, a collection at Baker's Crossing showed Devils River minnow to be the fifth-most abundant fish species there and the sixth-most abundant in the upper river (Brown 1954). In the mid-1970's Harrell (1978) found this to be the sixth-most abundant fish in the river. By 1989, collections from 24 locations throughout the range of the minnow yielded a total of only 7 individuals (Garrett et al.). Only one fish was obtained from Baker's Crossing and no more than two were obtained at any site. In 1979, Devils River minnow made up 6-18% of the *Dionda* population at the head springs area of San Felipe Creek. In 1989, none were present.

Land ownership in the areas where Devils River minnow occurs is mostly private. Exceptions include the Devils River State Natural Area, owned by Texas Parks and Wildlife Department and portions of San Felipe Creek, owned by the City of Del Rio. Primary land uses are for agriculture by cattle, sheep, and goat ranching. Generally, these areas are very remote with little human development, beyond those to support ranching operations. Primary communities within the Devils River watershed are Ozona and Sonora (each less than 5,000 in population) in the upper, intermittent portion of the stream. The Devils River is a popular location for recreational fishing and canoeing, although public access is limited.

Potential Problems Facing the Species

Because of a naturally restricted range, a reduction in that range (inundation of the lower portion of the Devils River; elimination of the Las Moras Creek population) and a decline in abundance within remaining populations (cause unknown), there is cause for concern for the status of the Devils River minnow. Remaining populations are potentially threatened by a) loss of habitat through reduction in spring flows, b) reduction in water quality and c) predation and competition with exotic species. However, since little is known of the life history requirements or the ecological interactions of the Devils River minnow, it is not possible to properly assess threats or fully implement recovery actions.

Conservation Actions

The following Conservation Actions are designed to: a) assess the current status of wild populations (CA #1); b) provide immediate security for the Devils River minnow (CA #2 & #3); c) implement actions needed for long-term conservation of the Devils River minnow (CA #4, #5 & #6) and d) fill in gaps in pertinent information (CA #7, #8, #9 & #10).

1) Determine the current status of the Devils River minnow and monitor changes.
    a) Coordinate access with private land owners and sample available habitat throughout the length of the Devils River, San Felipe Creek, Las Moras Creek and Sycamore Creek.
    b) Obtain scientific collecting permits from Mexico and determine if any Devils River minnows exist in the Río San Carlos, Río Alamo, Río San Juan, Río San Diego, Río San Rodrigo, Río Escondido or Río Sabinas in Coahuila, Mexico.
    c) Collect fish by seining and electrofishing all available habitats. At each collection site, all specimens collected will be identified and each species will be enumerated. Voucher specimens will be retained. Sampling effort at each site will be quantified. Sample sizes will be sufficient to show all species present and reveal relative abundance of all species present so as to allow determinations of population trends and competitive interactions. Obtain samples from selected locations in both fall and spring in order to measure seasonal fluctuations of population size. Data will be reported in terms of actual number of all fishes obtained and relative abundance.
    d) Determine microhabitat usage and species association. Area sampled, sampling duration and habitat characteristics will be recorded and used for quantitative characterization of range, relative abundance and habitat use. In addition, parameters of water quality (e.g., temperature, DO and TDS) and habitat structure (e.g., aquatic vegetation, channel morphology, substrate, flow and depth) will be measured and tested for correlation.
    e) These sampling efforts will be performed annually for the duration of the project.

2) Maintain genetically representative, captive populations of Devils River minnow at TPWD Heart of the Hills Research Station and at one or more alternate facilities deemed appropriate by USFWS (e.g., Dexter National Fish Hatchery) for reintroduction propagation and as insurance against extinction.

3) Reintroduce Devils River minnows reared from captive populations in order to reestablish populations in nature.
   a) The preferred broodstock for reintroduction is adults from the Devils River. Should those not be available, broodstock from San Felipe Creek may be used. No fewer than 50 adults (50:50 sex ratio) will be used in order minimize chance loss of rare alleles.
   b) The highest priority introduction sites will be 1) Finegan Springs, 2) Dolan Springs and 3) the vicinity of Dolan Falls. The first two are on the TPWD Devils River State Natural Area and the third is adjacent to the property of The Nature Conservancy of Texas. The first site is a known location of previous abundance and should therefore have a high probability of success. The second site has no records of smallmouth bass and the third site is the location for smallmouth bass removal in the Texas A&M experiment (#10, below).
   c) Upon analyzing results of the first stockings and determining microhabitat preferences, additional, appropriate stocking sites may be identified.
   d) Monitor reintroduced populations to assess stocking success and to record interactions with competitors and predators.

4) Continue and enhance protection of the San Felipe Creek watershed.
   a) The city of Del Rio will be working to reduce water consumption by 10-20% in San Felipe Creek by constructing a water treatment plant that improves the efficiency of the City's water storage and delivery system. The City has also hired a consulting firm to study alternate water sources to San Felipe Creek.
   b) The City is developing a Water Conservation Plan, as required by existing agreements with the Texas Water Development Board and the Border Environmental Cooperation Commission and in conjunction the Regional Water Resource Plan being developed under mandate of the Texas Natural Resource Conservation Commission.
   c) The City is also developing policies for preserving water quality and water flow as well as educating the populace on the value of San Felipe Creek as a natural resource that flows through Del Rio (Attachment B).
   d) The City has adopted a plan which limits population density over areas immediately adjacent to the San Felipe Creek.
   e) TPWD will assist the City in developing a Management Plan for the golf course that will protect San Felipe Creek from negative impacts.

5) Provide technical assistance to landowners on riparian protection and management.
   a) TPWD will provide information to private landowners regarding methods and actions for managing riparian areas such that stream flow, water quality and biological diversity are maintained.
   b) TPWD will, upon invitation by landowners, develop habitat management plans with these landowners that include the riparian management information.

c) TPWD will also provide guidance in pursuit of grants for private landowners and the City of Del Rio that will be used for activities that protect stream flow and water quality.

6) Review live bait harvest and selling practices in the Devils River area to develop methods and take appropriate actions (e.g., regulation, education) to prevent the further establishment of exotic, aquatic species within the historic range of Devils River minnow.

7) Document abundance and range of exotic fish species in the Devils River, San Felipe, Las Moras and Sycamore creeks using methods described in #1.

8) Obtain and analyze changes in flow data for the Devils River, San Felipe, Las Moras and Sycamore creeks.
   a) Existing studies such as the one performed for the Nature Conservancy will be reviewed.
   b) Any additional information needs will be resolved by requesting studies from the Texas Water Development Board and/or the Texas Natural Resources Conservation Commission designed to fill the gaps in the data.
   c) If correlations in spring flow and Devils River minnow abundance exist, a more thorough assessment of groundwater geology and recharge area will be performed.

9) With progeny of the captive population, use a simulated environment to determine ecological and life history requirements of Devils River minnow.
   a) Construct artificial habitat at Heart of the Hills Research Station designed to simulate portions of the Devils River. Information obtained in #1)d. will be used to design the artificial habitat. Two "streams" patterned after ones designed for stream ecology studies (Matthews et al. 1990; Lamberti and Steinman 1993) will be constructed to facilitate replication. Each creek will have six pools (2m dia.) and six riffles (0.5m x 2m).
   b) Determine microhabitat preference of Devils River minnow through diel and seasonal observation and analysis.
   c) Measure competition and predation interactions with associated fish species by manipulating species composition and abundance in each of the artificial streams and using procedures developed in previous studies (Finger 1982; Fraser and Cerri 1982; Schnick et al. 1986; Gilliam and Fraser 1987; Schlosser 1987; Brown 1991; Bugert and Bjornn 1991; Resetarits 1991; Vaughn et al. 1993).
   d) Determine water chemistry tolerance ranges by manipulating concentrations of components such as TDS, nitrate-nitrogen, phosphate and orthosphosphate in both static and artificial stream settings.

10) Determine *in situ* predator/prey interactions between smallmouth bass and Devils River minnow.
   a) TPWD is coordinating with Texas A&M University on a project currently underway that is designed to compare the Devils River fish community dynamics (including Devils River minnow) in the presence of smallmouth bass versus a section of stream where they have been removed.
   b) Results of the Texas A&M study will be reviewed and, if needed, TPWD will conduct further research to augment the study. The goal of the study will be to determine if smallmouth bass predation has an inordinate effect on Devils River minnows relative to

that of native predators and if so, what life stages of the two species are most important in the interaction.

c) Elimination of the smallmouth bass from the Devils River would be virtually impossible, even if warranted. However, removal from selected locations could have enough of a short-term, positive effect to allow re-establishment of Devils River minnow populations. Long-term effectiveness would be more likely achieved through regulations on bag and size limits which can be used to reduce abundance and modify population structure of smallmouth bass. Study results will be used to formulate management policies for smallmouth bass that will remove them as a threat to survival of Devils River minnows.

CRITERIA FOR SUCCESS

Because the reasons for the decline of Devils River minnow remain unknown, these actions have been designed to restore populations while simultaneously performing research that will provide guidance for maintaining the species at natural levels. Restoration of the populations may be rapid (as naturally happened with those in San Felipe Creek) or may take several years. During this time, parameters such as habitat quality, flow rates and competition/predation pressures will be better delineated and enable us to work with the community to take any needed remedial actions.

The Devils River minnow is vulnerable to extinction because of the reduced distribution and low population size. Improving this condition through captive propagation and successful reintroduction would provide immediate security for the species and allow the FWS to consider alternatives to a listing as Endangered.

Removal of the imminent risk of extinction would be attained by one or both of the following:

1) The proposed status survey may reveal the existence of a greater number of viable populations in Texas and/or Mexico than are currently known.
2) Captive propagation and stocking into the Devils River can be used to reestablish natural populations and would enhance the ability to determine causes for previous declines.

Restoration of the Devils River minnow will be considered complete when:

1) Population levels in San Felipe Creek and the Devils River are at historic levels. Two locations in San Felipe Creek (e.g., in the headsprings area and at the golf course) and three locations on the Devils River (e.g., headwaters, Baker's Crossing, Finegan Springs) will be used to represent the populations.
2) Viable populations exist in Sycamore and/or Las Moras creeks (historic levels are not known).
3) Ecological parameters that affect life history of Devils River minnow are known and appropriate safeguards are in place to insure that these parameters remain within the range needed for health of Devils River minnow populations.

Coordinator: Dr. Gary P. Garrett
Heart of the Hills Research Station
Texas Parks & Wildlife Department
Ingram, TX 78025
gpg@ktc.com

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Table 1. Conservation actions to be implemented.

ACTION ITEM	responsible party	initiation date	task duration	estimated cost/year
Determine the current status of the Devils River minnow and monitor changes	TPWD	11/97	5 years	$1,000
Maintain genetically representative, captive populations of Devils River minnow at TPWD Heart of the Hills Research Station and at one or more alternate facilities for breeding and as insurance against extinction	TPWD FWS	11/97 8/98	5 years 5 years	$8,000 $1,000
Reintroduce Devils River minnows reared from captive populations in order to reestablish populations in nature	TPWD	4/99	4 years	$500
Enhance protection of the San Felipe Creek watershed	TPWD City of Del Rio	3/99	Ongoing	$500 $3,000,000
Provide technical assistance to landowners on riparian protection and management	TPWD	3/99	Ongoing	$1,000
Review bait harvest/selling in the Devils River area and develop methods (e.g., regulation, education) to prevent the further establishment of exotic, aquatic species within the historic range of Devils River minnow.	TPWD	8/98	1 year	$500
Document abundance and range of exotic fish species in the Devils River, San Felipe, Las Moras and Sycamore creeks	TPWD	4/98	2 years	$1,000

Obtain and analyze changes in flow data for the Devils River, San Felipe, Las Moras and Sycamore creeks	TPWD	2/98	2 years	$3,000
With progeny of the captive population, use a simulated environment to determine ecological and life history requirements of Devils River minnow	TPWD	3/98	5 years	$1,000
Determine *in situ* predator/prey interactions between smallmouth bass and Devils River minnow	TPWD	3/99	4 years	$2,000

ATTACHMENT B

(830) 774-8510

November 14, 1997

Dr. Gary Garrett
Texas Parks and Wildlife Department
Heart of the Hills Research Center
HCO7, Box 62
Ingram, TX 78025

Dear Dr. Garrett:

In the course of our discussions and your visits to the San Felipe Creek over the past few years, we have pondered several questions which are of particular importance to the City:

- How does a city show off its most beautiful natural resource without harming it?
- How does one balance preservation and development?
- What is the best way to stabilize stream banks?
- What level of maintenance is most appropriate?

Our discussions have come about because of either your scientific study or our development planning, or both. We are always appreciative of your advice and concern, and pleased that you share our conviction that an increase in human activity along the Creek does not need to lead to a decline in natural beauty.

There has been little movement of late on the City's long-standing dream of a "Creekwalk" along the San Felipe. As you know, a number of years ago the City built retaining walls and sidewalks along a portion of the Creek. We now understand that the improvements made at that time are not the best choice for the ecosystem of the San Felipe Creek. Portions of the walls and walkways are now in disrepair, and there appears to be beginnings of a renewed momentum for the Creekwalk concept. This, and the recent discussions surrounding the health of the Devils' River Minnow in the San Felipe Creek prompted the City staff to discuss again the principles and practices on which future development should occur. I thought it appropriate that we share our thoughts with you. Attached to this letter you will find an outline of our ideas. These are not adopted guidelines, but we are committed to following them as we plan for the future.

As to the issue of water conservation, which is briefly discussed on the next page, there is a recent development which may impact water use. The City is under a mandate to construct is first-ever Water Treatment Plant. As water has always been cheap and plentiful, the City has never enacted official conservation measures. With the construction of the plant (expected to cost $30 million), water bills will increase, and we anticipate that the increased cost may cause water usage may drop as much as 10-20%.

Funding is always a concern, and I would ask that you keep us in mind as you hear about grant programs which might fit our agenda. Again, thank you for your continued support. I look forward to hearing you comments and suggestions.

Sincerely,

Beth Eby
Assistant City Manager

SAN FELIPE CREEK
DEVELOPMENT GUIDELINES

Goal #1 - Public access, along the entire stretch from Highway 90 to the Rio Grande, so that citizens and visitors can enjoy the natural beauty of the San Felipe Creek.

Goal #2 - Low-impact, low-density, self-sustaining, mixed-use development, which is consistent with recreational uses, and will be an asset to the community.

Goal #3 - The inclusion of environmental education wherever possible. Interpretive signs, murals, and hands-on activities which educate the public about the various components of the ecosystem are to be encouraged. Informed citizens are the best insurance for the Creek.

Water quality is of paramount importance. All existing activities and all future planning will be scrutinized for impacts on the San Felipe Creek in terms of runoff, potential for accidental spills, and any other source of pollution.

As much as possible, stream banks are to be preserved in their natural state, or returned to their natural state, as repair of existing sidewalks and retaining walls is performed.

Stream bank retention, repair, and reinforcement, where needed, is to be enacted by the "most natural" method practicable. Return to a completely natural state with the use of native vegetation is preferred; following that, the use of fiber mats, gabions, etc., is to be considered. Concrete, brick, stone, and mortar are to be the last resort. "Channelization" is to be avoided.

New sidewalks are to be placed close enough to allow users a view of the waterway, but far enough away so as not to encourage erosion or to disrupt existing vegetation. A "buffer zone" of 10' to 20' is preferred.

Regular removal of litter and debris is important, and should occur on a regular and frequent basis. Volunteer groups are encouraged to participate. All volunteers are to receive training from the Parks and Recreation Department on how to accomplish the task with the least disruption to the Creek.

Removal of vegetative overgrowth is to proceed carefully, in consultation with Texas Parks and Wildlife Department, the Watermaster, and/or other appropriate individuals or agencies.

There should be no new diversions of water into channels, canals, pools, fountains, etc.

Water flow is to be preserved to the extent possible. The City relies on the San Felipe Springs for its drinking water, and the San Felipe Irrigation Company diverts water from the Creek into its irrigation canals. Although these uses are essential to the community, and have never been shown to adversely effect the ecosystem, conservation measures could and should be considered.

Appendix C

City of Del Rio Management Plan for San Felipe Creek and the Devils River Minnow, September 2003

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Management Plan for San Felipe Country Club in Del Rio, September 2003

CITY OF DEL RIO MANAGEMENT PLAN
FOR SAN FELIPE CREEK AND THE DEVILS RIVER MINNOW

INTRODUCTION

The intent and purpose of this document is to make recommendations to staff and set policy with respect to the protection, preservation, restoration and management of the San Felipe Creek watershed. In addition, this document records information relevant to managing the natural and cultural resources of San Felipe Creek and its springs.

MISSION

The City of Del Rio seeks to preserve and conserve the natural and cultural resources of the San Felipe Creek for the use and enjoyment of the present and future generations of Del Rio citizens and visitors. The city is a signatory on the Devils River Minnow Conservation Agreement and has representation on the Devils River Minnow Conservation Team. The Management Plan for San Felipe Creek and the Devils River Minnow will enable fulfillment of the city's obligations towards conservation and restoration of the federally threatened, Devils River minnow (*Dionda diaboli*). For the purpose of protecting the drainage basin of San Felipe Creek, the area of conservation will be designated as that bounded by the 100 year floodplain (as defined by FEMA) plus a 100' buffer (see map – Appendix 1).

GOALS

- Conservation and protection of the water quantity and quality of San Felipe Creek.
- Public access, so that citizens and visitors can enjoy recreation, cultural resources and the natural beauty of San Felipe Creek.
- Low-impact, low-density, self-sustained, mixed-use development, which is consistent with recreational uses and with conservation of cultural and biological resources, and will be an asset to the community.
- Inclusion of environmental education wherever possible.

LOCATION AND HISTORY

San Felipe Creek emanates from the third largest spring system in Texas. Although there are several springs throughout the aquifer area, the City of Del Rio uses only the two main springs for its water supply. The aquifer derives its water from the Edwards and Trinity plateau, which lies on the Balcones fault zone. The underground water is believed to cover over 6,500 square miles. The West spring is classified as ground water and the East spring is classified as ground water under the influence of surface water.

In the pre-history of San Felipe Springs many different Indian tribes inhabited the springs, including the Apache and Pueblo Indians. In 1650 the first mission was built near the springs. In 1657 Franciscan Priests held a mass on the grounds around the springs and named them San Felipe Del Rio. The name San Felipe was used in honor of the King of Spain (which at the time was Phillip) and Del Rio meaning "of the river". San Felipe Springs offered and continue to offer many opportunities for agriculture and manufacturing in Val Verde County. The creek was the lifeline of the newborn community of San Felipe Del Rio. Water from the springs was used to water all crops and develop the first winery in the state of Texas (Val Verde Winery). Two gristmills were built to provide the first source of power in and around the area. San Felipe Agriculture, Manufacturing, and Irrigation Company played a key component in the building of two grist mills which provided power to the community and the canal system that irrigated the surrounding ranches and farm lands.

OVERVIEW AND SIGNIFICANCE

San Felipe Springs are the only source of water for the City of Del Rio and Laughlin Air Force Base. Flow from San Felipe Springs typically ranges from 50 to 90 MGD (million gallons per day; 77-139 cfs). Its meandering creek provides for recreational use, outdoor experiences and excellent habitat for wildlife. Its serene flow allows for several passive parks and swimming areas. The surrounding vegetation and landscape allows for excellent bird watching. The City of Del Rio, with local funds and grants (made possible by the NadBank/EPA), began construction of a water treatment plant in February 2001 and the plant was completed in August 2002. The water treatment plant is expected to pump 16 MGD from the East and West springs. Average daily water usage is currently 11-12 MGD. By the end of 2002, wells north of city may be able to supplement water supply by up to 4 MGD. The treatment plant is located on the east side of the creek. However, in order to pump water from the West Spring the contractors designed a structure that will not disrupt the ecology of the creek. The water treatment plant does not disrupt the flow of the creek. In light of a $14 million dollar grant given to the City of Del Rio by the Nadbank/EPA, we acknowledge the commitment to the conservation of the San Felipe Creek by both the City and Federal Government. With the anticipated growth of Del Rio the water treatment plant will also allow for expansion.

Nature tourism is the fastest growing segment of the tourism industry in Texas. San Felipe Creek has been designated by Texas Parks and Wildlife Department as a Nature Viewing Site for the Central Texas Nature Viewing Trail and will attract birdwatchers to the community.

HABITAT

Quality habitat for Devils River minnow is also quality habitat for most of the other organisms in the drainage, including humans. Protecting and in some instances enhancing the habitat can be beneficial to the Devils River minnow and the people of Del Rio. Components of the habitat interact and affect each other. These components include:

Stream – The stream consists of the flowing, aquatic habitat and its interactive organisms and physical elements. Organisms include plants, invertebrates, amphibians and fishes as well as terrestrial animals that depend on the stream. Physical elements include temperature, water chemistry, gradient, current and substrate.

Riparian – This zone is the area adjacent to and interactive with the stream. Natural riparian areas are structurally diverse and more productive in plant and animal biomass than adjacent upland areas. Riparian areas supply food, cover, and water for many organisms, and serve as migration routes for a variety of wildlife. Because riparian ecosystems often are relatively small areas and occur in conjunction with waterways, they are vulnerable to alteration.

Watershed - The watershed consists of all the surrounding land area that sheds rainfall into the San Felipe Creek Basin. It is made up of both upland, undeveloped lots and urban, highly developed residential and business areas. The status of the watershed can have a direct impact on the quality of water in San Felipe Creek and its ecosystem. Non-point sources and direct sources of pollution through runoff can especially have a damaging effect on the ecosystem. The upland zone is the area adjacent to the riparian zone. Natural upland areas in the San Felipe watershed contain many tree and shrub type plants, such as, huisache, cenizo, hackberry, and prickly pear cactus. These upland areas are key in providing food and habitat for maintaining the native fauna of West Texas. Upland habitat provides additional benefit by reducing sediment loads, fertilizer runoff, and contaminants from flowing directly into the creek.

DEVELOPMENT AND CONSERVATION

Subsequent to the flood of August 1998, the City of Del Rio has acquired a substantial amount of land adjacent to San Felipe Creek. The City of Del Rio Parks and Recreation Department plans to develop these areas into passive parks. The Parks will be developed with one major goal in mind, which is to create a people-friendly area that is conducive to nature. The theme is for the area to remain in its "natural state". Areas such as Bird Watching Sanctuaries, Walking Trails will be developed in conjunction with Passive Parks. For example: Trails will be built 10 to 20 feet away from (where possible) the creek, allowing natural vegetation to grow and act as a natural buffer zone between the creek and the developed area.

Because it is an urban park, other recreational opportunities will also be made available (e.g., baseball fields, playgrounds, etc.), but the City of Del Rio will take a precautionary stance in the development of San Felipe Creek. Wise planning, in conjunction with the Devils River Minnow Conservation Team, should allow a multi-functional greenbelt that protects the natural resources as well as provides the greatest benefit to the citizens of Del Rio.

WATER QUALITY

Water quality is of paramount importance. All existing activities and all future planning will be scrutinized for impacts on San Felipe Creek in terms of urban runoff, potential for accidental spills, and any other source of pollution.

The use of pesticides and fertilizers should be minimized on city property and discouraged from use among private citizens along the creek. All possible sources of point and non-point source pollution should be investigated and eliminated.

The population of domestic ducks which reside near Highway 90 serve as a direct source of concentrated fecal pollution causing excessive growth of water plants and algae. In still waters, such as the Blue Hole area, when these plants die in the summer and decompose the process removes oxygen in the creek waters which may directly and negatively impact fish populations as well as other aquatic inhabitants. In addition, the presence of large amounts of feces and coliform bacteria may present a health hazard to the children who swim at the Blue Hole. For these reasons, it is recommended that these domestic ducks be removed from the area.

Commercial development along the creek should be discouraged. Not only would it put these entities at risk in the event of a flood, but it would also create other sources of pollution. The City has the ability to control and restrict inappropriate development in the drainage basin through zoning ordinances.

The construction of conventional-style parking lots should be especially discouraged. Rainfall runoff from parking lots along the creek will end up polluting the creek with oils, gasoline and other pollutants. In the event that the construction of a parking lot is necessary, provisions should be made to construct a catchment (retention pond) to process the runoff or it should be directed to extensive areas of native vegetation to filter pollutants out.

The city of Del Rio Code of Ordinances has various existing ordinances that pertain to protecting water quality. Chapter 11, Flood Damage Prevention, is designed to minimize flood losses. It provides for the restriction or prohibition of uses, provides for the protection of facilities, controls the alterations of natural floodplains, stream channels or other natural barriers which accommodate floodwaters, controls the filling, dredging, grading, or other developments that may increase flood damage, and prevents or regulates the construction of flood barriers. The areas of special flood hazards are identified by the Federal Emergency Management Administration (FEMA) and permits are required for construction to ensure conformance with this ordinance. This ordinance also designates the City Manager as the Floodplain Administrator.

Another Ordinance is contained in Chapter 19.5, Parks, Recreation and Public Gathering Places. This provides for the conduct in public parks and in city property adjacent to the San Felipe Creek. It regulates behavior, recreational activities, traffic, commercial activities, sanitation, park property, and enforcement. Specifically, Article IV, San Felipe Creek Walk, Sections 19.5-150 to 19.5-173 provides for the planning, management and coordination of the activities which are conducted in that area and this is accomplished by the designation of the San Felipe Creek Walk Association as the official agency of the city to accomplish this.

Chapter 23, Sewers, regulates the discharge of wastes, provides rules for private sewage facilities and for licensing and regulation of the removal and disposition of private sewage facility wastes. Section 23.21 Same- To Public waters, states that no waste or wastewater may be discharged to public waters which contains acids, plating solutions or concentrated solutions. Fats, wax, grease, oils in excess of 100 mg/l or which may solidify or become viscous at temperatures between 32°F and 150°F may not be discharged into public waters. Objectionable or toxic substances, liquids or gases are similarly restricted and disallowed. Permits for discharges are required.

Chapter 24, Solid Waste, regulates the collection and disposal of solid wastes. This chapter provides for the residential garbage collection and for commercial disposal of wastes. The city landfill, permitted by TCEQ, is inspected periodically. Permit number for this facility is MSW 207A, as amended. Wastes are not allowed to collect in order to prevent such wastes from being carried or moved from the property by actions of the sun, wind, rain, or snow. Such wastes, if not collected and removed, could ultimately be deposited in public waters.

Also, Chapter 29, Water, contains general provisions for the city as the water purveyor, for regulation of wells, and for water conservation and drought contingency plans. The city council or its designated agent, the City Engineer, shall inspect the wells, have made or make analysis of the well waters, go unto private lands to inspect the wells, supervise and inspect the construction and require the owners to furnish all information on the well to include logs, geologic information and depth and size of well constructed. Further, the City is to monitor the daily water demand in case of emergency. The drought contingency plan provides for controls of water usage during droughts or emergencies.

The City of Del Rio via Ordinance No. O:2000-01 approved a revised Drought Contingency Plan and Water Management Plan on January 11, 2000. The plans contain various aspects to determine what is drought condition, what triggers the drought contingency plan, enforcement and fines, in order to establish practices for the conservation of water.

The plan defines essential water use, non-essential water use and other such watering. The plans set three contingency trigger conditions and these are mild water shortage, moderate water shortage, and severe water shortage. These trigger conditions set the plan in motion. Basically, this is a measurement of stored water quantities in the Bedell Reservoirs and others.

Once the plan is put into effect, notification is given to citizens via radio, television, and newspaper notices. Enforcement can be accomplished by fines and citations for non-compliance. The plan also can require a minimal use of water for watering purposes and establishes watering days based on locations and time of the year.

Since it was approved by the City Council, the plan has been put into use only on one occasion.

All ordinances above or parts thereof were briefly discussed and are pertinent to protecting the water quality in the San Felipe Creek and the two springs which provide the source of water for the city for domestic and industrial use, recreational use, and to maintain the quality of the public waters of the city.

PRESERVING NATURAL FLOW

Natural water flow is to be preserved to the greatest extent possible. There should be no new diversions of water into channels, canals, pools, fountains etc. The City relies on the San Felipe Springs for its drinking water, and the San Felipe Irrigation Company diverts water from the Creek into its irrigation canals. Although these users are essential to the community, and have never been shown to adversely affect the ecosystem, conservation measures could and should be considered.

Fountains in the creek are not advisable. They reduce flow through evaporation and they communicate a "water waste" message to the community. Natural flow is not only important to the San Felipe Creek ecosystem but also affects the Rio Grande ecosystem and ultimately, fresh-water inflow to estuaries of the Gulf of Mexico.

STREAM BANK AND RIPARIAN MANAGEMENT

As much as possible, stream banks are to be preserved in their natural state, or returned to their natural state as repair of existing sidewalks and retaining walls is performed.

Stream bank retention, repair, and reinforcement, where needed, is to be enacted by the "most natural" method practicable. Return to completely natural state with the use of native vegetation is preferred; following that, the use of fiber mats, gabions, etc., is to be considered. Concrete, brick, stone, and mortar are to be the last resort. "Channelization" is to be avoided.

New sidewalks may be placed close enough to allow users a view of the waterway, but must be far enough away so as not to encourage erosion or to disrupt existing vegetation. As a general rule, sidewalks should be no closer to the stream bank than 10' and should meander up to 40'-50' from the stream. Occasional water's-edge viewing areas may be constructed. These will be at natural "hard spots" on the stream bank and will be constructed to look and function as part of the natural system.

Buffer zones of native vegetation will serve as traps for any pollutants (fertilizers, pesticides, etc.) which may runoff from neighboring streets, parking lots, residential areas, or the golf course. It also will be attractive to birds, butterflies and other forms of wildlife which nature tourists and native residents will enjoy viewing.

In developed areas, such as along the creek-walk, the buffer zone should extend from the edge of the water up to within 2' of the sidewalk. A "buffer zone" of 10' to 20' is preferred. In undeveloped areas, it should extend all the way to the edge of any private property.

Private property owners (within the 100 yr + 100' zone) should be encouraged to allow their lots to revert to native vegetation as much as practical. To enhance the process, No Mow zones should be designated in open space areas adjacent to the creek. Mosaic patterns should be used to make the resulting combination of open and closed areas pleasing to the eye by avoiding hard edges. As a practical guide, no mowing should take place within and under the drip line of existing trees. No Mow zones also serve to provide habitat for birds and other wildlife.

Passive restoration of native vegetation, including shrubs and trees is the most practical, economically feasible, and preferred method for re-establishment.

EDUCATION

Interpretive signs, murals, and hands-on activities which educate the public about the various components of the ecosystem are to be encouraged. Citizens should be informed of the potential harm of introducing non-native organisms into or adjacent to the creek. In particular, aquarium fishes can be devastating to a spring-fed ecosystem such as San Felipe Creek. Informed citizens are the best insurance for San Felipe Creek.

LITTER REMOVAL

Regular removal of man-made litter and debris is important, and should occur on a regular and frequent basis. Volunteer groups should be encouraged to participate. All volunteers are to receive training from the Parks and Recreation Department on how to accomplish the task with the least disruption of the creek.

Dead tree snags should be left to provide nesting habitat for cavity nesting birds and perching locations for songbirds. They should be trimmed if they occur in high public use areas to prevent injury to citizens from falling branches and can be cut down entirely if the danger is too great. Dead trees that fall into the creek should be allowed to remain. They provide loafing areas for birds, amphibians and reptiles as well as shade and escape cover for fish.

Removal of vegetative overgrowth is to proceed carefully, in consultation with Texas Parks and Wildlife Department, the Water master, and or other appropriate individuals or agencies.

REMOVAL OF NOXIOUS, EXOTIC VEGETATION AND THE RESTORATION OF NATIVE PLANTS

Rivercane (*Arundo donax*) should be removed along the length of the creek with the cooperation and under the close supervision of personnel of the Texas Parks and Wildlife Department using EPA "wetlands" approved herbicide. This should be done only by prescription (due to the presence of a threatened fish species) and should be performed in the upper reaches of the creek first, to prevent re-establishment of the cane in lower areas through fragmentation. This should only be done after an agreement has been reached to allow re-vegetation of these areas with native vegetation through natural means. One year of experimentation with herbicides in lower reaches of the creek (where the Devil's River Minnow is known not to occur) should first be performed to fully assess the effects of treatments to aquatic species and the surrounding ecosystem.

Exotic plant removal should ultimately be done in short stretches at a time in order to maintain the stability of existing banks in the event of a flood. Other introduced plant species (Chinese tallow, elephant ears) should also be selectively removed from creek side areas.

As unwanted plants are removed, revegetation with native species is critical to success and system stability. Some segment-specific revegetation (e.g., butterfly gardens) may be desirable in some areas and passive revegetation may work best in others.

SIGNATURES

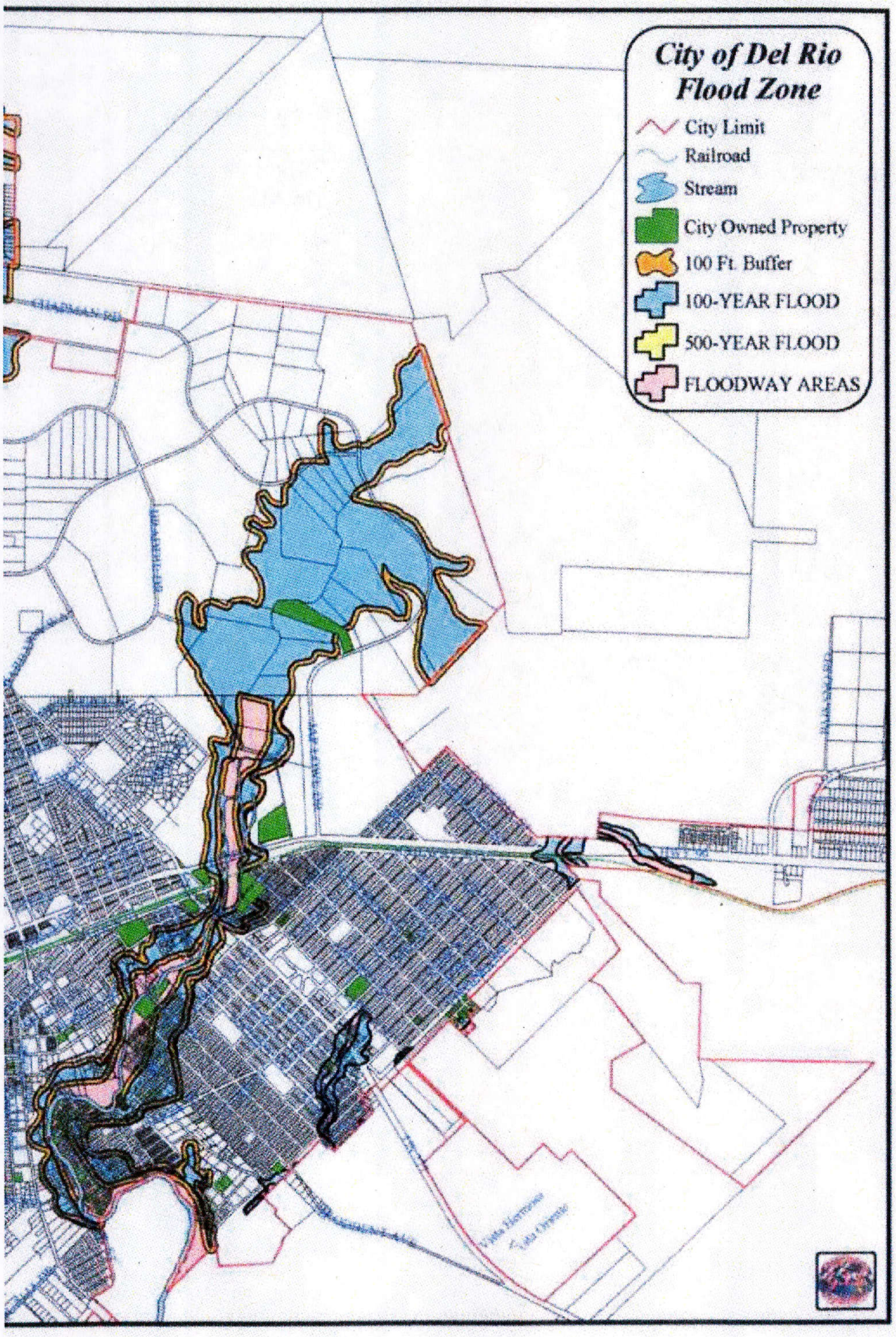
/s/ September 25, 2003

Dora Alcala
Mayor

/s/ September 25, 2003

Rafael Castillo
City Manager

APPENDIX 1 - Map of the 100 year floodplain (as defined by FEMA) plus a 100' buffer.



APPENDIX 2 - Species of San Felipe Creek watershed

COMMON PLANTS

Trees

- Pecan (domestic maybe some native)
- Sugar Hackberry
- Black Willow *Salix nigra*
- Texas Ash and Arizona Ash (non-native)
- Bald Cypress (probably introduced) *Taxodium distichum*
- Sycamore
- Cottonwood (probably introduced)
- Mulberry
- River Walnut
- Huisache
- Chinaberry (exotic)
- Tree Tobacco (*Nocotiana glauca)*
- Retama (Parkinsonia aculeata)

Shrubs

- Buttonbush
- Granjeno
- Seepwillow Bacchariss
- Cenizo (*Leucophyllum)*
- Kidneywood

Grasses

- African Rivercane (noxious exotic) *Arundo donax*
- Dallisgrass (introduced but great for birds)
- Bushy Bluestem
- Silver Bluestem
- Plains Bristlegrass
- Common bermuda

Forbs, Annuals & Perrenials

- Goldenrod
- Cardinal Flower
- American Water-willow
- Elephant Ears (exotic)
- White Boneset
- Golden-Eye (*Viguera dentata*)
- Redbud *Menodora heterophylla*
- Winecup
- Pink Evening Primrose
- Blue-eyed Grass *Sisyrinchium ensigerum*
- River Primrose *Oenothera jamesii*
- Frogfruit
- Blue Curls (Phacalea)
- Henbit
- Mexican Sage
- Dandelion
- Widow's Tears, Dayflower
- False Ragweed (*Partheneum sp.)*
- Marsh Fleabane
- Wild Petunia (*Ruellia sp.)*
- Wild Tobacco (*Nicotiana repanda)*
- Mexican Bastardia (*Bastardia viscosa)*
- Artemesia (*Artemesia ludoviciana)*
- Giant Ragweed (*Ambrosia trifida)I*
- Western Ragweed (*Ambrosia sp.)*

Vines

- Mustang Grape
- Sawleaf Greenbriar
- Poison Ivy
- Carolina Snailseed
- Pearl Milkweed (*Matelea reticulata)*
- Climbing Milkweed (*Sarcostema sp.)*
- Old Man's Beard (*Clematis drummondi*)

AVIFAUNA

- Pied-billed Grebe
- Neotropic Cormorant
- Double-crested Cormorant
- Ring-necked Duck
- Bufflehead
- Black-bellied Whistling-Duck
- Snowy Egret
- Great Blue Heron
- Green Heron
- Yellow-crowned Night-Heron
- Black Vulture
- Turkey Vulture
- Swainson's Hawk
- Red-Shouldered Hawk
- Sharp-shinned Hawk
- Zone-tailed Hawk
- Spotted Sandpiper
- American Coot
- Rock Dove
- Mourning Dove
- White-winged Dove
- Inca Dove
- Groove-billed Ani
- Chimney Swift
- Black-chinned Hummingbird
- Belted Kingfisher
- Green Kingfisher
- Ringed Kingfisher
- Golden-fronted Woodpecker
- Ladder-backed Woodpecker
- Northern Flicker
- Black Phoebe
- Vermilion Flycatcher
- Ash-throated Flycatcher
- Couch's Kingbird
- Western Kingbird
- Scissor-tailed Flycatcher
- Great Kiskadee
- Cedar Waxwing
- American Robin
- Northern Mockingbird
- European Starling
- Bewick's Wren
- Carolina Wren
- Purple Martin
- Barn Swallow
- Ruby-crowned Kinglet
- House Sparrow
- Pine Siskin
- American Goldfinch
- Lesser Goldfinch
- House Finch
- Yellow-rumped Warbler
- Common Yellowthroat
- Lincoln's Sparrow
- Chipping Sparrow
- Olive Sparrow
- Field Sparrow
- Summer Tanager
- Northern Cardinal
- Painted Bunting
- Red-winged Blackbird
- Great-tailed Grackle
- Hooded Oriole

SMALL MAMMALS

- Evening Bat
- Brazilian Free-tailed Bat
- Nine-banded Armadillo
- Eastern Cottontail
- Black-tailed Jackrabbit
- Mexican Ground Squirrel
- Spotted Ground Squirrel
- Eastern Fox Squirrel
- American Beaver
- Nutria (exotic)
- Common Gray Fox
- Striped Skunk
- Common Hog-nosed Skunk
- White-tailed Deer
- Ring-tailed Cat

NATIVE FISHES

- Mexican tetra
- Proserpine shiner
- Manantial roundnose minnow
- Devils River minnow
- Texas shiner
- Tamaulipas shiner
- Yellow bullhead
- Headwater catfish
- Mexican mosquitofish
- Gambusia sp.
- Longear sunfish
- Largemouth bass
- Rio Grande darter
- Rio Grande cichlid

Management Plan for San Felipe Country Club in Del Rio

BACKGROUND AND HISTORY:

Del Rio businessmen William Moore Abbey, B.B. Stafford, and C.C. Belcher formed a private corporation called the San Felipe Country Club in July 1921. Created to "support and maintain a Country Club for golf, tennis, and other innocent sports," its major feature was a nine-hole par-three golf course built around three of the largest of the San Felipe Springs. San Felipe was the first course civil engineer and professional golfer John Bredemus designed and built in Texas, and it solidified his reputation as a golf course architect. Bredemus went on to design many other important courses in Texas and Mexico. He co-founded the Texas Professional Golf Association in 1922 and was inducted into the Texas Golf Hall of Fame in 1991, 45 years after his death. With its original layout and early landscape remarkably intact, the San Felipe course is a prime example of early-twentieth-century golf course design.

The country club and golf course were successful right from the start, due largely to the promotional work of William Abbey. Soon after it opened, Del Rio golfers were playing in tournaments, and Abbey won the Princeton golf trophy in 1924. The first clubhouse for the San Felipe Country Club had been constructed in 1919 as an army officer's club and quarters for Camp Del Rio. The original building burned in 1927, and a second one built in 1947 still serves as the clubhouse. By 1953, a swimming pool and new tennis courts had been built on the country club grounds.

A second private organization, Del Rio Country Club, was formed in 1935. Primarily a social club, it coexisted with the golf club for many years. The two merged in 1966 and kept the name San Felipe Country Club. According to local historian and avid golfer Doug Newton, the San Felipe Country Club has been the center of social life for Del Rio's professional and business families ever since.

San Felipe Country Club Golf Course is approximately 70 acres in size. The country club is private, but the golf course which is owned by the City of Del Rio is open to the general public. Twenty to twenty-five thousand rounds of golf are played on the 9-hole course annually.

San Felipe Creek runs through the middle of the golf course in a north to south orientation for a total length of 2,100 feet. The upstream source of its flow comes from small springs and streams that originate on private property. The east and west springs which occur on the golf course proper are located on respective sides of the creek. Each of the springs serves as the source of drinking water for the city of Del Rio. Water is pumped from the springs up to the Water Treatment Plant located east of and adjacent to the golf course. The remaining water from the springs flows into the creek and serves as the major source of flow for San Felipe Creek.

The east springs form a stream that flows freely for 2,500 feet on the golf course before joining San Felipe Creek, just north of the Highway 90 Bridge on the golf course. The west spring flows for 1,400 feet through the golf course and then joins San Felipe Creek 200 feet south of the Highway 90 Bridge, below the golf course. San Felipe Creek runs for another 5 miles until it reaches the Rio Grande (Camp Dresser & McKee, Biological Assessment Final Report, May 2000)

The federally threatened, Devils River minnow occurs in San Felipe Creek and in particular, it is found most often in and just downstream of the San Felipe Country Club. This species was listed by the U. S. Fish and Wildlife Service in 1999 due to reduced population size and range. Factors identified as threats to this species included degradation of water quality and loss of habitat. The city of Del Rio is a signatory on the Devils River Minnow Conservation Agreement and has representation on the Devils River Minnow Conservation Team. The city has developed the San Felipe Creek Management Plan which will enable fulfillment of the city's obligations towards conservation and restoration of the Devils River minnow. Because San Felipe Springs emanate from within the San Felipe Country Club and an important segment of the creek flows through the grounds, it is the wish of the Country Club to insure that actions taken on this property do not detrimentally affect quality of San Felipe Creek or the Devils River minnow. For that reason, the Management Plan for San Felipe Country Club in Del Rio is designed to act in concert with the city's management plan and help to protect important natural resources in Del Rio.

OBJECTIVES:

- To use environmentally sensitive techniques for managing and maintaining a high quality golf course for the benefit of users while also promoting natural diversity.
- To protect and enhance the quality of San Felipe Creek and San Felipe Springs for the benefit of the Devils River minnow and the entire creek and riparian ecosystem.

DESIGN:

Any future construction or development should be designed to fit within the layout of the topography of the golf course, preserve selected habitats and avoid adverse effects on San Felipe Creek. Natural resource experts from Texas Parks & Wildlife Department should be brought in during the early planning phases for any development to ensure the protection of important wildlife habitats.

PROTECTION:

Protected areas should be kept free of intrusion. Except in rare cases, all equipment and personnel should be restricted to fairways or greens. A No-Mow buffer zone should be maintained along the edges of all water courses and springs to serve as a filter for any excess fertilizers or pesticides that may runoff during hard rains or watering and to prevent bank erosion. In addition, a wide buffer zone of native vegetation around the springs and their stream courses which eventually join San Felipe Creek can help keep errant golf balls out of these water areas. No-Mow buffer zones should be as wide as possible with a minimum of 20-30 feet, except in areas where it interferes with normal golf play. Examples of exceptions would be greens # 2 and #4 where the No-Mow Zone would be minimized to allow for a functional green. No chemical treatments should take place within these zones, except for noxious plant removal by prescription only. Protected areas are the riparian corridor and any future areas the country club decides to designate as No Mow zones such as along boundary fence lines. If No-Mow zones are established along boundary fences they would serve as habitat for birds as well as a filter for noise and chemical pollutants from the surrounding urban area. An increase in the local passerine bird population could help control insect pests on the golf course and function as a component of the integrated pest management plan.

RESTORATION:

Areas that must be disturbed anywhere on the golf course and are not fairways or greens should be re-seeded with native seed mixes or allowed to re-vegetate naturally using passive restoration.

PEST MANAGEMENT:

San Felipe Country Club is committed to using the most environmentally sensitive pest management solutions. Integrated Pest Management is the desired approach to dealing with pests. Integrated Pest Management, according to the University of California Statewide Integrated Pest Management Program, is "a strategy that focuses on long-term prevention or suppression of pest problems through a combination of techniques such as encouraging biological control, use of resistant varieties, and adoption of alternate cultural practices such as modification of irrigation or pruning to make the habitat less conducive to pest development. Pesticides are used only when careful monitoring indicates they are needed according to pre-established guidelines, treatment thresholds, or to prevent pests from significantly interfering with the purposes for which plants are being grown". The San Felipe Country Club will develop its own integrated pest management plan specifically designed to fit the purposes and needs of the Country Club while protecting the integrity of San Felipe Creek. An acceptable low level of damage by pests should be determined and incorporated into the plan. Research into the most environmentally compatible pesticides with consideration of organic\biological techniques should be initiated.

FERTILIZATION:

Fertilization is a necessary component to golf course management. Fertilizers will be used judiciously and only in quantities necessary. The County Club has no desire to be excessive or wasteful and recognizes that runoff from excessive use is harmful to San Felipe Creek.

NOXIOUS VEGETATION:

African rivercane, Chinese tallow, elephant ears and other invasive, exotic vegetation should be systematically removed using EPA wetland approved herbicides by prescription only. Rodeo is approved by the EPA to be used in wetland areas. The desired and most effective technique for application is by using a wick on individual stems that have been cut during the fall. An inventory of vegetation along watercourses should be performed by natural resource specialists.

OUT OF PLAY AREAS:

These areas are managed as native habitat. The open areas are managed as native short grasslands; while the wooded areas are managed as desert woodlands. Desert woodlands usually are found in low lying areas with deeper soils. Vegetation associated with these areas includes mature mesquite and sugar hackberry trees, and an assortment of shrub species such as granjeno, guayacan and Texas colubrina.

TEE BOXES:

Tee boxes at San Felipe Country Club are framed with native wildflowers and grasses.

LANDSCAPING:

The landscaping around the buildings and other facilities should be predominantly native vegetation. Grass clippings and other debris should never be disposed into San Felipe Creek. Grasses on fairways, greens and tee boxes are Bermuda-419 & Common Bermuda grass.

IRRIGATION:

The irrigation system at San Felipe Country Club should be state of the art. This system should make wise use of the irrigation water. The Country Club currently is receiving all of its irrigation water from the Water Treatment Plant in the form of backwash waste water thus increasing the efficiency of water use and eliminating the need for a discharge permit. The raw water storage lagoons have a capacity of approximately 190,000 gallons. When it is drawn down to a specific level, the Country Club is no longer able to continue pumping. There are two pumps that have a pumping capacity of 1,500 gallons per minute but only one pump can be used at a time.

RUNOFF AND WATER RECYCLING:

Runoff from the parking areas should be shunted through vegetation and then ultimately to surface retention ponds. This captures and filters the runoff so that it may be used in irrigation. Water used in the daily cleaning and maintenance of the equipment should be run through a filtering system, polished, and used again.

EROSION CONTROL:

Bare soil is mulched to cut down on wind erosion. As previously mentioned, vegetation should also be used around the ponds to cut down on bank erosion as well.

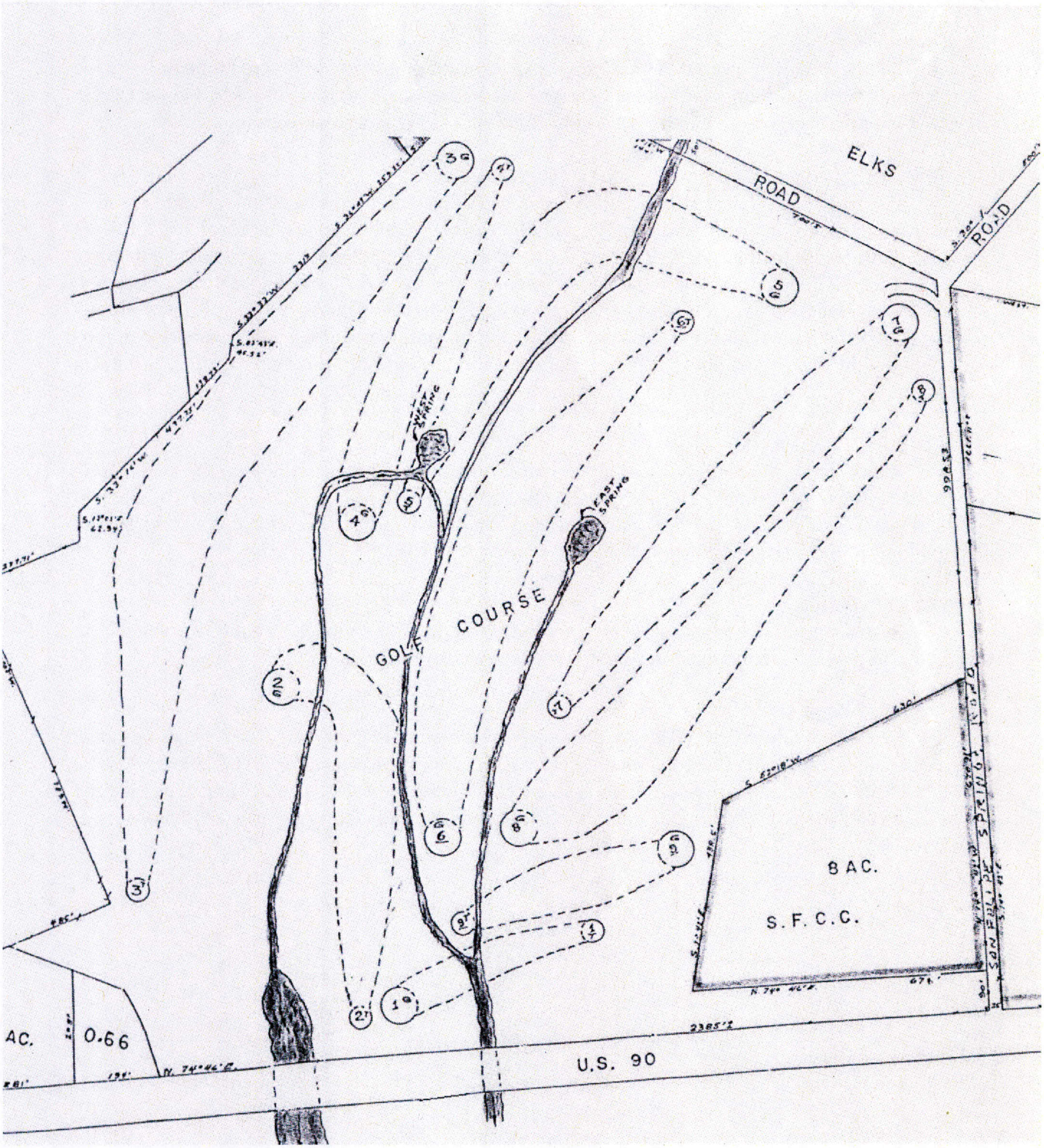
TRANSITION ZONES:

The "transition zones" of habitat (or "edges" where maintained areas meet natural ones) are managed as "soft edges" with gradually increasing heights of vegetation. This maximizes the beauty of the golf course as well as the biodiversity of these areas. These transition zones are the outer edges of the No-Mow Zones along the creek corridor and along property boundary fences (See map)

SIGNATURES

/s/ September 25, 2003	/s/ September 25, 2003
William D. Fritsch, President, San Felipe Country Club	Andy Dayton Golf Course Superintendent & Golf Pro

Map of San Felipe Country Club.



Appendix D

Comments on the Draft Recovery Plan and Responses

D.1 Public Review

A draft of this recovery plan was published and distributed for review by all interested parties. The Service published a notice in the Federal Register on February 23, 2005 (70 FR 8818-8819) that the document was available for public review and comment. The comment period lasted for 45 days and closed on April 11, 2005. We posted an electronic version of the draft recovery plan on the website of Region 2 of the Service. In addition, we also posted a fact sheet, questions and answers document, and a press release on the website that were available for review. We sent out by regular mail over 230 post cards to interested parties announcing the availability of the document. We distributed the press release to local news organizations. We mailed out several hard copies of the plan as requests were received.

D.2 Peer Review

Before the draft recovery plan was available, we asked seven individuals to serve as peer reviewers of the document. All agreed to participate, but five actually provided comments. The qualifications of the five peer reviewers and the requested focus of their review are provided in Table D-1.

Table D-1. Peer reviewers of the draft Devils River Minnow Recovery Plan.

Peer Reviewer	Qualifications	Focus of Review
Dr. Paul Holden	BIO-WEST, Inc., environmental consultants, Logan, Utah; long-time leader in research and conservation of western fishes; has served on many other recovery teams for aquatic species	Biology, Ecology, Recovery Strategy
Dr. Edith Marsh-Matthews	Assistant Curator of Fishes, Sam Noble Oklahoma Museum of Natural History, University of Oklahoma; Research biologist in stream ecology of freshwater fishes	Biology and Ecology
Dr. Tim Bonner	Assistant Professor, Department of Biology, Texas State University at San Marcos, research fisheries biologist	Biology and Ecology
Mr. Myron Hess, Esq.	National Wildlife Federation; attorney and policy specialist for water conservation in Texas; Project Partner, Texas Water Matters	Recovery Strategy, Water Planning
Mr. Tully Shahan, Esq.	Kinney County Attorney; member of Plateau Regional Water Planning Group; landowner on Pinto Creek; Director, West Nueces-Las Moras Soil and Water Conservation District; member, Texas Water Conservation Implementation Task Force	Implementation of Recovery Tasks

D.3 Public Comments Received

We received 10 responses during the comment period from interested parties. Of these, six provided substantive comments for which responses are included in the final recovery plan. The remaining four made no specific suggestion for changes to the draft plan. Of these four, three indicated support for recovery of the species, and one stated the Devils River minnow should be removed from the threatened species list.

D.4 Responses to Comments

Some comments were provided that were outside of the scope of the recovery planning process. For instance, some suggested changes in the listing status of the species (either to remove from the list or to list as endangered) or encouraged the Service to enforce other provisions of the ESA. Many suggested editorial changes to the text of the recovery plan, and the final recovery plan has been revised to incorporate many of these suggestions. The remaining substantive comments were taken into consideration in this final version of the Recovery Plan, and specific responses are provided below. Several of the comments were similar in nature and were combined and summarized for brevity. Comments are arranged into four categories based on the related topics of the comments: data quality, threats, recovery strategy, and recovery implementation.

D.4.1 Data Quality

D.4.1.1 *Comment:* The call in the Draft Recovery Plan for many studies points out the general lack of scientific information available on which to base this Recovery Plan.
Response: There are considerable knowledge gaps about the Devils River minnow and its conservation needs. Our mandate under the Endangered Species Act is to use the best available science to implement the programs for conservation of threatened and endangered species. While there is still much to be learned that will assist us to better manage the Devils River minnow, the basic threats to the species (water quantity, water quality, and non-native species) and general conservation needs (natural flows, clean water, and no non-native species) are obvious. Additional studies to fine-tune our understanding of the species and how it relates to its environment will allow us to better manage for its long-term survival.

D.4.1.2 *Comment:* With more sampling, Sycamore Creek may yield more fish (and at Mud Creek), and you may be pleasantly surprised by their abundance similar to recent findings at Pinto Creek.
Response: We agree that additional sampling in upstream areas of Sycamore and Mud creeks may find extant populations of Devils River minnow. The Recovery Plan calls for range-wide monitoring for the species to determine its status in locations such as this.

D.4.1.3 *Comment:* Clarify that much of the historic sampling was fairly limited in both time and samples; so as not to mislead readers on the amount of existing knowledge of the species.
Response: Changes were made to the Recovery Plan, Section 1.4, to more accurately reflect the historic efforts for sampling the species.

D.4.1.4 *Comment:* Research is needed on the specific tolerances and effects of various contaminants or water quality conditions on both individuals of Devils River minnows and on populations of the species (RA 1.3.2). It is unclear whether the Plan can assure that water pollutants can be curtailed to further minnow recovery.
Response: We agree that the research requested is needed to better understand how aquatic contaminants and water quality affect Devils River minnow. The Recovery Plan lays out a strategy for long-term conservation of the species by recommending actions that address the threats to the species. While there is no assurance that these actions will be taken, we believe that water pollutants can be controlled within the range of the species, depending on the willingness of local land and water managers (both rural and urban) to engage in watershed management practices that will maintain high quality groundwater and surface water. TCEQ has active programs aimed at protecting water from pollutants.

D.4.2 Threats

D.4.2.1 *Comment:* Brush encroachment across the watershed has also contributed to reduced spring flows. One way to enhance stream flow would be to eradicate some invasive cedar, willow, and mesquite forests in the watershed and along the Devils River itself.
Response: We support land management practices that strive for healthy, native vegetation communities across watersheds. We realize that healthy watersheds will produce natural hydrology for aquatic environments and conserve habitats for native aquatic organisms, like the Devils River minnow. We believe brush control projects must be well-planned and part of larger efforts to restore watersheds to support native natural resources. We have added language to the Plan in sections 1.7.1.2 (regarding threats to habitat) and 2.4 (Recovery Action 1.4.2, regarding watershed management).

D.4.2.2 *Comment:* TPWD introduced the smallmouth bass that decimated the Devils River minnow in many areas. The plan should disclose whether smallmouth bass are still being stocked by TPWD and whether other actions by this agency - especially those financed with Federal funds - are contributing to the harm of the Devils River minnow caused by smallmouth bass and other non-native fish.
Response: TPWD only stocked smallmouth bass into Amistad Reservoir in the early 1980s and have not stocked the species since that time. It is not known how the species traversed Dolan Falls and became established in the upper reaches of the Devils River. TPWD (or any other agency) does not stock any species considered to be harmful to the Devils River minnow. In addition, outdoor laboratory experiments and field studies have not provided evidence that smallmouth bass are particularly effective predators on Devils River minnow. It is still uncertain what effect smallmouth bass have on Devils River minnow.

D.4.2.3 *Comment:* No place can it be proved that the Devils River ran or is running from Beaver Lake to the confluence. Historic collections of Devils River minnows from this area were probably during intermittent stream flow. For all practical purposes, the Devils River begins at Pecan Springs.
Response: We agree that the Devils River begins at Pecan Springs. We appreciate the insight of comments from local landowners that shed light on the historical condition of area streams.

However, there is no empirical data to determine the historic extent of stream flows upstream of Pecan Springs. We do know that Devils River minnow were collected in the 1970s from Beaver Lake, well upstream of Pecan Springs. While this reach may have been flowing only temporarily, it would have likely had to sustain flows for considerable time for the species to be collected there. This suggests the range of the Devils River minnow was once farther upstream than it is today. Past time periods of drought and flooding have undoubtedly affected the extent of the flowing portion of the Devils River and the range of the Devils River minnow. This is part of the natural dynamic character of the river and the natural hydrologic regime for which the native fish community is adapted.

D.4.2.4 *Comment:* How do we know that areas dewatered are natural or not? Habitat and spring flow reductions are not the problem at this time, instead other threats may be of more importance. Information on the relationship between Devils River minnow and flow reduction is weak.
Response: Streams becoming dewatered in some areas are certainly a natural part of a natural hydrologic process resulting from droughts. In addition, most of the streams do not have adequate historic gauge records to conclusively determine a natural flow record and correlation to human-caused effects on flows. However, the fishes (and freshwater mussels in Las Moras Creek, see Howells [2003]) that once inhabited streams like Las Moras Creek would not have been able to survive dewatering, had it occurred as a natural phenomenon in the past. In addition, during prehistoric times if the fish were lost from a particular stream reach, there would likely have been opportunities for recolonization from other populations. This is very unlikely in present-day situation due to the fragmented habitat from dams. We know that drought does contribute to declining stream flow, however, groundwater pumping in excess of recharge also can contribute to declining spring flows and dewatering of otherwise perennial streams (Brune 1981). We do not know the specific effects of decreasing stream flows on the abundance of Devils River minnow. However, we are certain that if streams are dewatered, the species will not survive and is very unlikely to be naturally repopulated because their range is fragmented by dams. Other threats, such as water quality and non-native species, may be more important in affecting the species today. But the threat of complete dewatering of habitats is the most likely threat to result in complete loss of the species in the future.

Even natural events, such as droughts that lead to habitat loss, are considered in threatened and endangered species conservation. Often the effects of natural events on biological communities have a more serious effect on populations of rare species when coupled with other human-caused threats. For example, the effects of drought on spring flows may be much more detrimental when groundwater withdrawal for human needs is increased at the same time as the decrease in precipitation.

D.4.2.5 *Comment:* One landowner stated that he had observed obvious decrease of spring flow into Pinto Creek when irrigation wells in the Pinto Valley were pumping, indicating that any further groundwater withdrawal will have a direct, adverse impact on spring flows necessary to maintain adequate flows in Pinto Creek to support the Devils River minnow.
Response: The Service agrees that groundwater pumping can have direct effects on the quantity of spring flows and this activity is a considerable concern to the maintenance of Devils River minnow habitat.

D.4.2.6 *Comment:* The Service should consider whether minnow collection has factored in diminished populations in the wild.
Response: We do not believe that collection of Devils River minnow for scientific research and recovery purposes is a threat to the species. The number of individuals taken from the wild is a relatively small number. The Service limits researchers with valid recovery permits to a certain small number of voucher specimens they can remove from the wild during collection activities.

D.4.2.7 *Comment:* Add the Service as a responsible party for Recovery Actions #1.4.2 and #1.4.3. The Service has enforcement responsibilities under the ESA that are far broader than waiting until the dead bodies of the species are found before enforcement action is initiated. The Recovery Plan is one tool to exercise the Service's ESA authorities.
Response: We have added the Service as a responsible party for these two actions. The Recovery Plan does not, of itself, provided any enforcement responsibilities under the ESA. The Service can and will participate in proactive recovery efforts when our involvement is requested by State or local entities and our resources allow. Enforcement responsibilities of the Service would only be for projects involving a Federal action (ESA section 7 interagency consultation could occur) or where take of the species could occur (ESA section 9 prohibitions).

D.4.3 Recovery Strategy

D.4.3.1 *Comment:* The Recovery Plan is too vague and lacks descriptions of precise actions to be taken. For example, "restoring stream conditions," and "reducing pollutants," and "ensuring in-stream flows" are not sufficient to determine the actions needed to be accomplished for recovery. The Plan fails to adequately address these threats individually or cumulatively.
Response: The Recovery Plan is intended to be as specific as possible based on the best available science. Section 2.5, Control of Threats, is intended to explain how the specific recovery actions proposed in the plan relate to the recovery goals and criteria to reduce the threats to the species. In addition, Section 3.3, Implementation Schedule, includes a column that relates every proposed recovery action to a recovery criterion and one of the five listing factors that describe threats to the species. However, it is a challenge to prescribe detailed recovery actions when the exact remedies for the threats are not fully known. For example, we know that streams in urban environments are likely to become polluted and that human pollutants are destructive to natural aquatic environments. However, we do not know the intensity of water quality pollutants or their effects on the Devils River minnow because the data have not been collected. So in the absence of definite knowledge, we suggest the studies needed to better define these kinds of threats and general actions to reduce them. Any actions that serve to improve water quality would be helpful to alleviate this threat. Similarly, any actions that serve to maintain natural stream flows and protect aquatic habitats would be beneficial to the species' conservation.

The plan is intentionally broad in areas where we acknowledge uncertainty to allow flexibility for future work to determine what specific actions need to be taken to benefit the species. The Recovery Strategy (Section 2.2) outlines a perspective of adaptive management to adjust the strategy as additional information is gained (Section 2.2.7, Apply Adaptive Management). The implementation of many of the recovery actions designed to study the Devils River minnow and the threats to its existence, will continue to build on the foundation of science to construct new and creative ways to conserve the species and its ecosystem. We believe the plan's flexibility is actually beneficial by making it a living document that can integrate future novel conservation methods among potential partners in recovery implementation.

D.4.3.2 *Comment:* The recovery strategy is too general and proposes everything you would ever want to know about a species. Instead, the plan needs to focus on the limiting factors and correcting them. These factors broadly include loss of habitat, generally stream flow, and loss of recruitment.
Response: We believe it is prudent to take a broad approach to the recovery strategy when there is considerable uncertainty regarding the species and its habitats. While the broad factors limiting the population are known, the detailed specific needs for recovery can not be predicted without first conducting the scientific studies upon which to base management recommendations. It would not be prudent to eliminate the recommendation for much additional scientific investigation without a higher degree of certainty about the limiting factors for the species. Instead, we have attempted to focus on the highest priority needs through ranking the recovery actions in a logical fashion. This is intended to emphasize those actions, including identifying and correcting limiting factors and reducing the most imminent threats.

D.4.3.3 *Comment:* Recovery Criterion 3, regarding protection of water quality, seems unduly narrow to focus only on surface water. The need for protection of groundwater quality should be included as well.
Response: We concur, and changes were made to the plan accordingly. The protection of groundwater quality in formations that support stream flows in the range of the Devils River minnow is also an important consideration in the overall conservation of habitat for the species.

D.4.3.4 *Comment:* A very intense monitoring program, monthly or at least seasonally rather than annually, is needed—both monitoring Devils River minnow and potential limiting factors, such as stream flow, water quality, etc. Suggest raising Recovery Action 1.1.1 up to priority level 1a.
Response: We agree that more work needs to be done to better monitor the species and determine population relationships to the physical environment. However, these efforts are limited by the availability of resources to conduct such monitoring and detailed studies. The information we have regarding the Devils River minnow has largely been obtained through ongoing efforts by the TPWD and small Federal and private grant funding. Ideally, future habitat use studies will produce the necessary information to allow more precise recovery criteria and actions to be proposed. Very little information is available on the early life history, recruitment, and survivorship of the species in the wild. We agree this information could prove to be critical in the strategy for recovery of the fish. Monitoring is a critically important part of the recovery, however, it does not meet the definition of a priority task of 1a, therefore, the current priority of 1b was maintained.

D.4.3.5 *Comment:* The Plan needs a strong commitment to understand recruitment and the factors that limit recruitment. Much of 1.2, Biological and Life History Requirements, should be replaced by determining population level limiting factors. Suggest raising Recovery Actions 1.2.4 up to priority level 1a.
Response: We agree that investigations into limiting factors and, specifically, recruitment strategies of the fish, are important endeavors and may lead to better management options. In

response to this comment we have raised Recovery Action 1.2.4 from priority level 3 to 2. We do not believe it meets the definition of a priority 1a or 1b action. It would be premature at this time to eliminate the other recovery tasks for basic biological research. These actions are considered a lower priority and we agree that other actions should be completed first.

D.4.3.6 *Comment:* The plan understates the potential for the Kinney County Groundwater Conservation District to contribute to protection of the Devils River minnow.
Response: We concur and changes were made to the Plan to incorporate language that reflects the groundwater management authority of the Kinney County Groundwater Conservation District. We believe it is through cooperation of the District and other local entities that habitats for the Devils River minnow can be conserved.

D.4.3.7 *Comment:* Why were there no water users on the recovery team?
Response: The Rio Grande Fishes Recovery Team oversees recovery planning for seven listed fish species in New Mexico and Texas. Therefore, the Team covers a wide range of areas and interests and it is not feasible to have stakeholders from each different area participate directly as Team members. However, the Team does seek consultants from a wide range of interests from Federal and state agencies and private interests. Input from individual stakeholders was sought early in the process for recovery planning for the Devils River minnow from those who participated in the Devils River Minnow Conservation Agreement. These stakeholders included landowner representatives from Val Verde and Kinney counties and the City of Del Rio. The Service is committed to working collaboratively to build partnerships for the implementation of this recovery plan and does not limit these partnerships to Recovery Team members.

D.4.3.8 *Comment:* Suggest we leave Mexico out of the equation. Let their scientists prepare separate reports and findings using their money.
Response: The Service does not have any regulatory responsibilities for the Devils River minnow in Mexico. However, we must use sound conservation biology principles in our approach to ensuring the species does not go extinct. We feel it is important to plan for future research of the populations of the fish in Mexico and recognize the potential need for conservation of the fish there. We envision this will include working cooperatively with colleagues in Mexico and encouraging partners in Mexico to work on conservation of the species there.

D.4.4 Recovery Implementation

D.4.4.1 *Comment:* Reintroduction into Las Moras Creek seems rather far reaching unless you find a way to keep the spring flowing. Las Moras Spring ceased flowing in the 1980s also. There is uncertainty about whether chlorination of the swimming pool led to the loss of Devils River minnow or whether it was due to lack of spring flow. Withdrawal of groundwater will continue to influence Las Moras Spring flow. Discussion is occurring about exporting thousands of acre-feet of water from the supporting aquifer.
Response: We agree that to restore the Devils River minnow into Las Moras Creek long-term, we must have some assurance that local groundwater management is in place to ensure that the spring that supports the creek will remain flowing. The Recovery Plan anticipates that the Kinney County Groundwater Conservation District will implement groundwater conservation

plans to accomplish this important recovery strategy in Kinney County for Las Moras Creek. We agree that the loss of the fish from Las Moras Creek may have been due to the loss of flows from the spring. However, chlorine is harmful to aquatic life, and large, repeated input of chlorine into Las Moras Creek is not recommended for water quality maintenance.

D.4.4.2 *Comment:* Establishing additional Devils River minnow populations depend on numerous factors and may not be feasible. The goal is worth pursuing because efforts to reestablish populations will result in improved habitat for all fishes in the target streams. Preservation of genetic diversity through protection of all known populations will be essential for reintroduction (if feasible).
Response: We agree this aspect of the Recovery Plan to establish a new population at Las Moras Creek will be particularly challenging. But based on the best available information we believe it is a necessary action to ensure the long-term viability of the species. We also agree that, in the absence of genetic data and because the few existing populations are small, isolated with localized threats, and vulnerable to loss from random events (for example, droughts, floods, or diseases), we should continue to conserve all known populations of the Devils River minnow.

D.4.4.3 *Comment:* Concerned about funding the project (for restoration of Devils River minnow to Las Moras Creek) on a local basis. Taxpayers of Kinney County would not have the funds or be in favor of this issue. The cost of reestablishing Devils River minnow habitat (channel modification) is not mentioned in the Plan. Reestablishment will stop development and drive up cost of building due to need for Environmental Impact Statements and permits.
Response: Reestablishing Devils River minnow in Las Moras Creek is an important goal of the Recovery Plan. The species has such a restricted natural range, which is now reduced and fragmented, that restoring this population is important to ensuring the species long-term viability. The more populations we can conserve, the lower the overall risk of extinction of the species. However, we are not certain that such an effort is feasible, either biologically, because the species might not persist there if reintroduced, or practically, local support would not be in favor of such a project. The Service would not carry out such a project without the full support of state and local governmental authorities. In addition, any costs associated with this project would most likely be born by Federal and state agencies. Local taxpayers would not be required to pay for such a project, although voluntary cost-sharing by providing in-kind services from a nonfederal entity is a possibility. If the fish were proposed for reintroduction, it would likely be through a program of the Fish and Wildlife Service that reduced the potential for regulatory burdens on the local community. For example, we may be able to implement a Safe Harbor Agreement or designate the population as nonessential, experimental under section 10(j) of the ESA.

D.4.4.4 *Comment:* Many measures depend on non-federal, voluntary actions and there are no assurances these steps will actually be taken. The plan should disclose whether Federal agency actions or the use of Federal funds (for example, Corps of Engineers' permitting) are contributing to the imperilment of minnows via lowered instream flows or lower water quality.
Response: We are not aware of any Federal actions or funds that are contributing to the threats to Devils River minnow at this time. It is true that the recovery of this species is largely dependent upon the voluntary actions of local entities to accomplish recovery. While there is no assurance that voluntary actions will be taken, recovery for the species is not mandated by the ESA and is dependent on voluntary participation of various stakeholders. With the appropriate coordination

and communication, we believe that recovery can be achieved through the voluntary actions of our partners. The Service has a variety of programs available to assist State agencies and local communities achieve recovery successes, including funding grants, technical support and local agreements.

D.4.4.5 *Comment:* Suggest the Service establish temporary, minimum spring flow amounts for each stream that is inhabited by the Devils River minnow, below which "take" of the species or irreparable destruction of critical habitat will likely occur.
Response: Adequate biological and hydrological information is not available upon which to base specific flow recommendations for the conservation of the species. The Service recognizes that more information is needed to make management recommendations for instream flows and Recovery Actions under heading "1.3 Identify specific habitat preferences," in the Recovery Action Outline, are intended to collect just such information. Critical habitat is not designated for the Devils River minnow.

D.4.4.6 *Comment:* The Plan backs away from recommending prohibition on the release of exotics in minnow streams because they would be "impractical." This could lead to the extinction of the minnow. Another commenter indicated uncertainty about whether bait fish released on fishing trips has affected the environment, but indicated it is a consideration.
Response: We agree that bait fish released into Devils River minnow habitat are a concern. However, we believe the regulations TPWD have put in place are a reasonable attempt to control this threat. Only selected non-native species are allowed for legal use as live bait. These species have been used in this area for decades and have not shown to be a detriment to the natural environment.

D.4.4.7 *Comment:* The 10-year timeframe for recovery is overly optimistic.
Response: In estimating the time needed for recovery, we make the most optimistic estimate assuming resources will be available and partners will be willing to cooperate in the implementation of the Recovery Plan. Obviously without adequate funding and assistance from partners, recovery will take longer. Since we do not know when these will be available, we give the most optimistic timeframe that recovery would be possible if these resources were available to implement the plan as outlined.

D.4.4.8 *Comment:* Increase in the number of Devils River minnows collected in the Devils River over the last 5 years proves that cooperation between USFWS, TPWD and landowners can be compatible and accomplish goals.
Response: We agree that collaboration and cooperation are the key factors in the future success of conserving the natural environment and recovering the Devils River minnow.