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EXECUTIVE SUMMARY

Leon Creek is an important drainage system on the western side of San Antonio in Bexar County Texas. There are an estimated 4,360 structures located what is commonly referred to as the 500-year floodplain also referred to as the 0.2% annual exceedance probability. The flood risk along Leon Creek is generally associated with infrequent, high-intensity rainfall events that result in extremely rapid but relatively short-duration flood peaks associated with high velocity stream flows. In May 2013, rainfall amounts of 10 inches to 15 inches were received in the upper portions of the Leon Creek watershed in somewhat just over 12 hours. Runoff from this event created a peak flood elevation at the Leon Creek/I-35 gage of 27 feet, more than 12 feet over flood stage. Leon Creek inundated the jet engine test facility at Port San Antonio, a large industrial complex at the site of the former Kelly Air Force Base, with almost seven feet of floodwater. Flood damages within the watershed are estimated at approximately \$13,523,000 annually (2012 dollars).

The Feasibility Study and Environmental Assessment for Leon Creek examined an array of alternatives to reduce flood risks. Consideration was initially given to additional measures for ecosystem restoration and recreation as ancillary to flood risk reduction; however, no nationally significant or economically justified National Ecosystem Restoration (NER) or recreation measures were identified, and no ecosystem restoration or recreation components are included in the Recommended Plan.

The Recommended Plan provides for construction of a levee designed to protect against the 1% AEP event for the Jet Engine Test Cell located in Area of Interest-2, near the downstream end of the watershed. This feature includes 2,850 linear feet of channelization immediately downstream of the levee to mitigate for slight rises in water surface elevations caused by the levee. The channel work will utilize natural design parameters, including in-channel habitat components, in order to be self-mitigating in terms of aquatic impacts. Twenty acres of riparian vegetation will be installed in conjunction with the natural channel design. The Recommended Plan also includes the permanent evacuation of 4 single-family homes and 32 townhomes located within the 4% AEP floodplain. The Recommended Plan results in a \$2,128,000 reduction in Expected Annual Damages.

The total project cost for the Recommended Plan is estimated at \$28,966,000 and provides total annual net benefits of \$699,000 with a benefit-to-cost ratio of 1.49-to-1. The San Antonio River Authority is identified as the non-Federal sponsor for implementation of the recommended plan. Federal participation in the project is estimated at \$18,827,900 or 65 percent of the total project cost. Non-Federal participation in the project is estimated at \$10,138,100, or 35 percent of the total project cost.

INTRODUCTION

The U.S. Army Corps of Engineers (USACE) was asked by the San Antonio River Authority (SARA) to partner in a Water Resources Planning study for the Leon Creek Watershed in San Antonio and Bexar County, Texas. This draft feasibility report and integrated environmental assessment documents the Feasibility phase of the study initiated to investigate and recommend solutions to water resources problems in the study area.

Section 1 describes the Leon Creek study in terms of the need identified and defines the study purpose and scope as required under the National Environmental Policy Act (NEPA) for a feasibility report with integrated environmental assessment. This section also provides a general description of the study area and concludes with statements regarding governmental authorization for the study and the collaborating Federal, state, and local agencies.

STUDY AUTHORITY

The Leon Creek Feasibility Study is in partial response to the Guadalupe and San Antonio Rivers and Tributaries, Texas, Resolution adopted by the Committee on Transportation and Infrastructure, U.S. House of Representatives, House Resolution docket 2547, 11 March 1998, which reads:

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

STUDY PARTICIPANTS/COLLABORATIVE PLANNING

Engineering Circular 1105-2-409, "Planning in a Collaborative Environment," provides guidance for USACE to follow while conducting feasibility level studies in a collaborative planning environment. The Leon Creek Interim Feasibility Study uses collaborative planning to develop flood damage reduction measures and investigate the potential for ecosystem restoration that would ultimately restore degraded fish and wildlife habitat in the uplands and aquatics, and recharge the Edwards and Trinity Aquifers to provide habitat for up to seven endangered species.

STUDY SCOPE AND PURPOSE

The scope of this Interim Feasibility Study is to: identify problems, needs, and opportunities; develop and evaluate alternatives; select a recommended plan; and provide a feasibility level design of the recommended plan and a feasibility report and integrated environmental assessment. It will serve as a decision document for Congressional Authorization of a project to reduce flood damages within the Leon Creek Watershed located on the west side of the city of San Antonio, Bexar County, Texas. The primary focus of the Leon Creek Interim Feasibility Study is to reduce the risk of flooding within the Leon Creek Watershed.

STUDY NEED

A Guadalupe and San Antonio River Basins, Texas, Section 905(b) Analysis, dated December 2000, demonstrated a Federal Interest and a need to further investigate the water resources problems, needs, and opportunities and to evaluate alternatives to offer flood damage reduction, ecosystem restoration, watershed management and more effective water management in the Leon Creek Watershed.

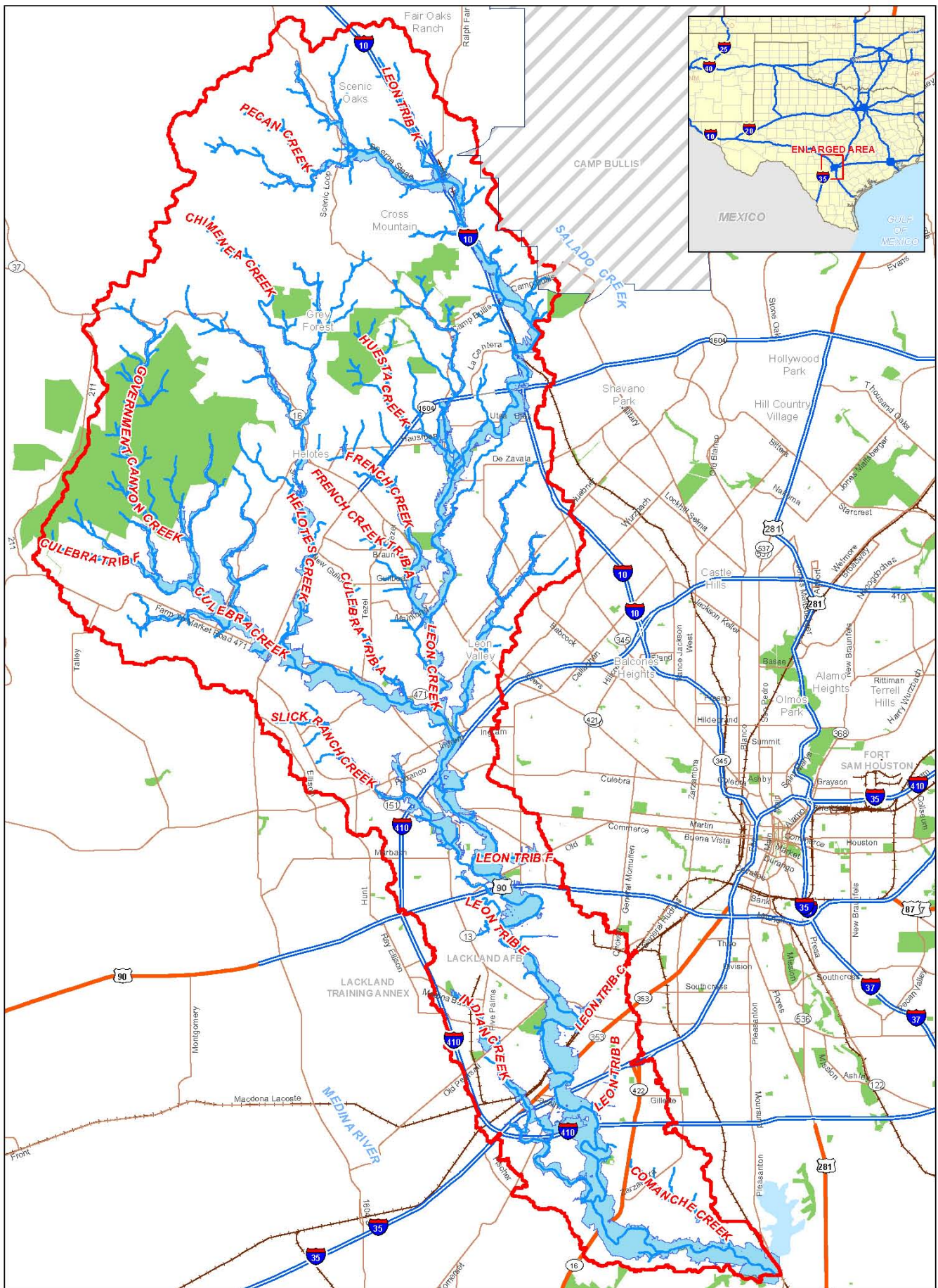
South-Central Texas, including the Leon Creek watershed, is one of the most flood prone areas of the United States (Ockerman, 2009). In October 1998, as much as 30 inches of rain occurred in the area in a two day period. The 1998 flood is believed to be the worst flood event experienced. Thirty-two lives were lost, and property damage was estimated to be \$500 million in the region. Since the October 1998 flash flood, ongoing development in the Leon Creek watershed and, subsequently, an increase in impervious cover have increased the risk of flood damage.

STUDY AREA

Leon Creek watershed is in western Bexar County in the greater San Antonio area. It originates in northwestern Bexar County and runs south-southeast for about 57 miles to its confluence with the Medina River. The drainage area of the Leon Creek watershed is approximately 238 square miles.

The study area includes outcrops of two major aquifers, Trinity and Edwards. Thin, rocky soils and fairly steep slopes characterize both areas. The Edwards Aquifer outcrop generally exhibits greater permeability and infiltration of rainfall than the Trinity Aquifer outcrop. Stream channels within both outcrops lose flow to karst features, such as fractures, sinkholes, and caves. Where it crosses the recharge zone, flow within the channel is relatively infrequent because of the loss of flow that percolates through the channel bottom to recharge the aquifer.

While the entire watershed is the study area, the flood risk management and ecosystem restoration measures are limited to the 0.2% annual exceedance probability (AEP) floodplain of Leon Creek and its tributaries (Figure 1-1). The 0.2% AEP floodplain (often referred to as the “500-year event”) contains approximately 32 square miles.



**US Army Corps
of Engineers**
Fort Worth District

Project: Leon Creek
Project Manager: Nova Robbins
Section: CESWF-PER-P-T
Date: October 19, 2012
Author: Lucas Daniels
Location: \\swf4st1bgs\projects\cwf\jobs\LeonCreek\Documents

**REFERENCE:
ESRI BASE DATASET
USGS NHD DATASET**

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**PROJECTION: NAD 1983
TEXAS SOUTH CENTRAL
STATE PLANE FIPS 4204**

**LEON CREEK
SAN ANTONIO,
TEXAS**

**INTERIM FEASIBILITY
STUDY
FIGURE 1-1.
STUDY AREA**

Legend

- ~~~~~ Streams/Rivers
- Lakes/Reservoirs
- Leon Creek Watershed / Leon Creek Study Area
- 500-Year Floodplain
- Military Installations

Miles

0 1.25 2.5 5 7.5 10



STUDY PARTICIPANTS, COOPERATING AGENCIES, AND CONGRESSIONAL DISTRICTS

USACE conducted this Leon Creek Interim Feasibility Study in cooperation with the San Antonio River Authority (SARA), which is the major non-Federal sponsor.

A number of agencies were asked to participate as cooperating entities in the Leon Creek study (see Appendix H “Correspondence”). USACE has and will continue to coordinate with Federal and State natural resource and other agencies, including the following:

- United States Fish and Wildlife Service (USFWS)
- United States Geological Survey (USGS)
- Natural Resource Conservation Service (NRCS)
- United States Environmental Protection Agency (EPA)
- Federal Aviation Administration (FAA)
- Federal Emergency Management Agency (FEMA)
- Texas Parks and Wildlife Department (TPWD)
- Texas Commission on Environmental Quality (TCEQ)
- State Historic Preservation Officer (SHPO)

The study area lies within the jurisdiction of Texas Congressional Districts 20 and 28, which are represented in the U.S. Congress by the Honorable Charles A. Gonzalez and the Honorable Henry Cuellar, respectively. The U.S. Senators for Texas are the Honorable John Cornyn and the Honorable Ted Cruz.

PRIOR STUDIES AND REPORTS

A number of previously published studies and reports, prepared by USACE (Fort Worth District) and other entities, were used in developing this feasibility report. This section lists the reports and describes their relevance to the Water Resources Planning study for the Leon Creek Watershed.

U.S. Army Corps of Engineers

Guadalupe and San Antonio River Basins, Texas Section 905(b) Analysis. U.S. Army Corps of Engineers, Fort Worth District, December 2000. This report identified potential projects within the Guadalupe and San Antonio River Basins that have a potential Federal interest. Study purposes were to investigate flood risk management, ecosystem restoration, watershed management, and water supply alternatives.

Leon Creek Interim Feasibility Study Alternative Description Report. Half Associates, Inc., June 2009. This alternative evaluation report, prepared under contract to USACE, evaluated preliminary flood risk management alternatives for the Leon Creek Interim Feasibility Study.

Others

Simulation of Streamflow and Water Quality in the Leon Creek Watershed, Bexar County, Texas, 1997-2004. U.S. Geological Survey Scientific Investigations Report, 2009. This report documented the use of the Hydrologic Simulation Program in Fortran (HSPF) model to simulate streamflow and water quality.

Conceptualization and Simulation of the Edwards Aquifer, San Antonio Region, Texas, SIR 2004-5277. U.S. Department of the Interior, U.S. Geological Survey, 2004. This report documented historic recharges into the Edwards Aquifer.

Diffuse-flow Conceptualization and Simulation of the Edwards Aquifer, San Antonio Region, Texas, SIR 2006-5319. U.S. Department of the Interior, U.S. Geological Survey, 2006. This report also documented recharges into the Edwards Aquifer.

Draft Edwards Aquifer Habitat Conservation Plan. Hicks & Company/RECON, March 2005. Prepared for the Edwards Aquifer Authority, this document outlines a habitat conservation plan for the threatened and endangered species associated with the Edwards Aquifer.

Leon Creek Watershed Master Plan Phase I – Final Report. AECOM, September 2008. This report documented the regional watershed planning by the San Antonio River Authority, City of San Antonio, and Bexar County to develop a comprehensive watershed management plan. Phase I of this effort analyzed possible detention alternatives in the Leon Creek Watershed. This report was used to screen detention alternatives that were not economically justified.

South Central Texas Regional Water Plan, Texas Water Development Board. 2011. This report documents the regional water planning to meet future water supply demand for a 21-county area including San Antonio.

Stream and Aquifer Biology of South-Central Texas - A Literature Review, 1973-97. Open File Report 99-243. U.S. Department of the Interior, U.S. Geological Survey, 2000. This report documented the biological resources within the streams and aquifers of Leon Creek.

SECTION TWO

AFFECTED ENVIRONMENT

Section Two establishes a baseline for each of the following resources within the study area; climate; geology, soils, and topography; land use; groundwater; hydrology and hydraulics; terrestrial resources; aquatic resources; threatened and endangered species; cultural resources; hazardous, toxic, and radioactive waste; recreational resources; and other social concerns.

Based on the environment as described, future without-project conditions were projected for the study period of analysis (50 years). The section concludes with descriptions of these “no action” conditions, which will be used as a baseline for measuring the impacts and benefits of alternative plans.

LOCATION AND DESCRIPTION

Leon Creek originates seven miles northeast of Leon Springs in northwestern Bexar County and runs southeast for 57 miles through Leon Valley and the western portion of San Antonio to its mouth on the Medina River, just west of Cassin. The study area encompasses the entire watershed, as shown in Figure 1-1.

At its headwaters, Leon Creek is a small stream with large-grained rocks, boulders, and limestone cliffs typical of a stream in the Edwards Aquifer Recharge Zone. It is a clear-running perennial stream from several springs located in the headwaters. As the creek transverses the Edwards Plateau, it becomes a flood-dominated, ephemeral creek with a few persistent pools, but does not flow most of the year. Upon entering the Texas Blackland Prairie, Leon Creek again becomes perennial and slower moving, supporting aquatic life year round. The channel does not become a wide, deep meandering channel until near its confluence with the Medina River. The Leon Creek Watershed includes several major tributaries including: Culebra Creek, Huebner Creek, French Creek, Slick Ranch Creek, Indian Creek, Helotes Creek, Babcock Tributary, Huesta Creek, and numerous smaller tributaries.

The Leon Creek Watershed is located entirely within the western section of Bexar County, stretching from the county’s northwestern limits to the confluence of Leon Creek with the Medina River southwest of the city of San Antonio. The middle portion of the watershed lies inside the San Antonio city limits and is highly urbanized. This portion of the watershed has experienced extensive ecosystem degradation and flooding as a result of the urbanization. The upper and lower portions of the watershed are in relatively undeveloped areas.

The total drainage area of this watershed is approximately 152,320 acres (238 square miles). The upper half of the Leon Creek watershed averages ten miles in width and the lower half averages four miles. Elevations within the watershed range from 1,900 feet National Geodetic Vertical Datum (NGVD) in the headwaters to 456 feet NGVD at the confluence with the Medina River.

CLIMATE

The study area has a subtropical, subhumid climate characterized by hot summers and mild, dry winters. Average monthly low temperatures range from 38.6° F in January to 74.0° F in July. Heaviest rainfall tends to occur in spring and early summer, and fall. The average annual rainfall is approximately 34 inches per year. Spring is the wettest season, with April and May often the wettest months. Spring thunderstorms generally are caused by successive frontal systems that move across Texas. The hills and associated elevation increases along the Balcones Escarpment assist in the uplift of air masses and formation of storms. Many large thunderstorms form along the escarpment, where they can stall and produce extreme precipitation. The USGS has identified a dozen or more storms during the past 70 years in this area with precipitation depths exceeding 15 inches over a few days. Of the 13 storms recorded worldwide for the greatest depth of precipitation in a single event, two occurred along the Balcones escarpment in the vicinity of the study area. The 1978 storm centered over Medina, Texas produced almost 30 inches of rainfall in 24 hours, while the 1935 storm in D'Hanis produced 22 inches of rainfall in less than 3 hours (Slade and Patton, 2002). More recently, a storm in May of 2013 produced in excess of 15 inches of rain in less than 24 hours within the San Antonio city limits. Two weeks later, a similar storm deposited more than 17 inches of rain in Maverick County and environs over a 36 hour period, an amount just shy of that area's average annual precipitation. (CNN.com)

GEOLOGY, SOILS, AND TOPOGRAPHY

San Antonio and Bexar County are on the boundary between the Gulf Coastal and Great Plains physiographic provinces. Dividing these two provinces in this region of Texas is the Balcones Escarpment, part of the Balcones Fault Zone. The escarpment extends from near Del Rio, Texas, northeast through Bexar County to Austin. Remnants of the escarpment extend as far north as Waco. The Balcones Escarpment rises approximately 1,000 feet above the coastal prairie to the south and east, creating a marked influence on the area's environment. Northwest of the escarpment lies the Edwards Plateau area of the Great Plains Province. Since the plateau's formation, it has eroded, becoming a rugged, hilly region dissected by numerous small streams with elevations ranging from 1,100 to 1,900 feet. Southeast of the escarpment and running along the base lies the Blackland Prairie area of the Gulf Coastal Province, with its gently rolling hills.

The study area lies within the Balcones Fault Zone, which is characterized by numerous parallel and *en echelon* faults, downthrown to the south. The topography is characterized by a gently rolling land surface that slopes southeast toward the Gulf of Mexico. Four predominant geologic formations or groups of formations crop out in the watershed: From north to south according to the San Antonio sheet of the "Geologic Atlas of Texas" (Brown and others, 1983), the surficial rocks primarily are

- (1) Glen Rose Limestone
- (2) Edwards Group undivided

(3) Navarro Group and Marlbrook Marl, Pecan Gap Chalk, and Austin Chalk

(4) Leona Formation and fluvial terrace deposits.

The outcropping Glen Rose Limestone is characterized by shallow, rocky, and clayey soils with relatively low to moderate infiltration capacity based on the Bexar County Soil Survey. The outcropping Edwards Group undivided is characterized by shallow- to moderate-depth clayey soils with relatively high infiltration largely because of faults, sinkholes, and other karst features. The outcropping Navarro Group and Marlbrook Marl, Pecan Gap Chalk, and Austin Chalk are characterized by deep clayey soils with moderate infiltration capacity. The outcropping Leona Formation and fluvial terrace deposits are characterized by deep clayey and sandy loam soils with relatively high infiltration.

Soils

The San Antonio and Bexar County area is composed of several general soil associations. Two major soil associations classified by the United States Department of Agriculture (USDA) occur along Leon Creek. They are the Trinity series found above the Commerce Street Bridge and the Frio series below.

The Trinity series consists of alluvial soils that are deep, dark colored, and nearly level. These soils are on the bottomland in the eastern and southwestern parts of the county. The Frio series consists of limy alluvial soils that are moderately deep, grayish brown or dark grayish brown, and nearly level.

Portions of the Leon Creek watershed contain prime farmland soils as defined by the Farmland Protection Policy Act (FPPA).

Topography

Elevation in the Leon Creek watershed ranges from about 460 to 1,930 feet above sea level. Land slopes generally are steeper in the northern (upstream) part of the watershed than in the southern (downstream) part. Overall, the Leon Creek stream channel slope is about 18 feet per mile. Some stream slopes in the northern part of the watershed (upper Culebra Creek and upper Helotes Creek) are greater than 60 feet per mile.

LAND USE

Land in the northwestern part of the Leon Creek watershed, upstream of Loop 1604 (SH 1604) is largely undeveloped rangeland and juniper and oak forests. It includes the Government Canyon State Natural Area (GCSNA), a roughly 8,600-acre area containing karst features and critical habitat for a number of threatened or endangered species. The lands in the upper northeast portion of the watershed are generally grasslands that have been highly degraded by grazing activities and/or urbanization. Land in the southern part of the watershed below SH-90 to the confluence with the Medina River is largely agricultural and includes Lackland Air Force Base. The central area of the watershed is comprised of relatively intense residential and commercial development. Within the watershed, undeveloped lands are undergoing conversion to suburban residential and commercial land use. The

2010 population in the study area was 340,133, an increase of 43 percent from 2000. Figure 2-1, depicts the land use in the 0.2% AEP in Leon Creek watershed.

AIR QUALITY

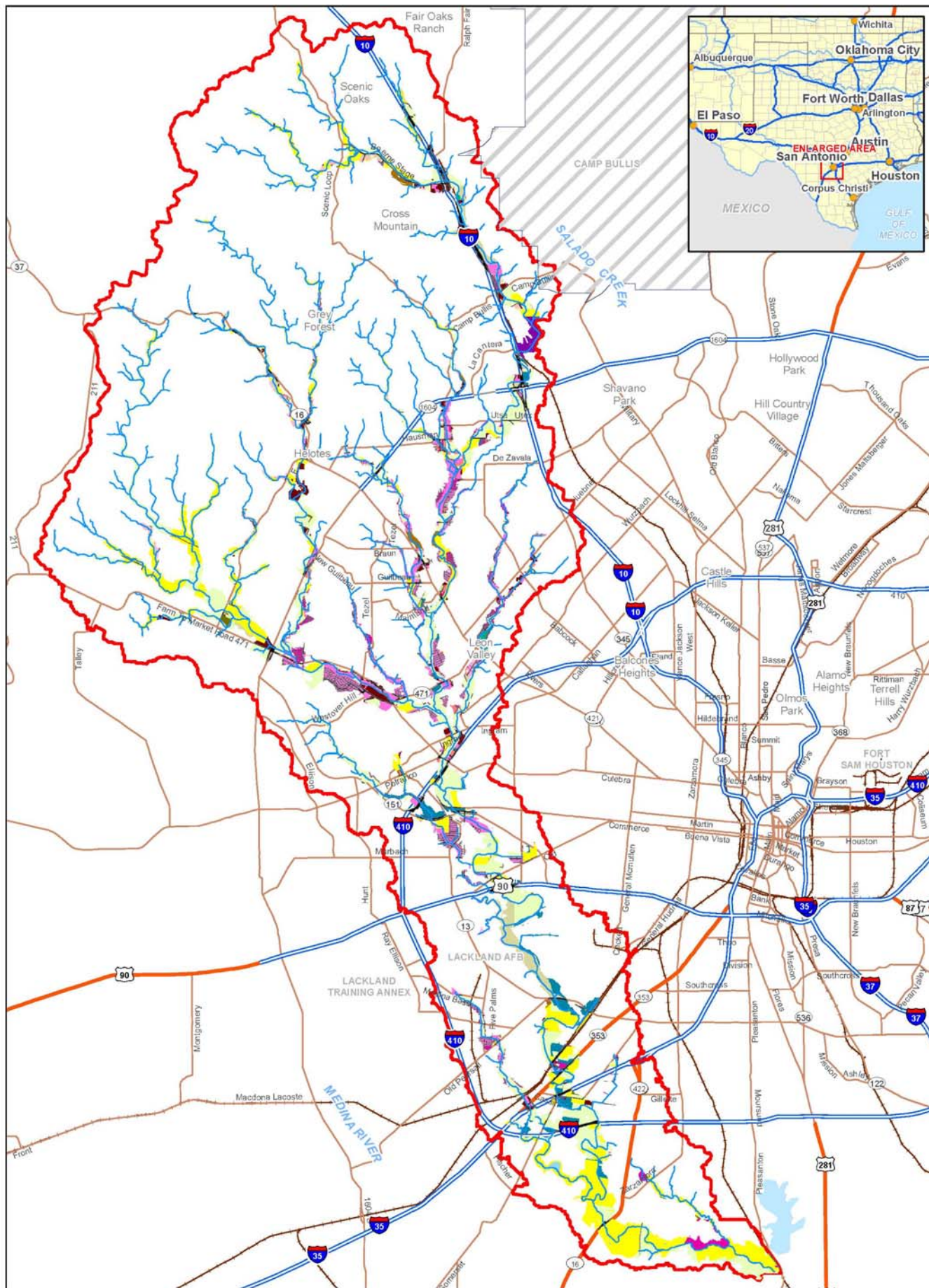
The study area is located in Bexar County, which is currently in attainment or unclassifiable status for all National Ambient Air Quality Standards (NAAQS) criteria pollutants as established and monitored by the EPA.

NOISE

Pursuant to Chapter 21, Article III of the City Municipal Code, maximum permissible noise levels depend on the land use of the property that contains the noise source (e.g., industrial, commercial, or residential) and the land use of the property receiving that noise. Maximum permissible noise levels range from the 63 A-frequency weighted decibels (dBA) in residential zoning districts to 85 dBA in the entertainment zoned districts. Baseline noise levels within the watershed are typical of those found in rural and urbanized areas, as applicable.

GROUNDWATER

Leon Creek contributes recharge to two major aquifers, Trinity and Edwards, as shown in Figure 2-2. The Trinity Aquifer extends in a band through the central part of the State from the Red River to the eastern edge of Bandera and Medina Counties. The Trinity is the primary water source for much of the Texas Hill Country. Most water consumers in northern Bexar, Bandera, Kendall, Comal, and Kerr Counties get their water from the Trinity. All of Bandera County, most of Kerr and Kendall Counties, and large parts of Comal and Bexar Counties serve as drainage or catchment area that recharges the Edwards Aquifer which serves as the primary source of water for the San Antonio metropolitan region. So even though water consumers in the Hill Country use a different aquifer, they are intricately tied to Edwards Aquifer issues, especially with regard to restrictions on development or discharges that could affect the quality of water that ends up as Edwards recharge.



**US Army Corps
of Engineers**
Fort Worth District

Project: Leon Creek
Project Manager: Nova Robbins
Section: CEMF-PER-PT
Date: October 10, 2012
Author: Lucas Daniels
Location: \\swf-fs1\projects\lcv\jobs\LeonCreek\Documents

**REFERENCE:
ESRI BASE DATASET
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PROJECTION: NAD 1983
TEXAS SOUTH CENTRAL
STATE PLANE FIPS 4204

**LEON CREEK
SAN ANTONIO,
TEXAS**

**INTERIM FEASIBILITY
STUDY
FIGURE 2-1.
LAND USE**

- Streams/Rivers
- Lakes/Reservoirs
- Military Installations
- Study Area

- Landuse Classification
- High Density Residential
- Medium Density Residential
- Low Density Residential
- Dispersed Residential

Legend

- Multi-Family Residential
- Commercial
- Urban
- Industrial
- Mining
- Mixed-Use
- Easements
- Utilities
- Transportation
- Cultivated
- Meadow
- Brush
- Woods
- Water

Miles
0 1.25 2.5 5 7.5 10



Edwards Aquifer System

Part of the Leon Creek Watershed lies over the Edwards Aquifer Recharge Zone. The Edwards Aquifer, and its catchment area in the San Antonio region, are approximately 8,000 square miles and include all or part of 13 counties in south-central Texas. The aquifer is a limestone formation associated with the Balcones Fault Zone. The aquifer is divided into three main parts: drainage area, recharge, and artesian zones, as shown in Figure 2-3. The Edwards provides valuable threatened and endangered species habitat. In addition, the Edwards Aquifer is the primary water supply source for the city of San Antonio.

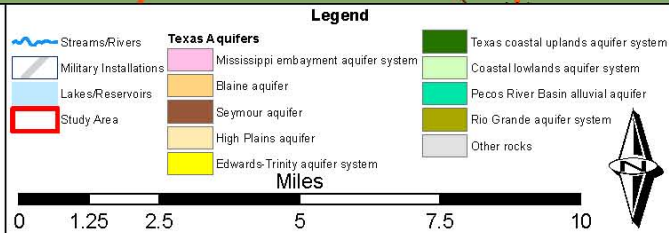
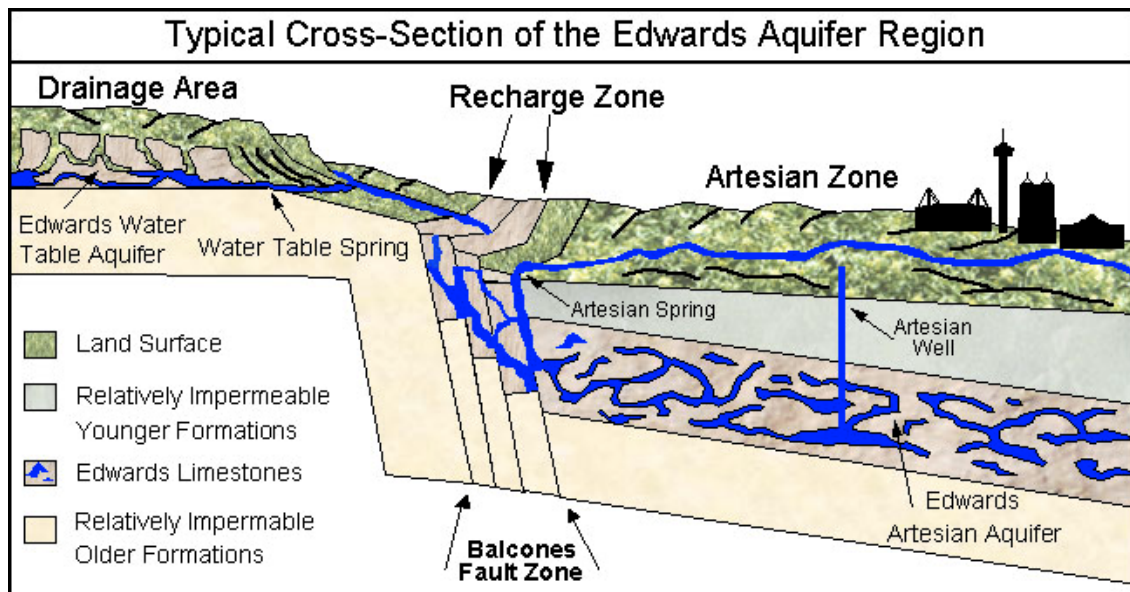


Figure 2-3. Edwards Aquifer Zones

Source: Eckhardt, 2007

Discharge from the aquifer is from both springs and artesian wells. The natural discharge of the aquifer is primarily from five major springs: San Marcos, Comal, Leon, San Antonio, and San Pedro. None of the springs listed above occur in the study area. Generally, the water in the Edwards Aquifer is of high quality. It meets all state standards for groundwater. Water quality of the Edwards Aquifer is affected by many factors, including increased pumping, degraded or polluted water entering the aquifer, non-point and point source pollution, and decreased recharge. Floodwaters entering the Edwards Aquifer normally carry many suspended solids and debris; the transmissivity of the aquifer is low purifying the water in the process. Figure 2-3 displays the aquifer zones of the Edwards.

The Edwards Aquifer is the primary source of groundwater within the study area. It is a Federally-designated sole source aquifer, a source of drinking water for the city of San Antonio. Because it is the sole source aquifer, and there has been increased demand for water supply without increased recharge, a successful lawsuit resulted in pumping restrictions on the Edwards Aquifer. The suit, filed under the Endangered Species Act, cited threats to threatened and endangered species in the Edwards Aquifer and the associated springs.

Trinity Aquifer System

Unlike the Edwards, the Trinity Aquifer recharges very slowly. Only 4–5 percent of water that falls as rain over the area ends up recharging the Aquifer, and water moves through the Trinity much more slowly than through the Edwards. The Trinity contributes a large amount of water as recharge for the Edwards, generally by faults in areas where the layers are juxtaposed by faults or where the Trinity underlies the Edwards. There are actually several aquifers that make up the Trinity system. The Trinity is a group of geologic deposits divided into several distinct formations, and each formation is in turn composed of several layers. In the vicinity of the Leon Creek Watershed, the formation is known as the Glen Rose formation. This formation, which is most familiar to the water users in south central Texas, is composed mainly of limestone which thickens toward the Gulf and is divisible into

upper and lower members. Indications are that the Glen Rose formation of the Trinity Aquifer has been overused in many places.

HYDROLOGY AND HYDRAULICS

Appendix G.1 contains the detailed hydrologic and hydraulic analysis of the study area, including discharges at specific locations within the Leon Creek Watershed. The major tributaries to Leon Creek are: Culebra Creek (82.3 square miles), Huebner Creek (12 square miles), French Creek (11.6 square miles), Slick Ranch Creek (11.5 square miles), and Indian Creek (11 square miles).

The Leon Creek basin does not fit a “typical” watershed shape. The portion of the watershed upstream of Huebner Creek is relatively steep and wide, with an average width of approximately 10 miles and a length of about 32 miles. The portion of the watershed downstream of Huebner Creek is relatively flat and narrow, with an average width of approximately four miles and a length of about 25 miles. Elevations within this watershed range from 1,600 to 456 feet National Geodetic Vertical Datum (NGVD).

Existing Conditions Hydrology

A watershed runoff model was developed using the USACE HEC-Hydrologic Modeling System (HEC-HMS), version 3.0, software. Data preprocessing and parameter generation was done using HEC-GeoHMS. The upstream study limit on each tributary was set at one square mile.

SARA provided a land use raster dataset to assist in developing initial parameters for the hydrologic model. Parameters were further refined using storm reproductions and frequency analyses.

The final product from this analysis was a Peak Discharges Summary table, which lists the 50, 20, 10, 4, 2, 1, 0.4, and 0.2% Annual Exceedance Probability (AEP) discharges for each location required to support the hydraulic analysis. For the complete table of more than 400 discharge locations, see Appendix G.1 “Hydrologic and Hydraulic Analyses.”

Existing Conditions Hydraulics

A standard-step, backwater model was developed using the USACE HEC-River Analysis System (HEC-RAS), version 3.1.2, for Leon Creek and tributaries with a contributing drainage area of at least one square mile. Data preprocessing and initial parameter generation was done using HEC-GeoRAS. To achieve accurate model results suitable for use in evaluating problems and opportunities identified during the plan formulation phase, each stream was modeled independently.

Floodplain Delineation

Water surface elevations were exported from each HEC-RAS model to ESRI ArcMap. HEC-GeoRAS tools were used to delineate the floodplains. The final product from this phase of analysis is a set of flood plain delineations were developed for the 50, 20, 10, 4, 2, 1, 0.4, and 0.2% AEP events for each stream studied.

Existing Conditions Results

Water surface profiles were developed for each stream in the watershed that was studied in detail. From this analysis, significant flood depths were found to occur on several stream reaches with the potential for damaging structures. Streams that were carried forward in to plan formulation are discussed in the next section.

EXISTING CONDITIONS FLOOD RISK MANAGEMENT

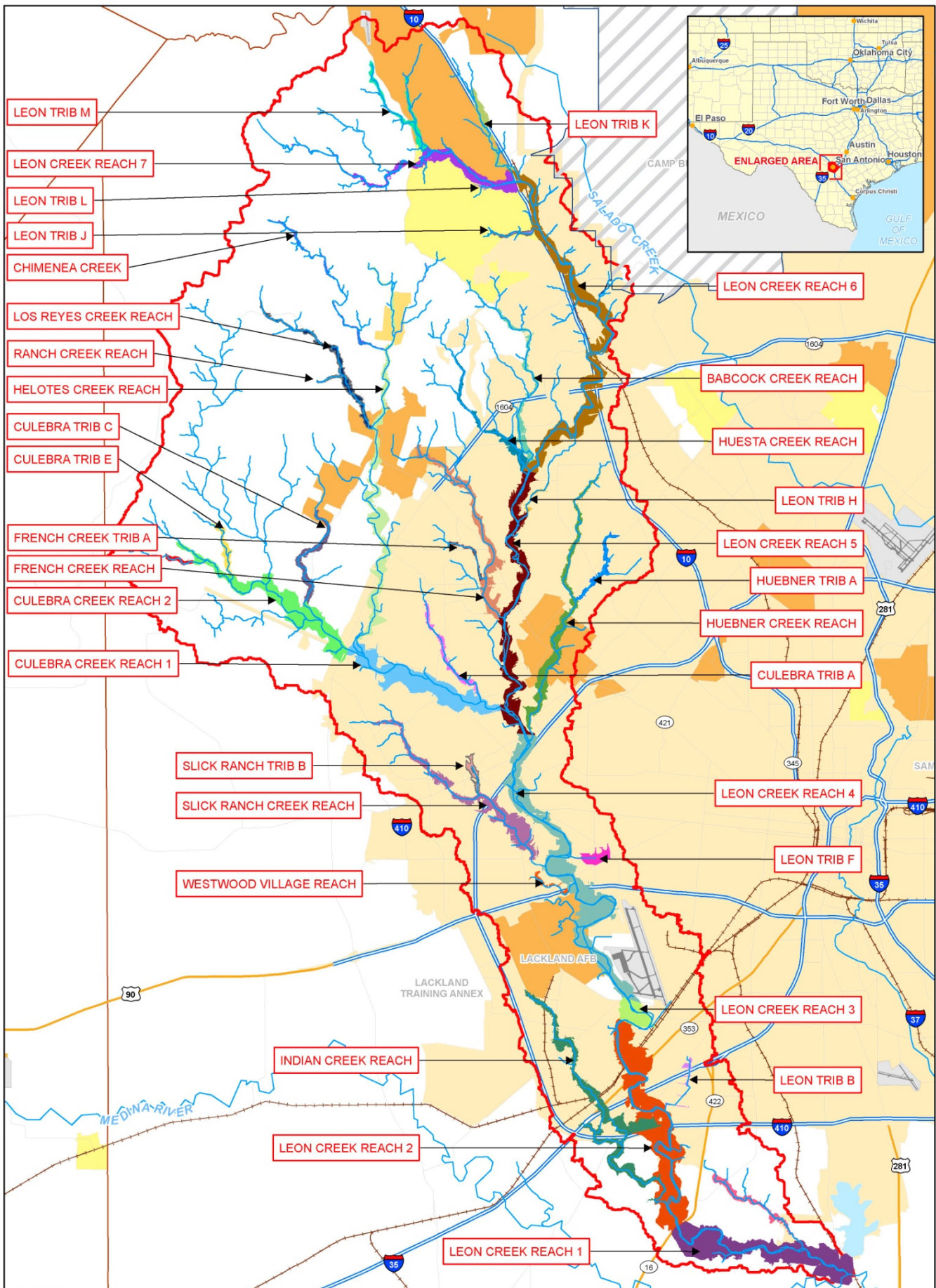
For a detailed socioeconomic flood damage and cost analysis, see Appendix A “Socioeconomics.”


Economic Reaches

Economic reaches were used as the basic framework for analysis of flood risk management alternatives, since both damages and benefits are computed by economic reach. As depicted in Table 2-1, the study area was initially divided into 35 economic damage reaches, based on the locations of confluences of Leon Creek with its tributaries and of major road crossings. Figure 2-4 shows the geographic locations of all 35 reaches

**Table 2-1. Existing Average Annual Damages by Economic Reach
(October 2012 Prices - \$000)**

Reach	Commercial	Multi-Family Residential	Mobile Homes	Public	Privately Owned Vehicles	Single- Family Residential	Total AAD
Babcock Trib	\$4	\$97	\$0	\$4	\$172	\$23	\$300
Chimenea Creek	<1	0	0	0	0	1	2
Culebra Creek R1	165	0	0	2	658	1,521	2,345
Culebra Creek R2	54	0	3	0	21	13	90
Culebra Trib A	0	0	0	0	29	64	93
Culebra Trib C	11	0	<1	0	7	14	32
Culebra Trib E	3	0	0	0	3	12	18
French Creek	123	1	0	10	40	116	290
French Trib A	0	0	0	0	0	<1	<1
Helotes Creek	78	0	0	12	123	315	527
Helotes Trib A	45	0	0	0	<1	2	48
Helotes Trib B	0	0	0	0	<1	<1	1
Huebner Creek	9	20	<1	31	135	323	518
Huebner Trib A	56	0	0	0	18	49	123
Huesta Creek	0	7	4	0	90	26	128
Indian Creek	16	0	0	<1	21	53	90
Leon Creek R1	0	0	1	3	<1	0	5
Leon Creek R2	72	0	96	<1	187	117	472
Leon Creek R3	1,702	0	0	0	0	0	1,702
Leon Creek R4	642	163	<1	120	33	188	1,147
Leon Creek R5	296	220	0	0	306	640	1,461
Leon Creek R6	987	0	3	42	78	70	1,180
Leon Creek R7	38	0	2	2	317	765	1,125
Leon Trib B	0	0	0	0	<1	<1	<1
Leon Trib F	0	0	0	1	41	63	106
Leon Trib H	0	0	0	0	0	<1	<1
Leon Trib J	0	0	0	0	0	<1	<1
Leon Trib K	175	0	0	0	0	0	175
Leon Trib L	0	0	0	0	0	0	0
Leon Trib M	0	0	0	0	0	0	0
Los Reyes Creek	15	0	0	<1	5	9	30
Ranch Creek	0	0	0	0	0	0	0
Slick Ranch	131	34	0	0	220	528	913
SR Trib B	86	<1	0	0	5	2	93
WW Village	3	0	0	0	3	3	9
Total	\$4,710	\$544	\$109	\$226	\$2,515	\$4,918	\$13,021





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Fort Worth District
Project: Leon Creek
Project Manager: Nova Robbins
Section: CESWF-PER-PT
Date: October 19, 2012
Author: Lucas Daniels
Location: \\swf-fs1\fgis\projects\cv\jobs\LeonCreek\Documents\

REFERENCE:
ESRI BASE DATASET
USGS NHD DATASET

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**PROJECTION: NAD 1983
TEXAS SOUTH CENTRAL
STATE PLANE FIPS 4204**

**LEON CREEK
SAN ANTONIO,
TEXAS**


**INTERIM FEASIBILITY
STUDY**

**FIGURE 2-4.
ECONOMIC DAMAGE
REACHES**

Legend

 Streams/Rivers	 Military Installations
 Lakes/Reservoirs	 Study Area

Miles
0 1.25 2.5 5 7.5 10



Based on economic viability, those reaches that warranted further investigation are listed below.

Leon Creek Economic Reaches

- 1** Confluence of Leon Creek with Medina River to downstream of State Highway 16
- 2** Downstream of State Highway 16 to downstream of the Jet Engine Test Cell Facility located at Port San Antonio (formerly Kelly Air Force Base)
- 3** Downstream of the Test Cell Facility to just upstream of SW Military Drive
- 4** Upstream of SW Military Drive to just upstream of confluence with Huebner Creek
- 5** Upstream of confluence with Huebner Creek to upstream of Babcock Road
- 6** Upstream of Babcock Road to upstream of I-10
- 7** Upstream of I-10 to end of study area

Culebra Creek Economic Reaches

- 1** Confluence of Culebra Creek with Leon Creek to downstream of Loop 1604
- 2** Downstream of Loop 1604 to end of study area

Additional Economic Reaches

- 1** Babcock Tributary
- 2** Culebra Creek Tributary A
- 3** Culebra Creek Tributary C
- 4** Culebra Creek Tributary E
- 5** French Creek
- 6** Helotes Creek
- 7** Huebner Creek
- 8** Huebner Creek Tributary A
- 9** Huesta Creek
- 10** Indian Creek
- 11** Leon Creek Tributary F
- 12** Leon Creek Tributary K

13 Los Reyes Creek**14 Slick Ranch Creek.****Value of Floodplain Inventory**

The 0.2% AEP floodplain contains 4,630 structures valued at \$1,157,588,000 using January 2008 price levels. The structures are composed of 3,757 (81.1%) single-family structures, 56 (1.2%) multi-family residential structures, 193 (4.2%) mobile homes, 513 (11%) commercial structures, and 111 (2.4%) public structures. Total valuation of single-family residential structures is estimated at \$812,722,000 (70.2%); for multi-family residential, \$72,029,000 (6.2%); mobile homes, \$4,797,000 (0.4%); commercial structures, \$248,559,000 (21.5%); and public structures, \$19,481,000 (1.7%). There are also an estimated 4,133 privately owned automobiles with a total valuation of \$81,768,000.

Single Event Damages

Economic damages were assessed for the floodplain structures that lie within each reach. The following provides a description of the structure values and privately owned vehicles for each reach in the study area. A detailed table of the specific structure inventory is provided in Table 3-2. Single-event structure damages are depicted in Table A-16 of the Economics Appendix.

Damages in the floodplain begin to accrue with the 50% AEP event involving eight structures and damages estimated at \$63,000, using January 2008 price levels. With the 10% AEP, a total of 408 structures receive damages estimated at \$11.5 million. Single-family residential makes up 45% of the structures and 33% of the damages. Commercial structures account for 28% of total structures and 59% of the damages.

With a 4% AEP event, 846 structures are projected to experience damages totaling \$31.9 million. Of these structures, 52% are single-family residential and 26% commercial. Single-family residential makes up 34% of total damages, while commercial structures account for 58% of total damages.

The 1% AEP event is projected to generate \$97.2 million in damages to 1,971 structures. Seventy-one percent of the structures are single-family residential, which accounts for 37% of the damages. Commercial structures account for 17% of the total structures and 54% of total damages.

In the 0.2% AEP event, 4,629 structures are projected to experience damages totaling \$245.4 million. Eighty-one percent of the structures are single-family residential and 11% are commercial. Single-family residential structures account for 51% of total damages, while commercial structures represent 41% of total damages.

Expected Annual Damages

The overall existing average annual damages (AAD) for the watershed is estimated at \$13,021,000. Single-family residential structures account for 37% of total EAD, commercial structures account for 37%, privately owned vehicles 19%, public structures 2%, multi-family residential structures 4%, and mobile homes about 1%. Table 2-1 shows the EAD for each reach in the study.

TERRESTRIAL RESOURCES

Vegetation

The Leon Creek Watershed is located within three vegetational areas of Texas, as shown in Figure 2-5. This section provides a general description of the two predominant vegetation areas: Blackland Prairies and Edwards Plateau. The third vegetational area (not described), South Texas Plains, comprises less than 1% of the study area.

Blackland Prairies

The Blackland Prairies area located in the central region of Bexar County was historically a large grassy plain. Now, the “prairie” has timber along the streams including a variety of oak (*Quercus* sp.), pecan (*Carya illinoensis*), cedar elm (*Ulmus crassifolia*), and mesquite (*Prosopis glandulosa*).

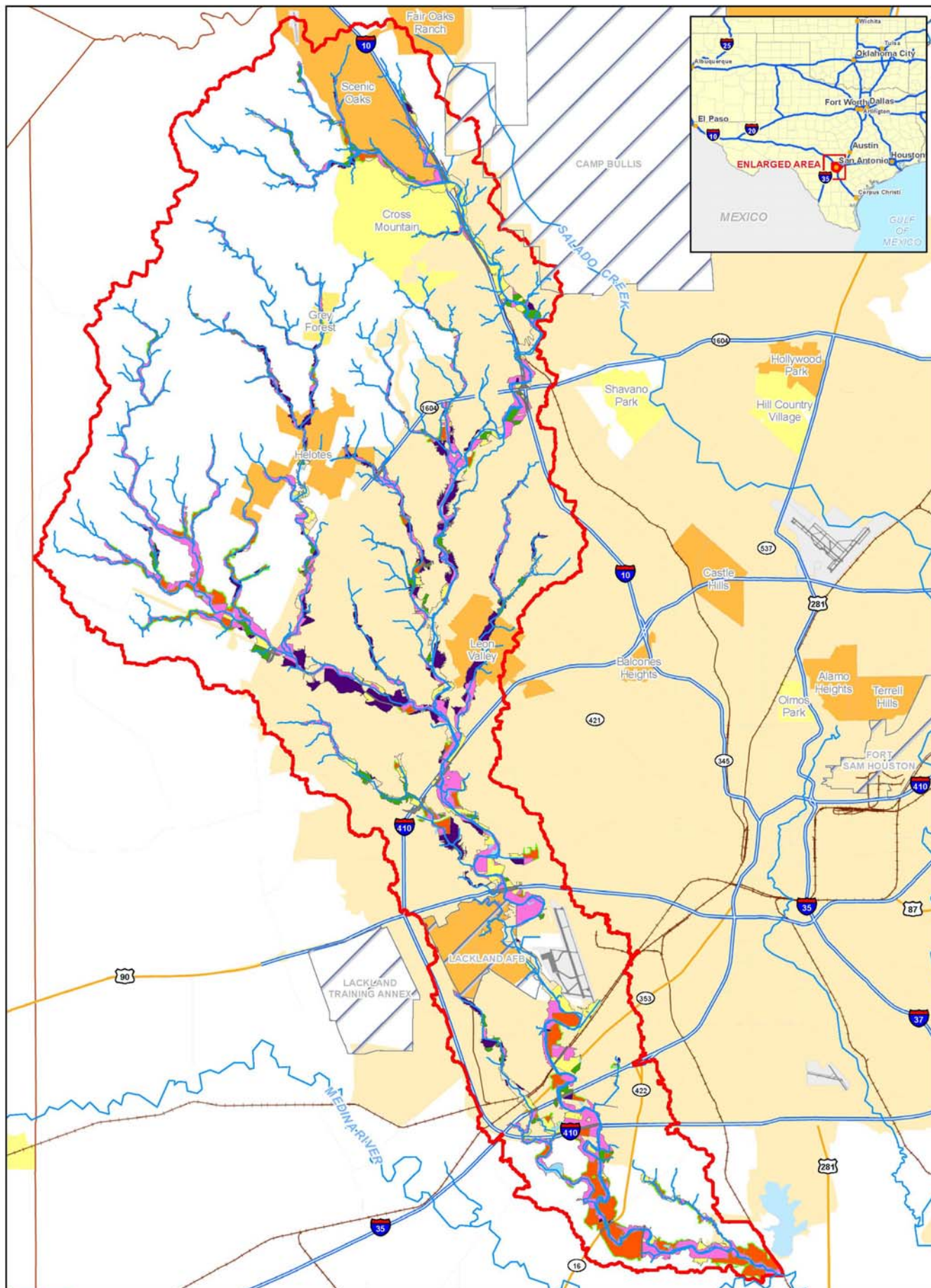
Most of this fertile area has been cultivated, and only small acreages of meadowland remain in original vegetation. In heavily grazed pastures, buffalo grass (*Buchloe dactyloides*), Texas grama (*Bouteloua rigidisetata*), and other less productive grasses have replaced the tall bunchgrasses. Mesquite and other woody plants have invaded the grasslands.

The original grass vegetation included big bluestem (*Andropogon gerardi*), little bluestem (*Schizachyrium scoparium*), Indian grass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), sideoats grama (*Bouteloua curtipendula*), hairy grama (*Bouteloua hirsuta*), tall dropseed (*Sporobolus asper*), Texas winter grass (*Stipa leucotricha*), and buffalo grass. Non-grass vegetation is largely legumes and composites.

Edwards Plateau

In the South Central Texas region, the Edwards Plateau vegetation area includes the northern portions of Bexar County. The soils are shallow, ranging from sands to clays, and are calcareous. This area is predominantly rangeland, with cultivation confined to the deeper soils.

The principal grasses are several species of bluestem (*Schizachyrium* and *Andropogon* spp.), grama (*Bouteloua* spp.), Indian grass (*Sorghastrum nutans*), common curly mesquite (*Hilaria belangeri*), buffalo grass (*Buchloe dactyloides*), and Canadian wild rye (*Elymus canadensis*). The rocky areas support tall or mid grasses with an overstory of live oak (*Quercus virginiana*) and other oaks (*Q. fusiformis*, *Q. buckleyi*, *Q. sinuata* var. *breviloba*), cedar elm (*Ulmus crassifolia*), and mesquite (*Prosopis glandulosa*). The heavy clay soils have a mixture of buffalo grass (*Buchloe dactyloides*), sideoats grama (*Bouteloua curtipendula*), and mesquite (*Prosopis glandulosa*). However, with lack of fire and large-scale landscape management, Ashe juniper (*Juniperus ashei*) has become one of the predominant plants within the Edwards Plateau, as Figure 2-5 entitled “Leon Creek Vegetation Classification” illustrates.



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Fort Worth District
Project: Leon Creek
Project Manager: Nova Robbins
Section: CESWF-PER-PT
Date: October 19, 2012
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**REFERENCE:
ESRI BASE DATASET
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PROJECTION: NAD 1983
TEXAS SOUTH CENTRAL
STATE PLANE FIPS 4204

**LEON CREEK
SAN ANTONIO,
TEXAS**

**INTERIM
FEASIBILITY STUDY
FIGURE 2-5.
VEGETATION
CLASSIFICATION**

Legend

- | | | | |
|----------------------|-------------------|-------------------|-----------|
| Streams/Rivers | Agricultural Land | Roads | Shrubland |
| Lakes/Reservoirs | Commercial | Grassland | Water |
| Military Boundaries | Residential | Riparian Woodland | |
| Leon Creek Watershed | | | |

Miles

0 1.25 2.5 5 7.5 10



Study Area Vegetation

In 2008, vegetation was digitized in the 500-year floodplain within the Leon Creek Watershed, from the headwaters to its confluence with the Medina River, to determine the cover type and acreage of each vegetation classification. The information was ground-truthed by the USACE, USFWS, and TPWD, and a total of seven different types of ground cover were identified for use within this area. Table 2-2 displays those classifications with their respective acreages.

Table 2-2. Vegetation Classification of the Leon Creek 500-Year Floodplain

Vegetation Class	Acreage
Streambed	1,061
Grassland	2,045
Urban	5,600
Agricultural	2,727
Riparian Woodland	9,038
Total	20,471

USACE, USFWS, and TPWD staff visited various sites along Leon Creek from the headwater of Leon Creek to its confluence with the Medina River. During the site visits, native vegetation at the majority of sites was found to be very diverse and dominated by mixed deciduous trees, such as black willow (*Salix nigra*), sycamore (*Platanus occidentalis*), oak (*Quercus spp.*), elm (*Ulmus spp.*), pecan (*Carya illinoensis*), sugarberry (*Celtis laevigata*), Ashe juniper (*Juniperus ashei*), and honey mesquite (*Prosopis glandulosa*). Scrub-shrub type vegetation included lotebush (*Ziziphus obtusifolia*), agarita (*Berberis trifoliata*), buttonbush (*Cephalanthus occidentalis*), Texas Mountain Laurel (*Sophora secundiflora*), and Texas persimmon (*Diospyros texana*). Some of the forbs found on site included: snow on the mountain (*Croton marginatus* and *C. monanthogynus*), and giant ragweed (*Ambrosia trifida*). Grasses observed were buffalo grass (*Buchloe dactyloides*), Virginia wild rye (*Elymus virginicus*), silver bluestem (*Bothriochloa laguroides*), King Ranch bluestem (*B. ischaemum*), little bluestem (*Schizachyrium scoparium*), foxtail (*Cetaria sp.*), sedge (*Carex sp.*), and switchgrass (*P. virgatum*). Flatsedges (*Cyperus erythrorhizos* and *C. pseudovegetus*) were also found (USFWS 2008a). Aquatic vegetation is discussed in the subsection below entitled “Aquatic Habitat.”

The original vegetation within the Upper and Urban Leon Creek, Culebra Creek, and Helotes Creek segments is described as a savanna that was rich in tall and mid-grasses with interspersed clumps of live oak and shin oak. However, overgrazing by livestock and the desire to suppress naturally occurring range fires has promoted a tremendous increase in the abundance of woody species. Such species include Ashe juniper, honey mesquite, huisache, and others that were historically restricted to the steep slopes of canyons, ridges, and ravines where fires could not reach them (Buechner, 1944).

Much of the watershed is still being used for agricultural purposes, such as grazing, row cropping, and hay production. However, a recent increase in population has promoted residential growth throughout much of the area. This development has resulted in clearing of large tracts of land for homes, businesses, and utility lines. A common practice observed is the clearing of brush and understory and leaving stands of oak species. The implications of increased impervious cover and the conversion to

Ashe juniper and other prolific hydrophytic (water-loving) species from native grasslands or savannas is that there is less water infiltration into the soils and more runoff. This results in shorter durations of flows in the creeks, which in turn results in less recharge into the aquifers. In addition, if hydrophytic vegetation gets established, their roots extend to the aquifer and deplete shallow aquifer levels.

The historic vegetation of the Lower Leon Creek segment is rolling to nearly level plains of the Northern Blackland Prairie ecoregion, with mostly fine-textured, dark, calcareous, and productive Vertisol soils. Historical vegetation was dominated by little bluestem, big bluestem, yellow Indian grass, and tall dropseed. Common forbs included asters, prairie bluet, prairie clover, and black-eyed susan. Stream bottoms were often wooded with bur oak, Shumard oak, sugar hackberry, elm, ash, eastern cottonwood, and pecan. Most of the prairie has been converted to cropland, non-native pasture, and expanding urban uses around San Antonio, which is a significant contributing factor to the water quality issues in the basin.

Habitat Value

The vegetation within the study area plays an important role in providing wildlife habitat. To measure the existing condition value of the vegetation as wildlife habitat, USACE, along with TPWD and USFWS, used the Habitat Evaluation Procedures (HEP) developed by the USFWS. Value is measured on a scale of 0.0 to 1.0, with 1.0 being the highest possible value. Appendix B “Ecosystem Evaluation” describes HEP methodologies in detail. Table 2-3 shows the results of the HEP assessment.

Table 2-3. Summary of Existing Habitat Suitability Index (HSI) and Habitat Units (HU) by Environmental Segment

Environ. Segment	Cover Type	Riparian Woodlands			Grassland		
		Acres	HSI	HU	Acres	HSI	HU
Upper Leon		878	0.47	413	408	0.80	326
Urban Leon		2,730	0.33	901	945	0.81	765
Culebra Creek		1,680	0.30	504	229	0.73	167
Helotes Creek		928	0.30	278	117	NA	NA
Lower Leon		2,822	0.32	903	346	0.60	208
Total		9,038		2,999	2,045		1,466

Wildlife

Overall, the Leon Creek Watershed provides good quality wildlife habitat, but some specific areas including GCSNA provide some of the most pristine native habitats in Texas. Wildlife populations within the undeveloped segments of the watershed represent a typical south-central Texas wildlife community. The animals are largely those commonly associated with farming areas. The farms in the watershed are relatively small. The fencerows and roadsides, when vegetation is allowed to grow on

them, provide habitat for birds and smaller mammals. Common types of wildlife found in the area include white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), armadillo (*Dasypus novemcinctus*), cottontail (*Sylvilagus*), jackrabbit (*Lepus*), ringtail (*Bassariscus astutus*), gray fox (*Urocyon cinereoargenteus*), American beaver (*Castor canadensis*), mourning dove (*Zenaida macroura*), wild turkey (*Meleagris gallopavo*), Virginia opossum (*Didelphis virginiana*), and several species of skunk (*Spilogale* spp). Due to urbanization and influences of man, the larger predators, such as the coyote (*Canis latrans*) and bobcat (*Lynx rufus*), have been reduced in numbers from the urban areas. However, they are common in remote areas of the watershed, such as within Camp Bullis Military Base. Various amphibians and reptiles including numerous species of frog (*Rana* spp), toad (*Scaphiopus* spp), turtle (*Chrysemys* spp), lizard, and snake are also found in the creek and the watershed.

Migratory songbirds, such as American robin (*Turdus migratorius*) and cedar waxwing (*Bombycilla cedrorum*), are also commonly found. Over 400 bird species have been observed within the study area, including the State and Federally Listed endangered species mentioned earlier, golden-cheeked warbler (*Setophaga chrysoparia*) and black-capped vireo (*Vireo atricapillus*) (Hawkins et al., 1997). Lack of large-scale suitable habitat for migratory waterfowl and shorebirds indicates that the area does not represent a major migratory stopping point. However, wetlands associated with the Leon Creek watershed can provide stopover habitat during migration.

During site visits, a variety of birds were observed along the Leon Creek watershed, including the canyon wren (*Catherpes mexicanus*), Bewick's wren (*Thryomanes bewickii*), painted bunting (*Passerina ciris*), Carolina chickadee (*Poecile carolinensis*), tufted titmouse (*Baeolophus bicolor*), cardinal (*Cardinalis cardinalis*), yellow-billed cuckoo (*Coccyzus americanus*), purple martin (*Progne subis*), barn swallow (*Hirundo rustica*), cliff swallow (*Petrochelidon pyrrhonota*), scissor-tailed flycatcher (*Tyrannus forficatus*), great-crested flycatcher (*Myiarchus cinerascens*), spotted sandpiper (*Actitis macularia*), cattle egret (*Bubulcus ibis*), little blue heron (*Egretta caerulea*), great blue heron (*Ardea herodias*), green heron (*Butorides virescens*), common nighthawk (*Chordeiles minor*), and red-tailed hawk (*Buteo jamaicensis*) (USFWS, 2008a).

AQUATIC RESOURCES

Leon Creek Watershed Characteristics

Due to the ephemeral nature of much of Leon Creek as it crosses the Edwards limestone formation, there is not an abundant amount of surface water in the watershed in the upper Leon Creek area. There are no reservoirs on the mainstem of Leon Creek. The remainder of the creek upstream of US Highway 90 in the recharge zone is dry except during rainfall events. Below or downstream of US Highway 90, Leon Creek is perennial in nature and is characterized by slow flows, large lagoons, pools, and riffle areas. These stream characteristics provide aquatic habitat for a variety of species.

Leon Creek receives water from spring flow, rainfall, storm water discharge, and return flows from sewage treatment plants. The creek generally flows south and enters the main portion of Port San

Antonio from the northwest, near the intersection of Billy Mitchell Road and Westover Road. Leon Creek drains a highly urbanized residential area and the Lackland and former Kelly Air Force bases.

The Texas Commission on Environmental Quality (TCEQ) breaks Leon Creek into two segments: Upper Leon Creek (Segment 1907) and Lower Leon Creek (Segment 1906). Segment 1907 is about 25 miles long and extends from 110 yards upstream of SH-16 northwest of San Antonio in Bexar County to a point 5.6 miles upstream of Scenic Loop Road north of Helotes. Segment 1906 is approximately 32 miles long and extends from the confluence with the Medina River to a point 110 yards upstream of SH-16 northwest of San Antonio. The aquatic habitat in the Upper Leon Creek segment is considered diverse. The headwater originates from spring flow and is classified as an ephemeral stream through this segment, with varying levels of available water dependent on its location above or upon the Edwards Aquifer Recharge Zone. The segment provides habitat for fisheries and other aquatic species. The substrate is rocky with cobble. Although many small man-made check dams hold water and fill with cobble, the creek has clear water with a diversity of aquatic in-stream vegetation and structure that provide fair aquatic habitat. There are a variety of flows, pools, and riffle complexes.

Ecologically, Lower Leon Creek can be subdivided into two subsegments: a middle or urban segment and lower rural segment. The middle segment of Leon Creek is not as diverse as the upper segment. This area is composed of very rocky substrate with boulder-size particles and a bedrock channel. Fractures in limestone outcrops are common and serve to recharge the aquifer. The creek is intermittent with most flows being the result of high-intensity rainfall events. Urban lawn irrigation may support a few persistent pools. The decrease in persistent water is attributed to several things, including groundwater pumping, growth of hydrophytic plants in the contributing watershed, and increases in impervious cover. The riparian zone in this area is narrower and is dominated by more scrub-shrub species, including Ashe juniper, mesquite, cedar elm, and live oak. The major degradation to this segment is due to the decrease and/or lack of base flow within the creeks, damage from channelization projects, and narrowing of the riparian corridor within this urban environment.

Important tributaries to Leon Creek within the study area include Culebra Creek and Helotes Creek. The Culebra Creek segment emerges from spring flow at its headwaters and traverses through the Edwards Aquifer Recharge Zone until its confluence with Leon Creek. Two tributaries in this segment begin in Government Canyon State Natural Area, which covers approximately 8,622 acres in Bexar County, just west of San Antonio. This area is a pristine, highly sensitive ecosystem due to the karst features and critical habitat identified for several endangered species.

The Culebra Creek segment is consistent with the Upper Leon Creek segment in terms of available water, riparian zones, substrate, and aquatic habitat. As the stream flows through the Edwards Aquifer Recharge Zone, available water remains only in persistent pools, and the riparian areas become narrower as it moves through the urban areas until its confluence with Leon Creek. A housing development is currently being built in the headwaters with a storm drain channeled into a culvert, which will add water to the small stream during rain events. From the confluence with Helotes Creek to the confluence with Leon Creek, Culebra Creek is surrounded by development on both sides. Stream functions in this area are greatly altered and degraded.

The Helotes Creek segment is categorized as an ephemeral stream and is similar in nature to upper Leon and Culebra Creek segments. The headwaters of Los Reyes, Chimenea, and Helotes Creeks are

spring fed and converge to create Helotes Creek, which has varying amounts of water depending on the location as it crosses the Edwards Aquifer Recharge Zone. Along much of this segment, the riparian corridor remains intact. North of the confluence of the three creeks, a great deal of this segment is listed as in or closely adjacent to Karst Habitat Zone 1 or 2. (For a discussion of karst zone definitions and their existence in the study area, see subsection entitled “Caves and Karst Species”).

The lower segment of Leon Creek again becomes a perennial stream that provides riverine aquatic habitat, as this segment is below the aquifer recharge zone. Aquatic vegetation species are the same species reflected in the other four segments, and the adjacent riparian areas again become wider with more bottomland hardwood species. In addition to spring flow, reuse water from the Lackland Air Force Base, Port San Antonio Test Cell Facility, and a San Antonio Water System (SAWS) wastewater recycling facility are discharged in this segment. This provides for higher levels of base flow; however, water quality is slightly impaired because of these facilities. In addition to water quality problems from the treatment plant, much of the area is agricultural lands which affect the water quality due to herbicide and pesticide runoff into this Leon Creek segment.

Water Quality

Water quality in Leon Creek is primarily the result of interaction between natural background conditions, industrial/municipal wastewater discharges, and urban storm water. The 2008 Texas Water Quality Inventory and [Clean Water Act Section] 303(d) List summarizes the status of the state’s surface waters, including concerns for public health, fitness for use by aquatic species and other wildlife, and specific pollutants and their possible sources:

1. Water bodies that do not meet the standards set for their use, or are expected not to meet their use standards in the near future
2. Pollutants that are responsible for the failure of a water body to meet standards
3. Water bodies that are targeted for clean-up activities within the next two state fiscal years

Development of a Total Maximum Daily Load (TMDL) is required for pollutants that exceed established water quality standards. A TMDL is an estimate of the maximum amount of pollution a body of water can receive and still meet the water quality standards set for its use. To determine whether a water body meets the standard for its use, the major parameter pollutants that are measured are metals, organics, fecal coliform bacteria, dissolved oxygen, and dissolved solids.

Based on the Texas 2008 Water Quality Inventory Section 303(d) List, Upper Leon Creek (Segment 1907 as defined by TCEQ) met the water quality standard for dissolved oxygen from 1996 through 2002. There was no future listing for Segment 1907 in the 303(d) List. However, in 2008 the San Antonio Water System (SAWS) listed Segment 1907 as unable to support contact recreation use due to elevated levels of fecal coliform bacteria.

In 2006, Lower Leon Creek (Segment 1906) did not meet the water quality standards for polychlorinated biphenyls (PCBs) in edible fish tissues nor for bacteria. TCEQ contracted with the Texas Department of State Health Services (DSHS) to collect fish samples through November of 2007

to verify PCBs in fish tissue. DSHS collected 50 fish tissue samples at five stations along the Lower Leon Creek. Also, the U.S. Geological Survey and City of San Antonio Metro Health were to collect sediment samples to confirm or deny the presence of PCBs in sediment (TCEQ, 2009).

In 2008, Segment 1906 failed to meet water quality standards for bacteria, PCBs in edible fish tissues, and dissolved oxygen. Recent data noted a “Concern” for dissolved oxygen (average). A carry-forward was added, for depressed dissolved oxygen. This water body will remain on the 303(d) List for depressed dissolved oxygen. The impairment has been assigned to Category 5c, meaning the water body does not meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants.

TCEQ will develop a total maximum daily load (TMDL) project to address the consumption advisory. A review of the water quality standards for water bodies designated as 5c will be conducted before a TMDL project is scheduled. The goal of the project will be to reduce contaminant concentrations in fish tissue to levels that constitute an acceptable risk to consumers.

Aquatic Habitat

For comparative purposes, the aquatic habitat is described by the same segments used for the vegetation description (see Table 2-4).

To establish a baseline existing condition, USACE, along with TPWD and USFWS, quantified the value of the aquatic resources using the physical aquatic habitat portion of the EPA’s Rapid Bioassessment Protocols (RBP). The analysis measures ten physical habitat parameters. Each parameter is given a score from 1 to 20, and the scores are summed for a total possible score of 200, with 200 being a pristine aquatic habitat. Table 2-4 lists the results of the assessment. A discussion of the aquatic habitat in each segment follows.

**Table 2-4. EPA Aquatic Habitat Assessment Existing Conditions Scores –
By Environmental Segment**

Habitat Parameter		Upper Leon	Urban Leon	Culebra	Helotes	Lower Leon
Epifaunal Substrate		14	8	16	14	18
Embeddedness / Pool Substrate		15	8	12	12	17
Velocity/Depth Regime / Pool Variability		12	10	14	13	15
Sediment Deposition		13	12	16	14	16
Channel Flow Status		2	2	6	5	16
Channel Alteration		16	9	13	16	14
Frequency of Riffles / Channel Sinuosity		18	12	15	16	16
Bank Stability	Left Bank	7	6	7	7	5
	Right Bank	8	5	7	9	5

Habitat Parameter		Upper Leon	Urban Leon	Culebra	Helotes	Lower Leon
Vegetative Protection	Left Bank	8	5	8	9	6
	Right Bank	9	6	7	8	6
Riparian Zone Width	Left Bank	8	5	8	10	7
	Right Bank	8	6	6	8	7
Total		138	94	135	141	148

Values for all creek zones are an average of multiple points. For individual results, see Appendix B “Ecosystem Evaluation.”

In-stream vegetation observed during site visits included: buttonbush (*Cephalanthus occidentalis*), water willow (*Justicia Americana*), duckweed (*Spirodela polyrhiza*), fern, pennywort (*Hydrocotyle sp.*), pondweed (*Potamogeton illinoensis*), sedge (*Carex sp.*), smartweed (*Polygonum hydropiperoides*), spatterdock (*Nuphar luteum*), needle spikerush (*Eleocharis acicularis*), switchgrass (*Panicum virgatum*), and water star grass (*Heteranthera dubia*).

In addition, the riparian vegetation is composed of hardwood species including, black willow (*Salix nigra*), green ash (*Fraxinus pennsylvanica*), cedar elm (*Ulmus crassifolia*), oak (*Quercus sp.*), sycamore (*Platanus occidentalis*), box elder (*Acer negundo*), and Ashe Juniper (*Juniperus ashei*). Exotic woody species observed included Chinaberry (*Melia azedarach*), Chinese privet (*Ligustrum sinense*), and Chinese tallow (*Sapium sebiferum*). These hardwood species provide an essential function to the aquatic environment. They help maintain stream banks, provide structure for cover, provide organic nutrients, and prevent erosion and sediment deposition. A large percentage of all wildlife species depend on riparian areas for some portion of their life cycle (Thomas et al., 1979; Johnson et al., 1977).

Aquatic Species

Aquatic macroinvertebrates and fish were present at all of the sites in the upper and lower Leon Creek segments, and some small fish and macroinvertebrates were present in the persistent pools in the middle segment. Below US Highway 90 and above State Highway Loop 1604, Leon Creek is good warm-water fish habitat. Several different species of fish were observed during site visits to the area including: largemouth bass (*Micropterus salmoides*), sunfish (*Lepomis*), catfish (*Ictalurus*), and minnow.

The tables in the Ourso and Hornig publication (2000) cover most or all of the species found in Leon Creek. Only the American green tree frog (*Hyla cinerea*), Blotched Water Snake (*Nerodia erythrogaster*), green anole (*Anolis carolinensis*), and a Texas Spiny Lizard (*Sceloporus olivaceus*) were found during the site visits. However, South Central Texas is one of the most diverse areas in the nation for reptiles and amphibians (Dixon, 2000).

Jurisdictional Waters Including Wetlands

Under Section 10 of the Rivers and Harbors Act of 1899 (33 USC 403), USACE has the responsibility to regulate *all work or structures in or affecting the course, condition or capacity of navigable waters of the United States*. Within Bexar County the San Antonio River and its tributaries are not considered to be Navigable Waters of the United States and are not regulated by Section 10; therefore, no further discussions on Section 10 will occur.

Under Section 404 of the Clean Water Act (33 USC 1344), Congress directed USACE *to regulate the discharge of dredged and fill material into all waters of the United States including wetlands*.

Therefore, activities that result in a discharge of dredged or fill material into Leon Creek or one of its tributaries would be regulated activities under Section 404. Currently, the National Wetland Inventory (NWI) maps for Bexar County show riverine wetlands. It is hard to quantify the wetlands because they are site-specific and normally very small. These wetlands are limited to within the stream banks and are classified as bottomland hardwood. The channel of Leon Creek would be considered a jurisdictional water; however, no jurisdictional wetlands immediately adjacent to the channel have been identified.

THREATENED AND ENDANGERED SPECIES

Leon Creek Watershed Species

According to the U.S. Fish and Wildlife Service, there are 19 Federally Listed Threatened and Endangered species that have the potential to occur in Bexar County, including the Leon Creek Watershed. These species are listed in Table 2-5.

Table 2-5. Federally-Listed Threatened and Endangered Species

Common Name	Scientific Name	Listing Status	Potential to Occur within the Study Area
[Unnamed] Ground Beetle	<i>Rhadine infernalis</i>	Endangered	Yes
[Unnamed] Ground Beetle	<i>Rhadine exilis</i>	Endangered	Yes
Black-capped Vireo	<i>Vireo atricapilla</i>	Endangered	No
Braken Bat Cave Meshweaver	<i>Cicurina venii</i>	Endangered	Yes
Cokendolpher Cave Harvestman	<i>Texella cokendolpheri</i>	Endangered	Yes
Comal Springs Dryopid Beetle	<i>Stygoparnus comalensis</i>	Endangered	No
Comal Springs Riffle Beetle	<i>Heterelmis comalensis</i>	Endangered	No
Fountain Darter	<i>Etheostoma fonticola</i>	Endangered	No
Golden-cheeked Warbler	<i>Dendroica chrysoparia</i>	Endangered	Yes
Government Canyon Bat Cave Meshweaver	<i>Cicurina vespera</i>	Endangered	Yes
Government Canyon Bat Cave Spider	<i>Neoleptoneta microps</i>	Endangered	Yes
Helotes Mold Beetle	<i>Batrissodes venyivi</i>	Endangered	Yes
Madla's Cave Meshweaver	<i>Cicurina madla</i>	Endangered	Yes
Peck's Cave Amphipod	<i>Stygobromus pecki</i>	Endangered	Yes
Robber Baron Cave Meshweaver	<i>Cicurina baronia</i>	Endangered	Yes
San Marcos Salamander	<i>Eurycea nana</i>	Threatened	No
Texas Blind Salamander	<i>Typhlomolge rathbuni</i>	Endangered	No
Texas Wild Rice	<i>Zizania texana</i>	Endangered	No
Whooping Crane	<i>Grus americana</i>	Endangered and Experimental Population, Non-essential	Migrant only

* E = Endangered; T = Threatened

Most species listed are associated with karst topography within the extreme Upper Leon Creek study segment. In addition to the Federal list, the State of Texas has provided a list of species of concern for consideration in evaluation of project impacts and for avoidance if possible. That list is maintained in project files.

Caves and Karst Species

USFWS has designated five karst zones in the Bexar County area, based on geology, distribution of known caves, distribution of cave fauna, and primary factors that determine the presence, size, shape, and extent of caves with respect to cave development. These zones are depicted in Figure 2-6. The five zones reflect the likelihood of finding a karst feature that will provide habitat for endemic invertebrates, as follows:

- 1 Areas known to contain one or more of the nine invertebrates
- 2 Areas having a high probability of suitable habitat for the invertebrates
- 3 Areas that probably do not contain the invertebrates
- 4 Areas that require further research but are generally equivalent to Zone 3, although they might include sections that could be classified as Zone 2 or Zone 5
- 5 Areas that do not contain the invertebrates

Locations within the study area that may support karst invertebrates include:

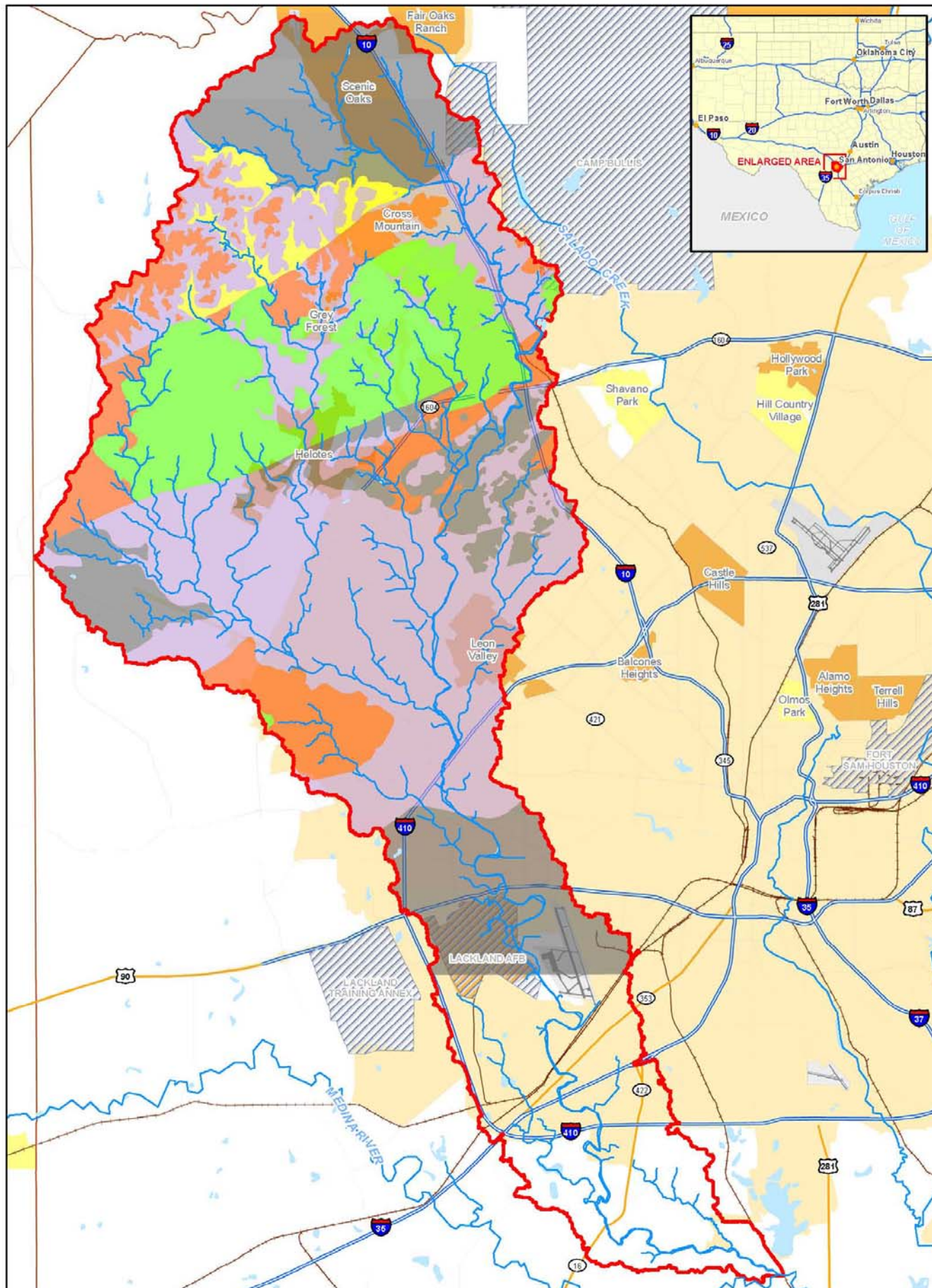
- The lower portions of the Upper Leon Creek segment support Zones 1 and 2 in various places, but the majority of the segment contains Zone 3.
- Within the Urban Leon Creek segment, a few areas support Zone 1 and Zone 2 designations:
 - Headwaters of Slick Ranch Creek
 - Upper most portions of the Urban Leon Creek mainstem
- The entire upper portions of the Culebra Creek segment support Zone 1 and 2 designations, while the lower reaches of the Culebra Creek segment supports mostly Zone 3 with some Zone 2 on the southwest side.
- The Helotes Creek segment supports some Zone 1 and Zone 2 areas and four critical habitat designations, but is mostly made up of Zone 3, especially in the lower parts of this segment.
- The Lower Leon Creek segment does not contain any karst zones or critical habitat.

Any proposed project alternatives or plans identified within Karst Zones 1–4 would require the ESA Section 7 consultation process with the USFWS.

CULTURAL RESOURCES

Cultural resources include properties of traditional cultural significance, such as burial sites and cemeteries, above ground resources as buildings and structures, and archaeological sites. Under the National Historic Preservation Act of 1966, as amended, the Federal Government must identify cultural resources within the Area of Potential Effect for any undertaking. Further, the government must assess the potential of adverse effects to resources meeting the criteria for inclusion in the National Register of Historic Places (NRHP) as defined in 36 CFR Part 60(4). Because of the large size of the Leon Creek watershed, data collection has been limited to previously recorded sites within the watershed as an indicator of the level of effort that will be necessary to fully investigate the site of

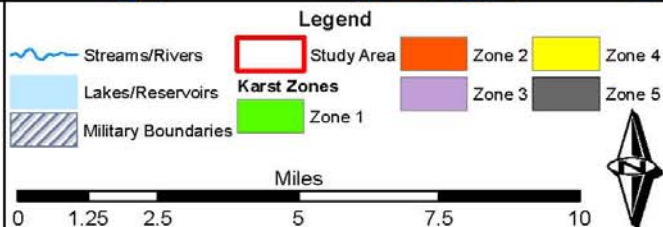
the Recommended Plan. As the project moves into the Preconstruction, Engineering, and Design, (PED) additional surveys including potential subsurface investigations will be required and completed as appropriate.



**US Army Corps
of Engineers®**
Fort Worth District
Project: Leon Creek
Project Manager: Nova Robbins
Section: C&SWF-P&R-PT
Date: October 19, 2012
Author: Lucas Daniels
Location: \\ewf-fst1dgs\project\el_creek\LeonCreek\Documents\

**REFERENCE:
ESRI BASE DATASET
USGS NHD DATASET**
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**PROJECTION: NAD 1983
TEXAS SOUTH CENTRAL
STATE PLANE FIPS 4204**

**LEON CREEK
SAN ANTONIO,
TEXAS**
**INTERIM
FEASIBILITY STUDY
FIGURE 2-6.
KARST ZONES**



Archaeological Resources

Given the broad nature of the Leon Creek Watershed study, only blanket generalization of cultural resources sites is feasible. Numerous cultural resources sites and properties are currently known and recorded for this expansive area. Some of the areas under consideration have been surveyed for cultural resources properties. For example, due to the large amount of survey done there, nearly one-third of the recorded sites within the Leon Creek Watershed are located within the Government Canyon State Natural Area. The recorded cultural resources sites include historic sites, such as old inns, homesteads, churches, historic artifact scatters, standing historic structures, burials and cemeteries, as well as prehistoric Native American sites, such as lithic scatters, villages, burials and possible cemeteries, hunting and butchering sites, and alluvially buried archaeological deposits. The number of cultural resources sites known to be associated with the study area is limited by the amount of work previously done. The full extent of cultural resource sites for the entire area is unknown pending full archaeological surveys of the proposed project locations.

Architectural Resources

In addition to the archaeological sites, many unrecorded potential historic resources are located in the Leon Creek study area. These are primarily historic farms and ranches that have been documented in the Texas Historical Survey. A thorough reconnaissance of the structures within specifically identified project areas will need to be conducted to determine if any standing building, bridges, or other structures might be eligible for the National Register of Historic Places (NRHP).

HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

At the request of USACE, Environmental Data Resources, Inc. (EDR, Inc.) conducted a search of available environmental records for sites along Leon Creek in San Antonio, Texas. The purpose of the search was to identify any sites where hazardous, toxic, or radioactive waste (HTRW) or petroleum products have been released or are likely to have been released to soil, groundwater, or surface water, and which might be encountered during construction of flood control projects in the subject area. EDR, Inc. produced two final reports, according to the requirements of American Society for Testing and Materials (ASTM) Standard Practice for Environmental Site Assessments, E1527-05. Submitted separately on February 5, 2007 and April 23, 2007, the reports listed all sites found in the records search. The first report addresses the upper portion of Leon Creek north and west of I-410 in San Antonio; the second report addresses the lower portion south and east of I-410. The complete search area extended in a half-mile wide corridor, beginning at the headwaters of Leon Creek northwest of San Antonio at latitude (north) 29.67884 degrees and longitude (west) 98.71734 degrees, and ending downstream at the confluence of Leon Creek and the Medina River south of San Antonio at latitude (north) 29.26443 degrees and longitude (west) 98.49435 degrees.

Sites were identified in the reports that could impact the design and construction of flood control projects for Leon Creek. Locations of these sites relative to the current channel of Leon Creek are shown on the accompanying EDR report figures in Appendix F, "Hazardous, Toxic, Radioactive

Waste.” Sites of greatest concern were found in the following databases, which EDR searched to create the list in their reports:

- TCEQ Solid Waste Facility/Landfill (SWF/LF)
- TCEQ Closed Landfill Inventory (CLI)
- TCEQ Leaking Underground Storage Tank Incident Reports (LTANKS)
- EPA Emergency Response Notification System (ERNS)
- EPA Hazardous Materials Incident Report System (HMIRS)
- TCEQ Spills (TX SPILLS)
- TCEQ Enforcement (ENF)

Other sites of possible concern in this report include those listed in the ERNS, HMIRS, TX SPILLS, and ENF databases.

- An unknown type of oil was spilled at one site listed in the ERNS database. Uncovered barrels of motor oil and antifreeze released onto the ground were reported at another.
- Two sites were listed in the HMIRS database. However, further information regarding any potential residual contamination was not found.
- Abandoned drums released an estimated 115 gallons of cement additives at one site listed in the TX SPILLS database, and a spill of an estimated 280 gallons of diesel fuel occurred at another, with cleanup at each reported as inadequate.
- The Texas Commission on Environmental Quality (TCEQ) issued formal written Notices of Violation for waste violations at two sites listed in the ENF database.

RECREATION RESOURCES

There are multiple Federal, state, and local parks and recreation facilities within the Leon Creek Watershed and the San Antonio Metropolitan area. The section describes regional as well as local recreation demand. This information is important to facilitate planning for a potential multi-purpose project and to design relevant recreational facilities.

The 2001 Texas Tech University survey for Texas Parks and Wildlife Department (TPWD) evaluated the total Texas population’s rates of participation (at least once in the past 12 months) in various outdoor activities. Table 2-6 lists the survey results.

Table 2-6. Texas Population Participation in Outdoor Recreation Activities

Activity	Participation
Picnicking	45%
Visit Historic Sites	41%
Swimming in Natural Waters	39%

Fishing	38%
Visit Park or Natural Area within one mile of home	35%
Trips or Outings to View Wildlife	34%
Visit Texas State Park	33%
Motorboating (excluding jet skis)	30%
Camping	27%
Bicycling	20%
Hiking	19%
Hunting	16%
Jet Skiing	12%
Canoeing/Kayaking	6%
Mountain Biking	5%
Rock Climbing	5%
Sailing	4%

Source: *Texas Parks and Wildlife for the 21st Century*, 2001 Local Recreation Demand

The City of San Antonio's Parks Department has recently prepared the *Leon Creek Greenway Master Plan*, which identifies specific locations for recreation. This recreation assessment recommends that military family and partnership potentials be considered in the recreation planning.

SOCIO-ECONOMIC CONDITIONS

The Leon Creek study area is primarily located in a heavily urbanized area, with some rural areas in the upper headwaters. The western portions of the study area are a mix of rural and urban areas, with residential and commercial development underway.

The population in the study area is predominantly minority, with approximately 57% being of Hispanic origin. Within Bexar County, the population is expected to grow 57% from 2015 to 2050. In the study area, 86% of the population had achieved education beyond a high school diploma, indicating a well educated population. Fewer than 10% had less than a high school education. The study area tends to have lower unemployment rates than the county as a whole.

There are an estimated 13,851 business establishments in the study area, with approximately 12% being retail, 9% construction, 6% health care, and 4.5% accommodation and food services. For the Alamo Workforce Development area, trade was expected to grow by 19% through 2014, education services by 27% and leisure and hospitality by 13%.

Overall, the study area had a slightly higher average household income (\$53,413) compared to Bexar County (\$44,718). Approximately 13% of the population in the study area is below the poverty level, compared to 16% in Bexar County.

Low Income and Minority Populations

In accordance with Executive Order 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations,” USACE conducted an analysis to identify minority and low-income populations within the study area. Data were collected using U.S. Census Bureau Data to examine both population and income in the study area at the most detailed level possible.

- There were 112 census block groups that intersect the study area, but only 110 with reported populations. Of these 110 census block groups, 71 have populations that are 50 percent or more minorities with regard to race and Hispanic origin. That represents 65 percent of the census block groups with reported population.
- For the study area as a whole, 59.2 percent of the population is minority. Of the 110 census block groups, 53 had total minority populations greater than 59.2 percent.
- In Bexar County, 64.4 percent of the population is minority. Of the 110 census block groups in the study area, 46 had total minority populations greater than 64.4 percent.

In assessing the existence of low-income populations for the study area, median household incomes for all 112 census blocks for the study area were examined. Based on a poverty threshold for a family size of three (considering that average number of persons per household for Bexar County is 2.84) an income of \$13,738 was used as comparison. Using this poverty threshold, only one census block group (181806.1) fell below this level. This area contains structures from two damage reaches, Babcock Tributary and Leon Creek Reach 6.

FUTURE WITHOUT-PROJECT CONDITIONS

To effectively evaluate alternatives for any proposed project improvements that might be implemented, it was necessary to forecast the most probable future conditions if no Federal action is taken to solve the water resource problems and opportunities. These conditions are known as the *future without-project* conditions. All project alternatives are measured against the future without-project conditions. For the purposes of this study, the period of analysis is 50 years.

Climate

Climate models indicate that temperatures will rise significantly over the coming decades, from 1°F by 2019 to 4°F by 2059 (Nielson-Gammon, 2012). While climate modes tend to agree on global patterns of precipitation changes, a high-level of uncertainty currently exists in predicting future precipitation probabilities on a state-level scale. However, the models tend towards a decrease in precipitation within the region.

Geology, Soils, and Topography

The geology of the study area will not change. Urbanization of the watershed is expected to continue in the future, thereby increasing impervious cover and making the watershed “flashier” in terms of

water discharging into creeks and leading to increased soil erosion. With the increases in urbanization, conversion of prime farmlands into non-agricultural uses will continue.

Land Use

Land use in the study area will continue to change as urbanization occurs. According to Ultimate Land Use data provided by SARA, the existing urban land use acreages per segment are expected to increase over the 50-year project life at rates that range from 17 percent in the Upper Leon Creek segment to 30 percent in the Lower Leon Creek segment.

Air Quality

Air quality within the San Antonio MSA is projected to remain about the same or improve due to the signing of an Early Action Compact.

Noise

The study area is located in developed areas of San Antonio. Noise levels would continue reflect the urbanized nature of the surroundings and would be subject to the San Antonio noise ordinances.

Groundwater

Groundwater has been and will continue to be affected by the changes in land use and vegetative cover. The increased impervious cover and increased residential subdivisions would continue to impact the Edwards Aquifer and its associated springs. Increased impervious cover increases runoff and affects infiltration into the aquifer. Under these conditions, the quality of water in the aquifer and the springs would be expected to degrade.

The Edwards Aquifer Authority (EAA) is directed to conserve, protect, and enhance the groundwater resources of the Edwards Aquifer and has developed the Edwards Aquifer Protection Plan as a strategy to reduce degradation of water quality within the aquifer system. The EAA helps to limit impacts to these resources, but impacts occur nonetheless. Although impervious cover regulations over the recharge zone help reduce these impacts, continued degradation is still projected under the future without-project conditions.

In the Leon Creek Watershed, there has been and will continue to be a general trend toward increased ecosystem degradation due to conversion of savannas to woodlands and increases in impervious Ashe juniper cover. These trends will have a negative impact on recharge, water quality, general ecosystem health and habitat value, and flooding. Lack of understory may contribute to a quicker runoff rate with a corresponding reduction of infiltration. This results in higher peak flows with shorter durations, which increases flood events and reduces aquifer recharge.

Flood Risk Management

In the absence of any Federal flood-risk management reduction project, the existing and future flood damages and other adverse impacts caused by continued potential flooding of the 4,630 structures within the 0.2% AEP floodplain in the study area would continue and likely increase. Although flood insurance would partially compensate for future flood losses, the damages would still occur at an estimated average rate of \$13.5 million annually (includes damages to privately owned vehicles) at October 2012 price levels. In addition, the costs for flood fighting and recovery, public damages, the potential loss of life, and the overall threat to human health and safety would continue. Small, localized flood control projects would probably be constructed to address localized events, but the large floods would continue to cause extensive flood damages and possible loss of life.

The City of San Antonio and Bexar County both have a “no rise” ordinance which requires that the increased runoff resulting from the proposed development will not produce a significant adverse impact to other properties to a point 2000 feet downstream. The City provides a Fee In Lieu Of (FILO) payment to the regional storm water fund in lieu of on-site detention as a mitigation option. Developers who wish to participate submit an adverse impact analysis or storm water management plan. Once City staff verify the development will not have any adverse impact 2000 feet downstream, then the developer can opt to participate in the Regional Storm Water Management Program (RSWMP) by paying a fee in lieu of detention. All developers participate in the RSWMP by paying the FILO, except in mandatory detention areas; by construction of on-site or off-site detention; or by participation in a regional off-site regional storm water facility to mitigate increase in runoff. The FILO is based on the type of development and the increase in impervious cover. Any development that has an increase of impervious cover greater than 100 square-feet is subject to the FILO. The City is giving credit to developers who implement Low Impact Development (LID) best management practices. These BMPs can include rain gardens, bio-swales, vegetated filter strips, green roofs, rain cisterns, and tree boxes to name a few. SARA is actively coordinating with the City on reviewing the LID plans for those who wish to get credit. These measures are intended to limit the effect of future urbanization and increases in impervious cover on the timing and amount of urban runoff.

For this study, future conditions represent the fully developed floodplain, estimated to occur 25 years after the base for existing conditions. Hydraulic and hydrological estimates for the future without-project conditions were entered into HEC-FDA to calculate expected annual damages for the future condition. As described in Appendix G.1 “Hydrologic and Hydraulic Analysis,” future conditions generally show increased flows and damages, but some reaches experienced a decrease in flows. Table 2-8 shows the EAD values for future without-project conditions by economic reach alongside the existing conditions EADs for comparison.

To determine any potential benefits from alternatives, these two EAD values were used to create average annual equivalents (AAE) or equivalent annual damages. Equivalent Annual Damages are the summation of the base year (2010) expected annual damages plus the discounted value of the most likely future year (2035) expected annual damages. The future expected annual damages shown here are discounted over the project life of 50 years at a Federal discount rate of 3 3/4 percent.

**Table 2-7. Existing and Future Without-Project Expected Annual Damages and Without-Project Average Annual and Equivalent Annual By Economic Reach
(October 2012 Prices - \$000)**

Reach	Existing Without-Project AAD	Future Without -Project AAD	Without-Project EAD
Babcock Trib	\$ 300	\$ 466	\$ 395
Chimenea Creek	2	2	2
Culebra Creek 1	2,345	1,766	2,013
Culebra Creek 2	90	86	88
Culebra Trib A	93	106	100
Culebra Trib C	32	41	37
Culebra Trib E	18	19	19
French Creek	290	259	272
French Trib A	< 1	< 1	< 1
Helotes Creek	527	537	533
Helotes Trib A	48	48	48
Helotes Trib B	1	<1	1
Huebner Creek	518	453	481
Huebner Trib A	123	129	126
Huesta Creek	128	131	130
Indian Creek	90	92	92
Leon Creek 1	5	4	4
Leon Creek 2	472	595	543
Leon Creek 3	1,702	2,125	1,945
Leon Creek 4	1,147	1,209	1,183
Leon Creek 5	1,4617	1903	1,374
Leon Creek 6	1,180	1,612	1,428
Leon Creek 7	1,125	1,183	1,158
Leon Trib B	< 1	< 1	< 1
Leon Trib F	106	162	138
Leon Trib H	< 1	< 1	< 1
Leon Trib J	< 1	< 1	< 1
Leon Trib K	175	196	187
Leon Trib L	0	0	0
Leon Trib M	0	0	0
Los Reyes Creek	30	42	36
Ranch Creek	0	0	0
Slick Ranch	913	1,206	1081
Slick Ranch Trib B	93	107	101
WW Village	9	8	8
Total	\$13,021	\$14,488	\$13,523

Terrestrial Resources

Encroaching urban and rural development activities are expected to negatively impact the watershed's vegetation. The existing forested riparian vegetation zone in much of the watershed is already narrow with several grass and shrub openings. The number and size of openings would continue to grow, and there would be fewer acres of forest. Loss of habitat, particularly riparian woodlands, would reduce the number of wildlife and bird species in the watershed. Migratory songbirds are particularly susceptible to loss of habitat along their migration routes.

Aquatic Resources

Eventual construction of subdivisions will lead to the building of new roads, parking lots, and structures that will cause increased runoff and less infiltration into the ground, which will affect aquatic resources. With increased construction, there will be increased sediment loading in the creeks, which will negatively affect the aquatic resources in the creeks and the aquifer.

The increase in peak flows, increased construction, and increase of impervious cover would be expected to contribute to increases in sediment transport and turbidity from construction activities. These increases are not expected to affect the existing riparian zone to the point that riparian woodland restoration activities would not be sustainable. To the contrary, riparian woodland restoration would help offset some of these impacts from future impervious cover. Water quality in Leon Creek is expected to degrade from slight to moderate as Bexar County continues to develop. The construction of new residences and businesses would produce additional sediment load from site runoff. After completion, increases in impervious surface area, traffic, lawn fertilizing, and other human activities would adversely impact the creeks. Degradation of water quality would reduce the number of aquatic biota. According to USFWS, the overall diversity of fishes and other aquatic species is already low; further loss of aquatic biota would be damaging to the aquatic ecosystem.

With increased urbanization, there will be continued reduction in the riparian zone width. People tend to want to move close to creeks for their aesthetically pleasing atmosphere and distance from neighbors. When riparian zones are decreased, valuable wildlife habitat and corridors and aquatic resources are destroyed. The aquatic ecosystem needs the allochthonous inputs and shade that riparian habitat provides. The Urban Leon segment north of US Highway 90 and south of State Highway Loop 1604 has experienced historical development within the floodplain; additional development is expected to be limited and proper storm water controls will most likely be implemented, because the area is within city limits. However, the riparian vegetation within much of this area has been lost to clearing for city parks, roads, and golf courses. It is expected that this area will continue to be managed at its current state. In addition, because the habitat is disturbed, invasive species will become established in the area, and the remaining intact riparian areas will decline over time. For a more detailed analysis, see Appendix E.

Cultural Resources

Cultural resources in the study area would remain undisturbed unless future development activities uncovered the resources.

Socio-Economic Conditions

Population

Stated earlier, the Leon Creek study area is located primarily in a heavily urbanized area with some rural areas in the upper headwaters. The area will continue to see increases in population based on

population projections for Bexar County which is expected to grow by 57 percent between 2015 and 2050.

Recreation Resources

The San Antonio area would see continued construction of recreational facilities as the city grows; however, it is expected that the growth rate in some of these communities will not allow for recreation infrastructure to keep pace. Therefore, there will always be a demand for additional recreational facilities, especially for activities people tend to do close to home such as walking and picnicking.

SECTION THREE

PLAN FORMULATION AND DEVELOPMENT OF ALTERNATIVES

Leon Creek is primarily a flood risk management (FRM) project. Early in the study process, consideration was given to the incorporation of ecosystem restoration and recreation features where opportunities might be complementary to flood risk reduction. The strategy was to first to identify areas where FRM measures and alternatives could be implemented, and then to consider ecosystem restoration (ER) and/or recreation opportunities that might exist in these same areas. This constrained approach is a different paradigm than looking broadly throughout the watershed for stand-alone ER or recreation opportunities.

PROBLEMS AND OPPORTUNITIES IDENTIFICATION

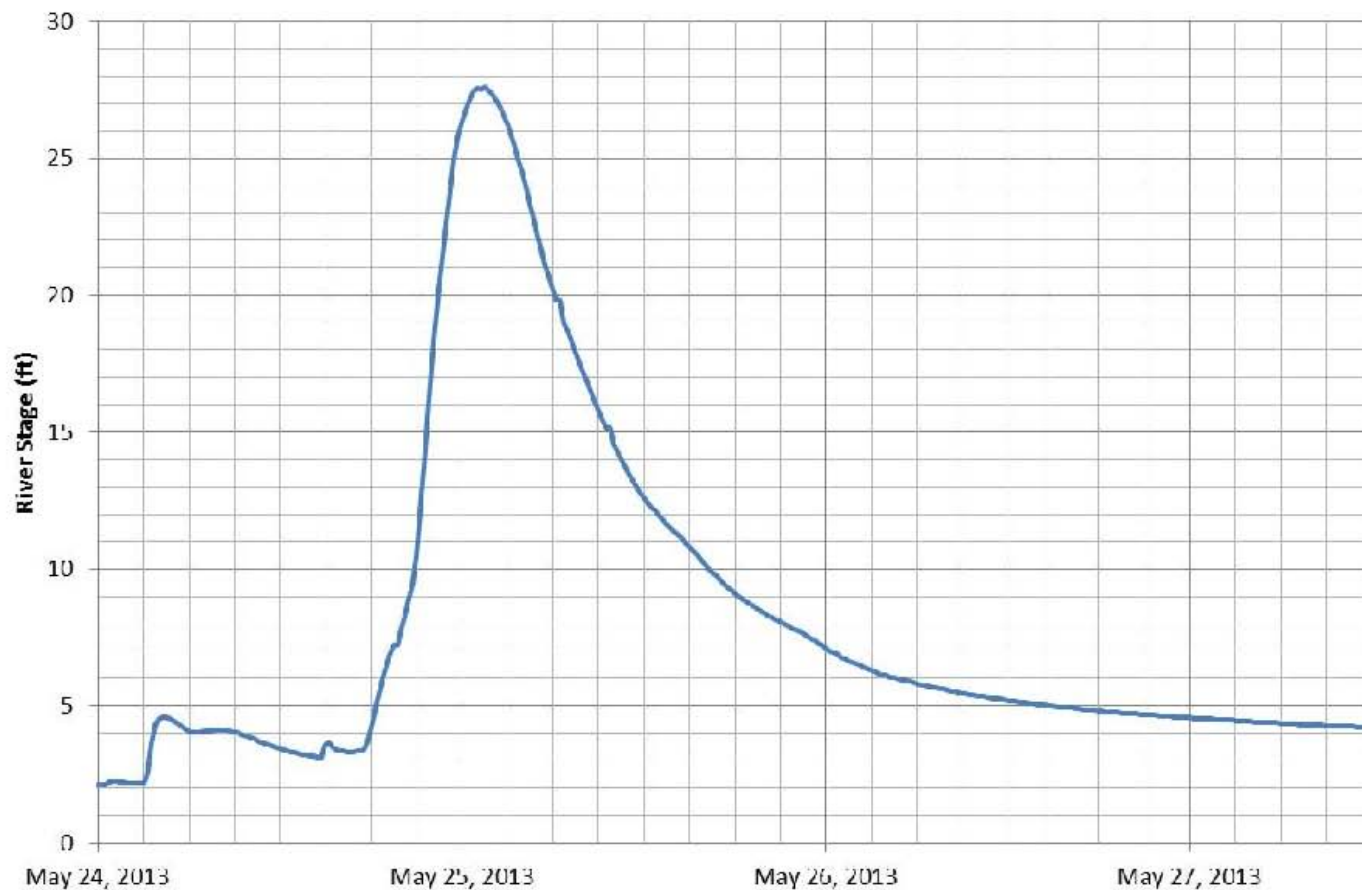
As noted in previous sections, there are significant flood risks in and around the city of San Antonio along Leon Creek and its tributaries. The flood risk is generally associated with infrequent, high-intensity rainfall events which result in extremely rapid but relatively short-duration flood peaks associated with high velocity stream flows. Of the 13 storms recorded worldwide for the greatest depth of precipitation in a single event, two occurred along the Balcones escarpment in the vicinity of the study area. A storm centered over Medina, Texas in 1978 produced almost 30 inches of rainfall in 24 hours, while the 1935 storm in D'Hanis produced 22 inches of rainfall in less than 3 hours (Slade and Patton, 2002).

More recently, the storms of August 2007 and May 2013 are typical examples of the flood risk faced by study area residents. Within a 24-hour period in August 2007, large portions of the Leon Creek watershed received between 12 and 16 inches of rain, with almost the entire watershed receiving 6 to 10 inches in that same period. (Jackson, undated) Velocities were sufficient to sweep at least one automobile off Grissom Road in the central portion of the watershed. Main traffic lanes on Interstate 10, as well as US Highway 90 and State Highway 16 (both of which cross Leon Creek) were all closed due to the flood hazard. Eleven persons died within the city of San Antonio.

In August of 2007, the portion of the Leon Creek watershed near the I-35 intersection reported in excess of 8.25 inches of rain in 24 hours due to flooding associated with Tropical Storm Erin. The event achieved a peak rainfall intensity of 2.25 inches per hour while the Helotes Creek sub-watershed just to the north reported total rainfall amounts of almost 7 inches with a peak rainfall intensity of 3.8 inches per hour. (SARA, 2007) In May 2013, rainfall amounts of 10 inches to 15 inches were received in the upper portions of the Leon Creek watershed in just over 12 hours. Runoff from this event resulted in a peak flood elevation at the Leon Creek/I-35 gage peaked at 27 feet, more than 12 feet over flood stage. During the storm, Leon Creek inundated the jet engine test facility at Port San Antonio, a large industrial complex, located on the site of the former Kelly Air Force Base, with almost seven feet of floodwater.

As shown in the hydrograph (Figure 3-1) below, Leon Creek rose from within-bank levels to its peak flood stage in approximately six hours, tapering off somewhat more slowly but generally returning to within-bank conditions in less than 24 hours.

Leon Creek at I-35 May 25, 2013



**US Army Corps
of Engineers** ®
Fort Worth District

Project: Leon Creek
Project Manager: Kousa Robbins
Section: O BEM - P BIL-PT
Date: October 10, 2012
Author: Lucas Daniels
Location: Year 15 Hydrograph
Output: LeonCreekHydrograph

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Figure 3-1. Leon Creek Hydrograph

High velocities present the primary flood concern with respect to safety. Three persons lost their lives during the May 2013 flood, all of whom were swept from their vehicles as a result of swiftly flowing water. Most flood damages are associated directly with out-of-bank flow. Seven feet of water flowed through the jet engine test facility at Port San Antonio for a short duration, according to a media report (KSAT.com, May 15, 2013). Backwater flooding is limited to a few areas along Leon Creek Trib F.

Approximately 4,629 structures would be expected to receive damage from a 0.2% Annual Exceedance Probability (AEP) event, and expected annual damages in the watershed are estimated at \$12.3 million. More than 1,500 single-family homes are located within the 1% AEP flood plain, and within several isolated pockets, damageable properties are located within the 50% AEP floodplain. Not only is it a large economic burden when flooding occurs, but there is concern for public health and safety. In sharp contrast, this same watershed can experience periods of low or almost nonexistent flow in certain areas, resulting in degradation of the channel and its environs. Despite these problems, there are potential opportunities to reduce flood damages as well as restore balance to the area's water resources.

There are problems for the Leon Creek ecosystem as well. Because the riparian woodlands of the watershed have been severely degraded due to residential development and urbanization, there is a need to restore this valuable riparian woodland habitat to improve the overall aquatic character and habitat of the creek. Potential multiple ecosystem restoration opportunities exist in the Leon Creek study area, ranging from restoration of riparian and aquatic ecosystems to improvement of endangered species habitat.

The major problems and opportunities of the Leon Creek study area are summarized in Table 3-1.

Table 3-1. Leon Creek Watershed Problems and Opportunities

PROBLEM	OPPORTUNITY
1 Substantial flood damage threats exist for the study area, with more than 1,900 total structures likely to be affected (damages of nearly \$97 million) by a 1% AEP flood event in and around the city of San Antonio.	Reduce risk of flood damages in the Leon Creek Watershed.
2 Short warning times and high velocity flood flows present significant risk to human safety during flood events.	Contribute to greater public awareness of the hazard presented by flood flows.
3 Leon Creek and its tributaries often dry up entirely, without even minimal flow.	Restore natural hydraulic conditions in the Leon Creek Watershed.
4 Within much of the Leon Creek Watershed, development has encroached to the extent that riparian areas have vanished, or become too degraded to support quality aquatic and terrestrial habitats.	Where compatible with flood risk reduction measures, restore riparian vegetation along Leon Creek and its tributaries.
5 Aquatic habitat has become degraded or totally lost within Leon Creek and its tributaries.	Where compatible with flood risk reduction measures, restore natural low-flow, riffle/pool/run sequences and stabilize stream banks within the Leon Creek watershed.

	PROBLEM	OPPORTUNITY
6	Residents of the urbanized portion of the Leon Creek watershed lack adequate opportunities for open space enjoyment and outdoor recreation activities within their neighborhoods.	See opportunities to incorporate open space and recreational amenities where compatible with flood risk reduction measures.

RESOURCE PLANNING

This section describes the goals, objectives, and constraints in planning for projects to address the identified problems and opportunities in the Leon Creek Watershed.

Goals

Corps policy requires that Federal water and related land resources planning be directed so as to contribute to the principle of National Economic Development (NED) and/or contribute to the National Ecosystem Restoration (NER).

- Contributions to NED are economic benefits—increases to the net value of the nation's goods and services, expressed in monetary units. NED contributions must also consider the environmental effects of proposed changes on ecological, cultural, and aesthetic attributes of natural and cultural resources.
- Contributions to NER are environmental benefits—increases to the net value of the nation's significant habitat, expressed in habitat units or other values.

The goals of this study are to contribute to NED by reducing flood damages and providing ancillary recreation opportunities where appropriate. While ecosystem opportunities exist as well as opportunities for the area's water resources, flood risk management remains the primary objective.

Objectives

Plans formulated during this study were evaluated based on their contributions to NED, consistent with protection of the Nation's environment. In addition to these National objectives, additional planning objectives evolved from meetings with area residents, contact with the local sponsors, state and Federal agencies, and from observations made in the area. Specific needs, desires, and goals of the community were identified. The following planning objectives for this study were identified during the initial stages:

1. Reduce risk of flood damages within the Leon Creek Watershed and decrease the number of residents who reside in the 4% AEP and 1% AEP floodplains by 80%. Protect all structures in the 1% AEP floodplain from flood damages. Performance of alternatives in achieving this objective would be measured by the predicted annualized value of flood damages.
2. Reduce risk to life, health, and welfare of Leon Creek Watershed residents by decreasing flood risk to the extent practicable. Performance of alternatives in achieving this objective would be assessed qualitatively.
3. Restore ecosystems to a more diverse and sustainable natural condition by increasing aquatic and riparian habitat. Performance of alternatives against this objective would be measured by habitat units of other functional equivalent.
4. Increase opportunities for public use and recreation to residents of the Leon Creek Watershed and surrounding areas. Enhance connections between new and existing recreation. Performance of

alternatives against this objective would be measured by opportunities for recreation visits provided and/or the economic value of the recreation opportunities provided.

As discussed in introduction, the Project Delivery Team initially sought opportunities to address identified ecosystem restoration and recreation problems where compatible with flood risk reduction objectives. During the formulation process, it became apparent that large-scale measures to address flood risks would not be economically justified and that opportunities to address nationally significant ecosystem restoration problems in conjunction with development of localized flood risk reduction alternatives would be limited. The localized nature of the economically justified FRM measures also limited the team's ability to identify compatible recreation features that would substantially address Study Area recreation needs. Ultimately, plan formulation focused exclusively on flood risk reduction as defined in Objectives 1 and 2 above.

Constraints

Constraints are restrictions that limit the planning process, and they include legal and policy constraints that apply to every USACE study, as well as study-specific constraints that only apply to this study. To provide direction for the plan formulation efforts, the following constraints were taken into account:

1. Avoid impacts to natural water features, such as springs, seeps, and wetlands. These features provide significant contribution to ecological functions and quality of life within the Leon Creek Watershed and protection/avoidance of these features is of high priority to the project sponsor.
2. Avoid disruption to the natural character of the floodplains, where present in the Leon Creek Watershed, to the extent practicable.
3. Government Canyon State Natural Area is hydraulically connected to Leon Creek and the Edwards Aquifer. Actions that adversely impact water resources and create significant project controversy should be avoided or mitigated. These effects would include interruptions to water flow and decreases in water quality and/or quantity.
4. Lackland Air Force Base is located adjacent to Leon Creek. Ecosystem restoration projects that can attract wildlife, such as wetlands and riparian woodland restoration, may increase the potential for a wildlife-aircraft collision and must be coordinated with the FAA. Provisions of the Memorandum of Agreement between the FAA, U.S. Air Force, U.S. Army, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service and U.S. Department of Agriculture to Address Aircraft-Wildlife Strikes (2003), the Corp of Engineers agreed to extensive coordination and cooperation with the FAA in order to minimize possibilities of aircraft strikes.
5. Portions of the study area, particularly the Government Canyon Natural Area provide habitat suitable for Federally listed threatened or endangered species. In addition, karst invertebrates are known to inhabit the Edwards Aquifer system underlying portions of the Leon Creek watershed. Impacts to these species should be avoided, minimized, and/or mitigated to the extent possible.

INITIAL SCREENING OF STRUCTURAL MEASURES

Areas of Interest

Flood damages are not uniformly distributed throughout the watershed but are concentrated in specific locations where damageable properties are located in floodplains of varying frequencies. Twelve such areas of interest (concentrations of damageable structures) were identified early in the study process and are shown in Figure 3-2. Generally speaking, the Areas of Interest (AOIs) are located inside Loop 1604 and are found along Culebra Creek and Helotes Creek as well as the main stem of Leon Creek. Table 3-2 presents a cross-walk of the AOIs with the economic reaches contained in the Flood Damage Assessment model (HEC-FDA) and indicates the number and value of damageable properties located in each AOI.

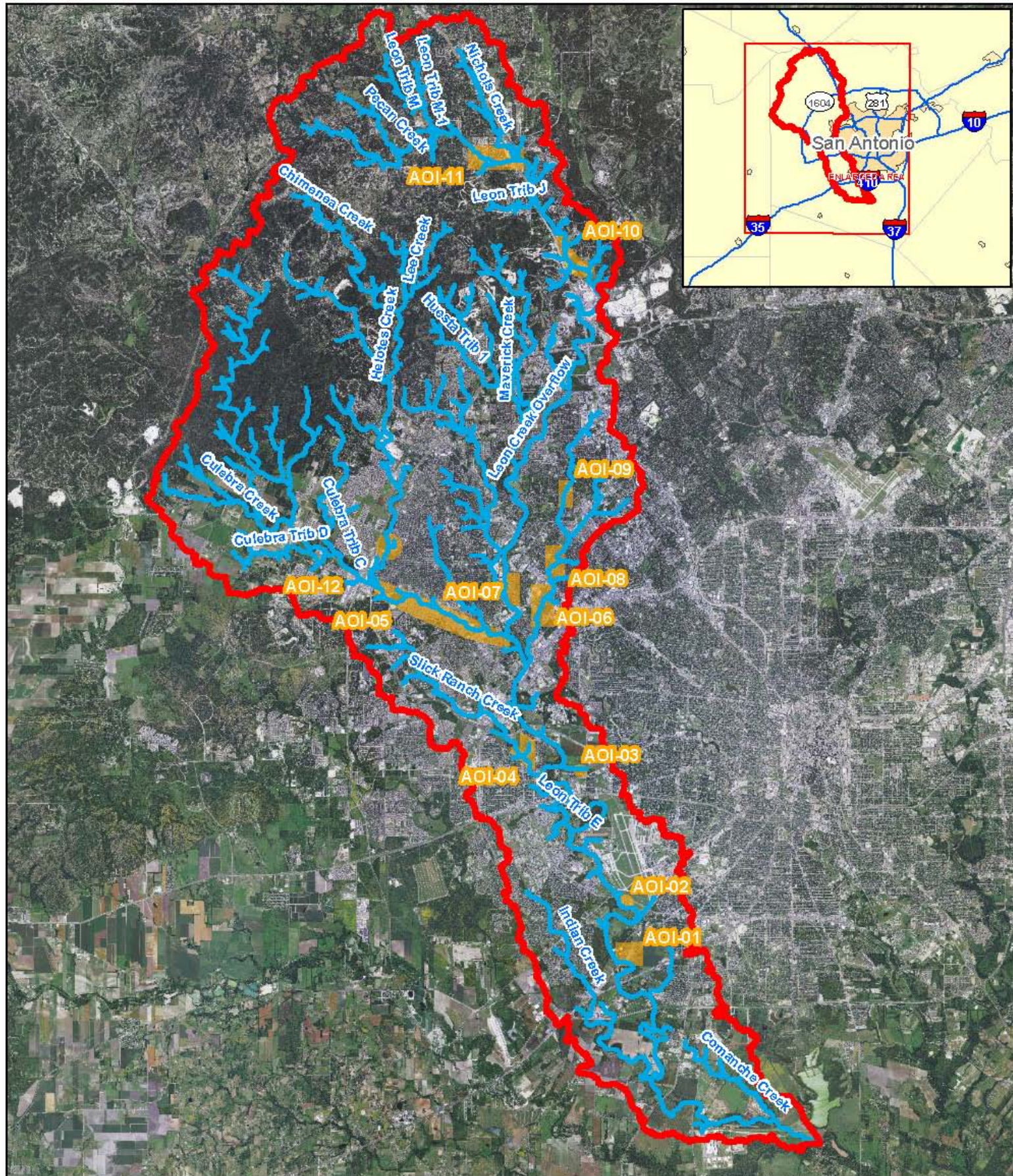
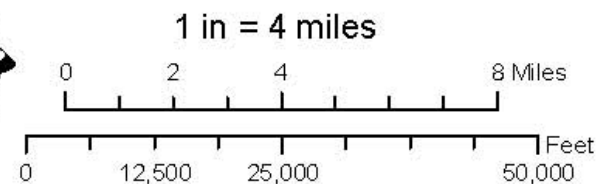


Figure 3-2.
Areas of Interest
Structural Analysis



US Army Corps of Engineers
Fort Worth District

Project: Leon Creek
Project Manager: Maura Robbins
Section: O BEM - P BLP
Date: October 10, 2012
Author: Lucas Daniels
Location: Leon Creek
File: LeonCreekStructuralAnalysis

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**Table 3-2 Damageable Property in each Area of Interest
(October 2012 price level - \$000)**

	Reach/ Structure Type	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
		No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value
AOI-1	Leon Creek 2																
	Single-Family	0	0	10	1,064	26	2,978	32	3,266	33	3,289	33	3,289	34	3,441	36	3,747
	Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mobile Home	0	0	10	19	78	213	116	499	117	760	117	1,035	117	1,482	118	2,056
	Commercial	0	0	25	1,248	36	1,342	41	1,409	43	1,529	50	2,142	58	2,873	61	3,207
	Public	0	0	0	0	0	0	2	9	3	14	3	14	3	14	3	14
AOI-1	Total	0	0	99	3,047	157	6,047	191	7,545	196	7,708	203	8,321	212	9,204	218	9,852
AOI-2	Leon Creek 3L and 3R																
	Single-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Commercial	0	0	2	344	5	35,447	5	35,447	5	35,447	5	35,447	6	35,468	6	35,468
	Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AOI-2	Total	0	0	2	344	5	35,447	5	35,447	5	35,447	5	35,447	6	35,468	6	35,468
AOI-3	Leon Trib F																
	Single-Family	0	0	0	0	0	0	16	2,340	26	3,416	59	6,401	81	7,715	100	9,235
	Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Public	0	0	0	0	0	0	1	73	1	73	1	73	1	73	1	73
AOI-3	Total	0	0	0	0	0	0	17	2,413	27	3,489	60	6,474	82	7,788	101	9,308
AOI-4	Slick Ranch																
	Single-Family	0	0	44	6,213	104	14,874	140	20,030	155	22,294	170	24,472	209	30,144	255	36,859
	Multi-Family	0	0	0	0	1	336	4	1,345	5	1,681	6	2,017	6	2,017	6	2,017
	Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Commercial	0	0	0	0	0	0	0	0	0	0	5	15,798	5	15,798	8	16,970
	Public	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AOI-4	Total	0	0	44	6,213	105	15,210	144	21,375	160	23,975	181	42,287	220	47,959	269	55,846
AOI - 5	Culebra Creek 1																
AOI - 5	Single-Family	0	0	0	0	6	1,443	68	16,355	199	51,099	360	93,381	697	174,875	972	239,869
AOI - 5	Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AOI - 5	Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AOI - 5	Commercial	0	0	0	0	1	60	8	645	10	1,023	19	1,758	52	13,458	65	19,137
AOI - 5	Public	0	0	0	0	0	0	0	0	0	0	0	0	1	218	2	265

	Reach/ Structure Type	50% AEP		20% AEP		10% AEP		4% AEP		2% AEP		1% AEP		0.4% AEP		0.2% AEP	
		No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value
AOI - 5	Total	0	0	0	0	7	1,503	76	17,000	209	52,123	379	95,139	750	188,551	1,039	259,272
AOI-5/7	Leon Creek 5L and 5R																
AOI-5/7	Single-Family	0	0	0	0	0	0	0	0	42	7,083	142	23,772	246	41,916	328	56,043
AOI-5/7	Multi-Family	0	0	0	0	0	0	1	2,694	8	19,060	13	27,417	17	37,457	17	37,457
AOI-5/7	Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AOI-5/7	Commercial	0	0	1	157	9	3,367	14	8,560	16	9,121	19	9,424	24	11,194	36	35,726
AOI-5/7	Public	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3	1
AOI-5/7	Total	0	0	1	157	9	3,367	15	11,254	66	35,264	174	60,613	289	90,567	384	129,226
AOI-6/8/9	Huebner Creek																
	Single-Family	0	0	2	30	10	1,538	50	10,189	100	19,910	170	35,498	290	63,494	360	79,724
	Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	2	1,287	10	11,184
	Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Commercial	0	0	1	24	2	76	3	230	3	230	5	473	6	484	7	498
	Public	1	93	2	105	5	170	10	249	13	888	15	2,519	15	2,519	16	2,575
AOI-6/8/9	Total	1	93	5	159	17	1,784	63	10,669	116	21,028	190	38,490	313	67,784	393	93,980
AOI-10/11	Leon Creek 6																
AOI-10/11	Single-Family	0	0	0	0	2	482	6	1,428	25	7,332	45	14,144	68	21,972	89	29,680
AOI-10/11	Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AOI-10/11	Mobile Home	0	0	0	0	0	0	0	0	8	265	15	522	25	663	40	915
AOI-10/11	Commercial	0	0	3	29	26	3,218	52	34,407	66	37,575	77	46,421	89	58,045	97	60,366
AOI-10/11	Public	0	0	0	0	5	698	13	2,110	16	2,619	22	2,896	27	3,103	30	3,335
AOI-10/11	Total	0	0	3	29	33	4,399	71	37,945	115	47,791	159	63,982	209	83,783	256	94,295
AOI-11	Leon Creek 7 and Huebner Trib L																
AOI-11	Single-Family	1	117	7	2,540	46	17,299	104	38,547	156	61,329	184	70,625	216	84,238	239	91,646
AOI-11	Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AOI-11	Mobile Home	0	0	0	0	0	0	1	125	1	125	1	125	1	125	1	125
AOI-11	Commercial	0	0	0	0	8	721	8	721	10	1,684	13	2,595	20	6,984	23	8,869
AOI-11	Public	0	0	0	0	2	67	2	67	2	67	2	67	2	67	2	67
AOI-11	Total	1	117	7	2,540	56	18,086	115	39,459	169	63,204	200	73,412	239	91,414	265	100,707
AOI-12	Helotes Creek																
AOI-12	Single-Family	0	0	0	0	5	2,126	11	3,991	30	7,585	106	21,814	162	33,127	233	46,579
AOI-12	Multi-Family	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AOI-12	Mobile Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AOI-12	Commercial	0	0	4	48	17	1,201	29	2,236	39	3,115	42	3,448	44	3,983	53	4,847
AOI-12	Public	0	0	0	0	0	0	0	0	0	0	4	66	4	66	19	3,875
AOI-12	Total	0	0	4	48	22	3,327	40	6,227	69	10,701	152	25,328	210	37,177	305	55,302

Measures Considered

A wide variety of structural measures was initially considered in an attempt to identify economically justified flood risk reduction strategies. The array of initial measures available for consideration included channel modification, bypass channels, levees, local detention, regional detention, and overbank storage. Based on site visits, review of aerial photography and prior technical reports (including the Bexar County Flood Insurance Study and the SARA regional stormwater detention master plan), and best professional judgment, a number of potential alternatives from these measures were screened from consideration in specific Areas of Interest.

In general, the initial screening process employed a hierarchical approach; detention strategies, whether regional in nature or on-site, were generally considered first. The primary reason for this preference is that much of the Leon Creek flooding results from peak-on-peak flooding from tributaries, and a detention approach was highly applicable. Detention would also be expected to improve conditions in damage centers further downstream as well as in the immediate vicinity of its location and was thought to provide the maximum opportunity to benefit multiple portions of the study area simultaneously. Where detention was infeasible, channelization options were considered next, with levees considered only where the other options were not expected to be effective. Table 3-3 portrays the results of this largely qualitative screening process and indicates that detention was initially considered as a measure for all damage centers except 3 and 4, which are located on very small tributaries with insufficient storage capacity.

Channelization was considered as a viable measure for damage centers 4, 7, 9, and 12. It was not considered for AOI's 1 and 2 because the extremely large flow quantities would require dropping the channel bottom an estimated 6 to 8 feet, and excavation of that magnitude was not considered to be feasible. Flooding in AOI 3 results primarily from Leon Creek backwaters, and channelization was estimated to be ineffective for that condition. In AOI-5, Culebra Creek is already channelized from back-of-house to back-of-house and down to bedrock; additional channelization was not considered feasible. Similarly, AOI-s 6,7, 8, and 10 were estimated to have insufficient grade, or insufficient room (or both) for channelization to be effective. Leon Creek in AOI-11 is already channelized to bedrock.

Because of the urban nature of the watershed (in consideration of both space requirements and the possibility of overtopping) levees were considered only for very specific applications. In AOI -2, a levee is already present -- it simply isn't large enough to be effective. In AOI-3, a levee was felt to be the only effective way to prevent backwaters out of the residences, while in AOI-7, the channelization option was expected to be constrained by a landfill and was expected to be insufficient to prevent significant flood damages, so levees were considered as an alternative. Consideration of a levee in AOI-11 was specifically requested by the Sponsor.

A bypass channel was considered in AOI-2 because there was a bend in channel (natural oxbow) specifically in a location that was subject to flooding. Similarly, AOI-1 was the only damage center having a suitable location for overbank storage, so that option was considered in the initial screening for that location.

Table 3-3 identifies the initial group of measures (21) evaluated for economic justification. Narrative descriptions and plates depicting the original twenty-one measures are included in Appendix G.1. Locations for each measure are shown in Figure 3-3.

Table 3-3. Initial Array of Measures

	Regional Detention	Local Detention	Channel Modification	Levee	Bypass Channel	Overbank Storage
AOI-1	#11,12,13,14,17					#1
AOI-2	#11,12,13,14,17			#2,3	#4	
AOI-3				#6		
AOI-4			#5			
AOI-5	#11,12,13,14					
AOI-6	#9	#7				
AOI-7	#17		#20, 21	#15, 16		
AOI-8	#9	#7				
AOI-9	#9		#8			
AOI-10		#18				
AOI-11		#18		#19		
AOI-12	#11	#12	#10			

Economic Analysis – Initial Suite of Alternatives

The economic analysis of the initial suite of alternatives is discussed in detail in Appendix A, Economics. Water surface profiles were developed for each alternative and compared individually to those of without-project future condition. Future average annual damages were computed using HEC-FDA, with an interest rate of 4.125 percent (the Federal interest rate in effect at the time of the analysis) and an analysis horizon of 50 years. Total Annual Benefits are the dollar amount of flood damages reduced by the specific alternative, as indicated by the difference in average annual equivalent (damages) in the without-project and the with-project condition. Table 3-4 provides a summary of the economic performance of the initial suite of alternatives. (October 2010 price levels, 4.125% Federal Interest Rate)

Table 3-4 Economic Performance - Initial Suite of Alternatives

Alternative	Name	Without-Project EAD (\$)	With-Project EAD (\$)	Total Annual Benefits (\$)	Total Annual Costs (\$)	Net Benefits (\$)
1	Leon Creek Overbank Mod	13,593,450	13,444,070	149,380	987,000	-837,620
2	Leon Creek 100-Year Levee	13,593,450	12,543,800	1,049,650	593,700	455,950
3	Leon Creek 500-Year Levee	13,593,450	11,659,930	1,933,520	\$789,300	1,144,220
4	Leon Creek Bypass Channel	13,593,450	12,466,140	1,127,310	239,600	887,710
5	Slick Ranch Crk Channel Mod	13,593,450	13,392,860	200,590	*	*
6	Leon Trib F 500-Year Levee	13,593,450	13,474,430	119,020	73,700	45,320
7	Huebner Trib A Pond	13,593,450	13,319,190	274,260	1,028,400	-754,140
8	Huebner Channel Mod	13,593,450	13,577,210	16,240	78,700	-62,460
9	Huebner Creek RSWF**	13,593,450	13,565,200	28,250	279,300	-251,050
10	Helotes Channel Mod	13,593,450	13,486,660	106,790	431,200	-324,410
11	DC-12 Helotes Creek RSWF	13,593,450	12,091,260	1,502,190	678,000	824,190
12	Helotes Quarry Pond	13,593,450	11,566,850	2,026,600	498,000	1,528,600
13	Government Canyon RSWF	13,593,450	12,138,410	1,455,040	1,630,500	-175,460
14	Government Canyon RSWF	13,593,450	11,671,520	1,921,930	858,000	1,063,930
15	Leon 100-Year Levee	13,593,450	13,291,180	302,270	1,204,500	-902,230
16	Leon 500-Year Levee	13,593,450	13,322,910	270,540	414,500	-143,960
17	Quarry at the Rim	13,593,450	13,199,770	393,680	\$1,342,600	-948,920
18	AOI-11 Ponds	13,593,450	12,538,300	1,055,150	1,054,100	1,050
19	Boerne Stage Rd Improvement	13,593,450	***	***	***	***
20	300' BW Channel – Leon R5	13,593,450	13,273,280	320,170	920,400	-600,230
21	200' BW Channel – Leon R5	13,593,450	13,283,160	310,290	352,800	-42,510

*Costs not calculated for this alternative – see Appendix A for discussion

** Regional Storm Water Detention

*** Analysis consisted of incorporating the Boerne Stage Road Improvements (constructed by others) into the HEC-RAS model. No significant effect on water surface profiles observed.

Note that the initial analysis of Alternatives 5 and 19 was truncated. Alternative 5 consists of incorporating a channel modification project already constructed by the City of San Antonio in the Slick Ranch Creek segment of the watershed. The original thinking was that the sponsor might seek credit for this work as a part of the Federal project. Benefits for this alternative were estimated, but the Sponsor decided not to proceed with additional investigations in this area. Alternative 19 consisted of incorporating an already-constructed road improvement project in the vicinity of AOI-11 into the model to determine the degree to which the road improvements might function as a levee and provide ancillary protection. No significant effect on water surface profiles was observed with the road improvement in place and no additional analysis was conducted.

Additional “First-Generation” Alternatives

During the later phases of the initial screening, the team developed and screened several additional concepts. Alternative 22 was developed to address damages in AOIs 6, 8, and 9. The alternative represented a combination of Alternative 7 (localized detention on Huebner Trib A) and Alternative 9 (localized detention on Huebner Creek at Prue Road.) The marginal increase in benefits by combining the alternatives was minor and resulted in significant negative net benefits.

Alternative 23 was developed to address damages in the lower end of AOI-5, at the confluence of Culebra and Leon Creeks. Several variations of channel modifications were formulated; however, all had negative net benefits.

Assessment of Initial Screening

Based on the initial screening, the team focused their attention on those damage centers where it appeared that an economically justified project could be developed. In AOI-2, Alternatives 2, 3, and 4 all had positive net benefits, suggesting that further analysis was warranted in this area. All four regional detention options upstream of AOI-5, as well as local detention in the vicinity of AOI-11 (Alternatives 11, 12, 14, 18) demonstrated positive net benefits, suggesting additional evaluation.

Alternative 6 (AOI-3) had positive net benefits but was not evaluated further based on lack of sponsor interest/support. Finally, a comparison between the performance of Alternative 20 and 21 (AOI-7) indicated that reducing the channel bottom-width significantly improved project performance, and suggested that evaluation of additional (smaller) alternatives might result in positive net benefits.

REFINEMENT OF STRUCTURAL ALTERNATIVES

Based on the team's assessment of the initial screening results, additional analysis was conducted in order to refine and optimize promising alternatives. This effort was focused in AOI-2 (Leon Creek Reach 3), AOI-5 (Culebra Reach 1 and Leon Reach 5), and AOI-7 (Leon Creek Reach 5). As in the initial screening, the focus of this phase of plan formulation and identification was NED benefits. However, as discussed below, consideration of the Environmental Quality (EQ) Account played a significant role in the screening process as well. Consideration was given to Other Social Effects, most particularly in the context of risks to human health and safety, and Regional Economic Development. However, these considerations did not significantly alter plan selection.

This phase of the analysis used a 4.125% interest rate, which was the Federal interest rate in effect at the time and a 50-year period of analysis. The refinement process was initially conducted for each damage center (Area of Interest) individually. Potential combinations of optimized alternatives for multiple Areas of Interest are discussed in the subsequent sections of this report.

AOI-2 (Leon Reach 3)

The primary structures in AOI-2 are a large Jet Engine Test Cell facility and a mix of commercial properties. These structures are located in an area which incorporates the former Kelly AFB and has been redeveloped through the Base Realignment and Closure process as Port San Antonio. Port San Antonio is a multi-purpose, 1,900-acre facility established to serve as an aerospace complex and industrial hub. The Jet Engine Test Cell facility is owned by Port San Antonio, and is operated by Kelly Aviation Services which provides jet engine testing primarily for the Department of Defense. An existing levee/berm is located between the test facility and Leon Creek but is insufficient to prevent overtopping by frequent events. Flood damages start around the 20% AEP event. The initial screening evaluated both levee alternatives and channel modifications. Both types of alternatives were carried forward into more detailed analysis.

The original channel modification (Alternative 4) consisted of a bypass channel beginning just downstream of the crossing of Leon Creek and Military Drive and extending 2,738 feet in a south-southwesterly fashion, transferring flood flows across rather than along the oxbow in Leon Creek. The generic alignment of the bypass channel is depicted in Figure 3-4. During refinement of this alternative, the team identified a 48-inch sewer main that would require relocation. In response, the bypass channel alignment was modified slightly to avoid the high cost associated with this activity. Three scales of this alternative (100-feet, 40-feet, and 25-feet bottom-width) were evaluated. The economic performance of the refined bypass channel options is shown in Table 3-5. (Alternatives 2B, 3, 4A, 4B, and 4C)

The original levee concepts (Alternatives 2 and 3) consisted of adding a levee along Leon Creek from cross-section 85024 to 87627 along the east side of Leon Creek in order to prevent damages from occurring for the 1% and 0.2% AEP events, respectively. The 1% AEP levee has a maximum height of approximately 17 feet, while the 0.2% AEP levee has a maximum height of approximately 20 feet. The generic levee alignment is shown in Figure 3-3. A key element of the refinement of the levee alternatives for AOI-2 was the development of an internal drainage plan to mitigate storm flows behind the levee. This plan consisted of a storm drain and ditches which drain to a sump area. The sump area includes an

outlet culvert protected by a flap gate. The economic performance of both levee scales is shown in Table 3-5 (Alternative 2B and Alternative 3).

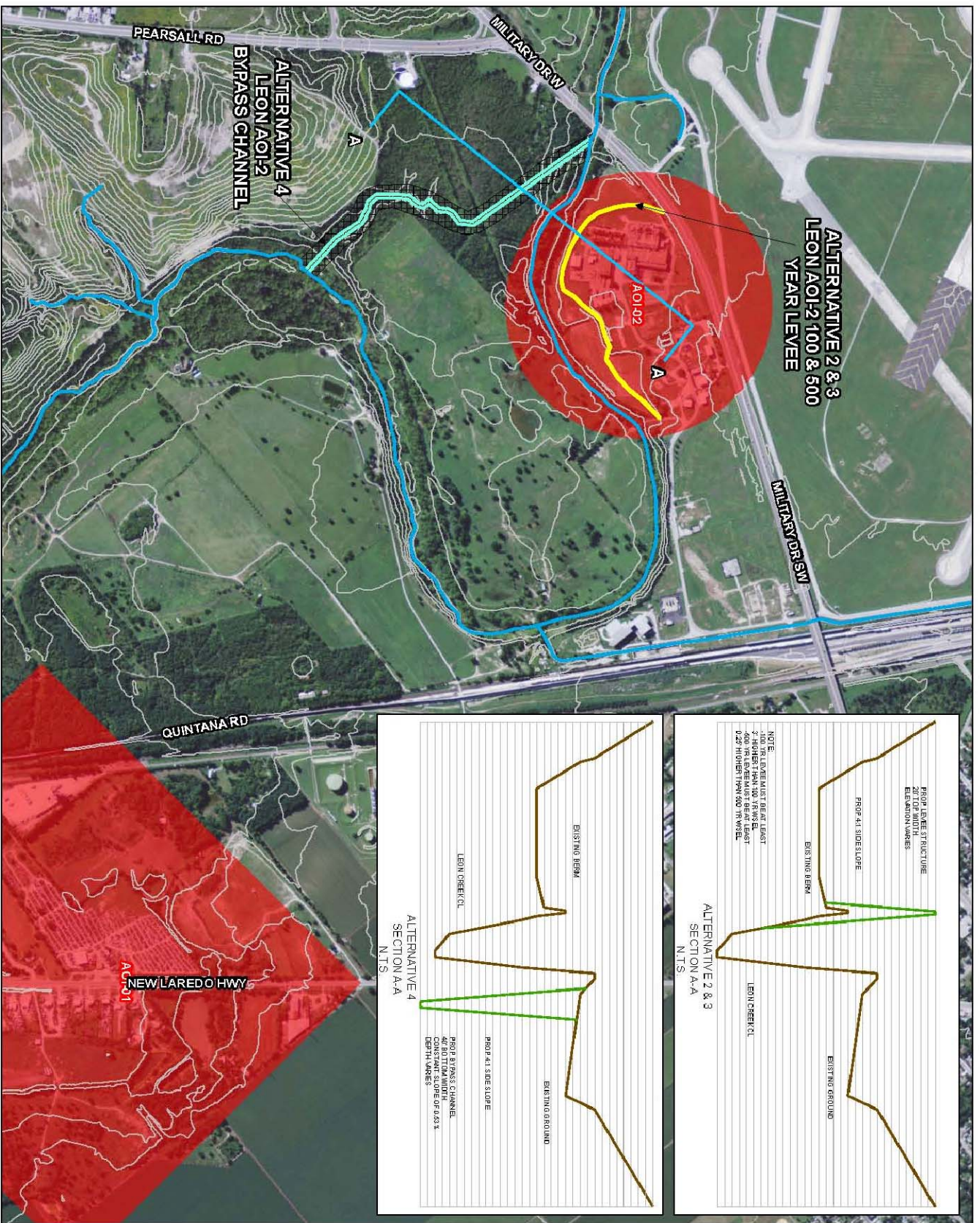


Figure 3-4 Alternatives Evaluated- AOI- 2

In an attempt to reduce the upstream increase in water surface elevations caused by the levee, a combination plan comprised of the 2B levee with the 4C bypass channel was evaluated (Alternative 2B/4C Combo). This concept increased net benefits but did not mitigate induced damages to the degree anticipated.

**Table 3-5. Economic Performance of Refined Alternatives – AOI-2
(October 2010 Price Levels/4.125% Federal Interest Rate)**

ID	Description	Annual Benefits	Annual Costs	Net Benefits
2B	1% AEP Levee w/int drainage	\$1,520,880	\$637,400	\$883,480
	Levee 2B/Channel 4C Combo	\$1,751,490	\$813,300	\$938,190
3	0.2% AEP Levee	\$1,933,800	\$789,300	\$1,144,500
4A	25' BW Channel	\$455,730	\$152,800	\$302,930
4B	40' BW Channel	\$545,640	\$165,800	\$379,840
4C	100' BW Channel	\$701,140	\$220,300	\$480,840

Based on the information contained in Table 3-5, the Project Delivery Team (PDT) determined that the levee alternatives performed significantly better than the stand-alone channel improvement alternatives. However, the upstream induced damages were of concern. In specific upstream areas, water surface elevations were as much as 1.5 feet higher with the 2B levee than under the Future Without-Project condition. A second set of refinements to the levee alternatives attempted to focus specifically on these upstream inducements. Based on the screening above, the team also explored the apparent benefits of adding additional channelization to the levee alternatives. The second-level refinements of the levee alternatives are described below and portrayed in Figures 3-5 and 3-6.

- **1% AEP Levee + Hydraulic Mitigation.** This alternative consists of adding a levee along Leon Creek from cross-section 85024 to 87627. The levee would run along the east side of Leon Creek in order to prevent damages from occurring for the 1% AEP storm event in AOI-2. The levee elevation would range from 640 feet on the downstream end to 649 feet on the upstream end. The greatest difference between the levee elevation and the existing ground elevation is 16.87 feet. In addition, for mitigation purposes, the channel was widened upstream of the Military Highway Bridge. From its origin, a 40-foot bottom width channel would run to a point immediately downstream of this bridge, and transition to 80-foot bottom width adjacent to the levee. Based on evaluation of the water surface profiles, the upstream channel modifications are sufficient to eliminate the induced increase in water surface elevations upstream of the levee.
- **1% AEP Levee + Hydraulic Mitigation + Bypass Channel.** This alternative consists of the 1% AEP levee/hydraulic modification described above with the addition of a 2,738-foot bypass channel on Leon Creek to divert flows away from AOI-2. The bypass channel would follow a south-southwest direction and pass some of the flows past the oxbow in Leon Creek before

tying back into Leon Creek. The bypass channel would begin just downstream of the crossing of Leon Creek and Military Drive around Leon cross-section 87864 and tie back into Leon between cross-sections 78641 and 77693. The bypass channel would have a bottom width of 40 feet and a constant slope of 0.53%.

- 0.2% AEP Levee + Hydraulic Mitigation. This alternative consists of a larger levee along Leon Creek from cross section 85024 to 87627 along the east side of Leon Creek. The levee elevation would range from 644 feet on the downstream end to 653 feet on the upstream end. The greatest difference between the levee elevation and the existing ground elevation is approximately twenty feet. This levee was combined with the hydraulic mitigation upstream of the Military Highway Bridge as described above. However, inspection of the water surface profiles for this configuration revealed that the upstream channel modification alone was insufficient to reduce the increase in water surfaces induced by the larger levee and that induced damages remained. Accordingly, this configuration was dropped from further evaluation and an economic analysis was not performed.
- 0.2% AEP Levee + Hydraulic Mitigation+ Bypass Channel. This alternative consists of the same features described above -- the larger levee along Leon Creek from cross-section 85024 to 87627 and the hydraulic mitigation upstream of the Military Highway Bridge – plus the 40-foot bottom-width bypass channel from Military Drive to the vicinity of Leon Creek cross sections 78641-77693.

**Table 3-6. Economic Performance of Refined Alternatives – AOI-2
(October 2010 Price Levels/4.125% Federal Interest Rate)**

ID	Description	Annual Benefits	Annual Costs	Net Benefits
2B +	1% AEP Levee+Hydraulic Mitigation	\$1,749,500	\$828,700	\$920,800
2B + 4C	1% AEP Levee+Hydraulic Mit+Bypass	\$1,750,260	\$1,001,600	\$748,660
3 + 4C	0.2% AEP Levee+Hydraulic Mit+Bypass	\$1,938,090	\$1,154,300	\$783,790

This analysis, as shown in Table 3-6, indicated that the bypass channel had only a very small effect on benefits and added substantially to costs. The larger levee also increased annual benefits as compared to the smaller levee; however, net benefits were essentially similar to those of the 1% AEP Levee + Hydraulic Mitigation plan. In contrast, the Hydraulic Mitigation added significantly to project performance. In addition to eliminating the induced increases in water surface elevations upstream of the levee, the hydraulic mitigation further reduces the water surface elevations by up to 2 feet in select locations and improves the annual benefits by \$228,620. The net annual benefits increase from \$883,480 to \$920,800, as can be seen by comparing Table 3-5 to Table 3-6 above.

Downstream water surface profiles with-and-without the project were compared in order to verify that the Levee + Hydraulic Mitigation alternative did not induce damages downstream of the project area. The comparison between the first floor elevations and the various water surface profiles with the 1% AEP Levee with Hydraulic Mitigation in place are virtually unchanged from the without project condition, indicated that there are no downstream induced damages. Additional detail is provided in the Economics Appendix.

A preliminary mitigation plan for the proposed plan has been developed. Consultation between team members and resource agencies indicates that reconstruction of the existing levee would result in insignificant impacts to the natural environment. The area in its current condition is heavily disturbed grassland that is frequently mowed. It appears that any needed relocation of existing utilities including an electrical power transmission line could be accomplished without impacting riparian vegetation along Leon Creek. Environmental impacts associated with the channel modifications would require environmental mitigation. However, in comparison with the stand-alone channelization alternatives, the extent and severity of potential in-channel impacts would be less for the levee alternatives. With respect to the choice between the levee configurations, the two levee scales both include the same upstream channel modification, and accordingly would carry the same mitigation requirement. As a result, the PDT was able to conclude that the screening of alternatives to reduce flood risks for this portion of the study area was not sensitive to mitigation costs. Additional discussion of environmental mitigation requirements is discussed in subsequent sections of the report.

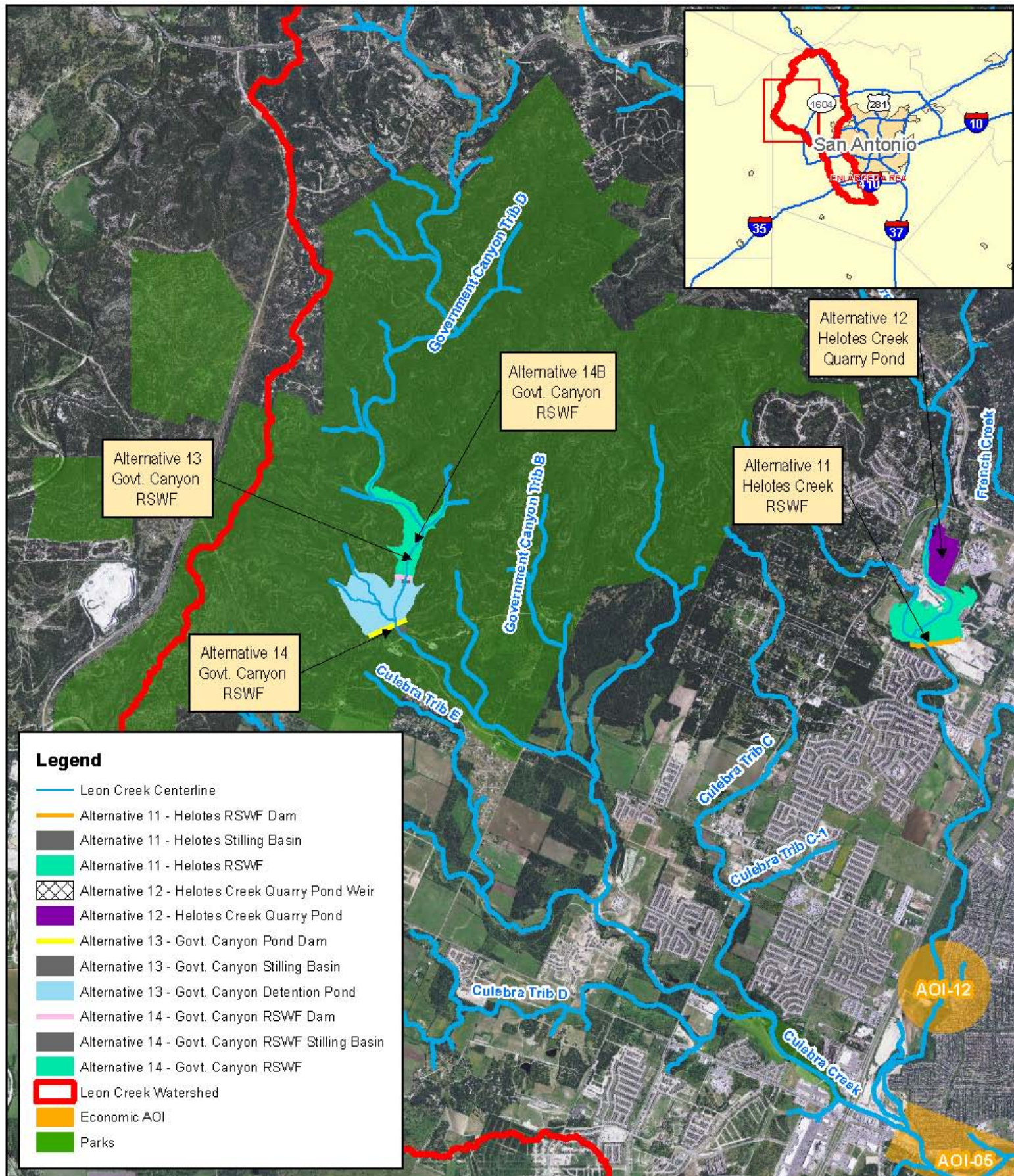
Based on this analysis, the PDT identified the 1% AEP Levee with Hydraulic Mitigation (Alternative 2B w/Mit) as the NED alternative for AOI-2 based on annual net benefits of \$920,800. Discussions with the Sponsor indicated that the Sponsor was satisfied with the level of protection provided by this alternative,

and was not inclined to pursue the larger levee. As a result, this alternative is recommended by the PDT for inclusion in the final plan.

AOI-5 (Culebra Reach 1 and Leon Reach 5)

AOI-5 constitutes one of the largest concentrations of damageable structures in the study area. Over 360 residential structures and 19 commercial structures are susceptible to damage from the 1% AEP event. Most structures in the damage center are located along Culebra Creek, but the damage center also includes structures on Leon Creek in the immediate vicinity of the Culebra Creek confluence. In the initial screening analysis, regional-scale detention was demonstrated to be the most promising strategy to reduce flood risks for this damage center. Four detention alternatives upstream of AOI-5 were evaluated. Two sites were located on Helotes Creek in addition to two sites in Government Canyon. An additional configuration in Government Canyon was evaluated during the more detailed planning iteration. These locations are shown in Figure 3-7. Note that all alternatives in Government Canyon are located within Government Canyon State Park.

Alternative 13 would consist of a detention facility created by a 60-foot high, 350-foot wide dam to be located on Culebra Creek approximately 1.5 miles upstream of the park entrance. This alternative would provide approximately 5,600 acre-feet of storage. Alternative 14 would consist of a 51-foot high dam located upstream of the Alternative 13 site with maximum storage of approximately 6,900 acre-feet. In the initial screening, Alternative 14 generated positive net benefits. Because of the environmental and cultural significance of the Government Canyon area, a smaller version of Alternative 14 (Alternative 14B) was added. However, as shown in Table 3-7, this detention option did not yield positive net benefits.



US Army Corps of Engineers
Fort Worth District

Project: Leon Creek
Project Manager: Kousa Robbins
Section: CBEW - P&E-PT
Date: October 10, 2012
Author: Lucas Daniels
Location: Year 1518 project
Output: Leon Creek documents

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**Figure 3-7.
Detention
Locations
Upstream
of AOI 5**



1 in = 1 miles

0 0.5 1 2 Miles

**Table 3-7. Economic Performance of Refined Alternatives – AOI-5
(October 2010 Price Levels/4.125% Federal Interest Rate)**

ID	Description	Annual Benefits	Annual Costs	Net Benefits
11	DC-12 Helotes Creek RSWF	\$1,540,530	\$678,000	\$862,530
12	Helotes Quarry Pond	\$2,026,620	\$498,000	\$1,528,600
12	Helotes Quarry Pond (Upper Bracket)	\$2,060,580	\$3,791,810	-\$1,731,230
13*	Gov't Canyon Site 1 (5,600 ac-ft)	\$1,455,040	\$1,630,500	-\$175,460
14*	Gov't Canyon Site 2a (6,870 ac-ft)	\$1,921,930	\$858,000	\$1,063,930
14B	Gov't Canyon Site 2b (1,845 ac-ft)	\$541,840	\$984,300	-\$442,460

* Alternatives 13 and 14 presented unchanged from initial screening

It is important to note that the initial cost estimates did not include environmental or cultural resource mitigation costs. All Government Canyon sites present significant environmental concerns, to include significant endangered species implications. Based on these considerations, regional detention in Government Canyon was not considered further.

In comparison to the Government Canyon sites, both Helotes Creek sites (Alternatives 11 and 12) generated positive net benefits in the initial screening. However, the difference between Alternatives 11 and 12 is both a matter of scale and location. In comparing the two, Alternative 12 has both higher benefits and lower costs, suggesting that it is located at the better site. Indeed, it takes advantage of an existing 50-acre quarry site (soon to be abandoned) that has been excavated to 100 feet below natural grade. This alternative would divert flood flow via a lateral weir into the quarry to take advantage of the 5,000 acre-feet of storage provided therein. This alternative would also include a pump station to evacuate stored flood waters from the detention site at a controlled rate after peak flood flows have passed.

With respect to project scale at the Alternative 12 site, development of a smaller-scale project at this site can be demonstrated qualitatively to be inferior in performance to the 5,000 acre-foot scale. The storage is provided essentially “free” with acquisition of the site. Utilizing less of the available storage would significantly reduce benefits without achieving any appreciable cost savings. On the other hand, consideration of a larger-scale plan would most likely require blasting or other excavation, which would be expected to increase costs substantially.

To validate this expectation, the PDT developed an option at the Helotes Quarry site which would store more water than Alternative 12 and would be expected to provide a greater reduction in flood risk. The “Larger Helotes Quarry” alternative would divert and store an additional 2,400 acre-feet of floodwaters. In order to provide this storage, excavation and blasting would be required. As a result, estimated first costs increased from just over \$10,000,000 to more than \$70,000,000 with only a negligible increase in benefits. A detailed economic assessment is included in Appendix A. Based on this analysis, the PDT

determined that the optimum scale of storage is full utilization of the existing quarry at the existing scale (sufficient to contain the 0.04 % AEP discharge) as conceptualized in Alternative 12 and depicted in Figure 3-8.



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Fort Worth District

Project: Leon Creek
Project Manager: Marie Vanderpool
Section: O&M/P&E-PT
Date: June 3, 2011
Author: Dawn Tran
Location: Leon Creek
Output: Leon Creek documents

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**Figure 3-8.
Alternative 12
Helotes Quarry
Detention Site**

**PROJECTION:
SOUTH CENTRAL TEXAS
STATE PLANE
FIPS 4204 FEET**



Feet
0 250 500 750 1,000

Unlike a levee or channelization strategy, the detention approach to flood risk reduction incorporates a need to evacuate the detention site after a flood event in order to regain the storage. As with a reservoir, the possibility exists that a second flood event might occur before full storage has been regained, however the team considered that the quarry has sufficient capacity to accommodate the remote probability of the occurrence of back-to-back flood events.

Environmental mitigation costs for the Helotes quarry detention alternative are minimal since there is very limited land needed beyond the quarry pit itself. Analysis of the quarry including berm but excluding pump pad - which could be constructed on previously disturbed lands - indicates that approximately 4.5 acres of forest would be impacted by the project. It is estimated that 1.11 average annual habitat units associated with the forest would be lost for the life of the project prior to environmental mitigation. Subsequent analysis indicates acquiring 4 acres of woodlands along the edge of the existing quarry near the creek channel with appropriate management would be sufficient to mitigate forest impacts.

Operation of the detention quarry to provide flood risk management benefits has been evaluated for potential impacts to aquatic resources. The evacuation pump has been sized to drain the quarry sufficiently for it to capture additional flood flows during subsequent runoff events. The rate of flow necessary to evacuate would not produce erosive flows to the intermittent Helotes Creek channel or banks nor would they adversely impact aquatic life. Therefore, no aquatic mitigation is required for this project alternative.

Overall, the cost of anticipated mitigation is relatively small and is not viewed by the PDT as a significant variable in the screening of alternatives for this portion of the study area. With annual net benefits of \$1,471,995 and a benefit-to-cost ratio of 3.65 to 1.0, the Helotes Quarry Detention Pond (Alternative 12) is identified as the highest-performing alternative for AOI-5 and recommended for inclusion in the final array of alternatives..

AOI-7 (Leon Reach 5)

Area of Interest-7 is located upstream of the Leon Creek/Culebra Creek confluence and consists of both single and multi-family residences with a mix of commercial structures. During the initial screening, five structural alternatives to reduce flood risk were evaluated. This suite of alternatives included two levee scales (Alternatives 15 and 16), a detention option (Alternative 17), and channelization (Alternative 20 and 21). Neither of the levee scales produced positive net benefits during the initial evaluation and were dropped from consideration.

Alternative 17 was developed to address damages in AOI-7, located in Leon Creek Reach 5, but benefits were anticipated to downstream reaches of Leon Creek as well. The alternative consists of diverting flows from Leon Creek into a quarry. The location is part of the Leon Creek Master Plan and is located north of Loop 1604 and east of IH-10. A lateral weir would divert some flood flows to a diversion channel which in turn would drain into the detention facility. Unlike the quarry on Helotes Creek, however, the Quarry at the Rim facility is a working quarry with an estimated economic life of 25 or more additional years of operation. When costs adequate to cover the condemnation value of the property's future income stream are included in the analysis, this alternative fails to generate positive net benefits.

Additionally, the local Sponsor has indicated that they are not willing to pursue condemnation of a working commercial establishment, and this alternative was dropped from further consideration.

Alternative 20 was initially suggested by the Bexar County Flood Control District and consists of approximately 6,125 feet of channel deepening and widening, using a bottom width of 300 feet to contain the 0.2% AEP event. Alternative 21 consisted of a shorter (3,820 feet) and smaller channel (200-foot bottom-width) to contain the 1% AEP event. While both alternatives failed to generate positive net benefits, economic performance improved significantly for the smaller channel. Accordingly, a number of increasingly smaller channels were evaluated, each reducing the amount of negative net benefits, until an optimal size was achieved with the 85-foot bottom-width channel. The results of this analysis are shown in Table 3-8.

**Table 3-8. Economic Performance of Refined Alternatives – AOI-7 Channel Plans*
(October 2010 Price Levels/4.125% Federal Interest Rate)**

ID	Description	Annual Benefits	Annual Costs	Net Benefits
20	300'-BW Channel	\$320,170	\$920,400	-\$600,230
21	200'-BW Channel	\$310,290	\$352,800	-\$42,510
21C	150'-BW Channel	\$315,570	\$352,500	-\$36,930
21D	100'-BW Channel	\$291,540	\$262,000	\$29,540
21E	85'-BW Channel	\$273,770	\$238,100	\$35,670

* Alternatives 20 and 21 presented unchanged from initial screening

Alternative 21E was tentatively identified by the team as the NED plan for AOI-7. (The naturally-occurring channel within the project footprint of Alternative 21E is approximately 80 feet in width. A smaller scale would conceptually involve filling in the channel, which seemed counter-intuitive and was not evaluated.)

Based on the tentative identification of Alternative 21E as the NED plan, updated and refined cost estimates were prepared. Specifically, Corps Real Estate and Cost Estimating personnel updated preliminary real estate and construction costs developed by the Contractor for screening purposes. As a result of this effort, the estimate of annual costs for the alternative increased to \$291,404. This increase in costs resulted in negative annual net benefits in the amount of \$17,634. Additional detail is provided in Appendix A (Economics) and Appendix G.5 (Cost Estimates).

Due to lack of positive net benefits, Alternative 21E was dropped from further consideration. Ultimately, no structural alternatives were found to be justified in terms of reducing flood risk in AOI-7.

AOI-11 (Leon Reach 6-7)

During the initial screening, Alternative 18 generated positive net benefits. Alternative 18 was developed to address damages in AOI-11, located on Leon Creek Reaches 6 and 7. The alternative consists of two ponds located upstream of AOI-11. Leon Trib M Pond is an inline pond located approximately 4,000 feet upstream of the northernmost crossing of Boerne Stage Road. It has a 42-foot high 300-foot wide dam providing storage of approximately 350 acre-feet. Leon XS 285313 Pond is an inline pond approximately 1.3 miles upstream of the crossing of Leon Creek and Huntress Lane. It has a 38-foot high 350-foot wide dam providing storage of approximately 450 acre-feet.

During the refinement stage, minor cost adjustments were made to Alternative 18, resulting in average annual equivalent of \$12,538,300 and annual benefits of \$1,055,150. Annual costs are estimated at \$1,054,100, yielding net annual benefits of \$1,050 and a benefit-to-cost ratio of 1.00. With minimal annual benefits, and believing the area to have historical significance, the local sponsor chose to not move forward with this alternative. No other alternatives evaluated to reduce flood risks for this area generated positive net benefits, and the PDT recommends no structural alternatives for AOI-11.

Further Refinement of Structural Alternatives

Additional refinements were done to those alternatives given serious consideration for inclusion in a tentatively selected plan. These refinements included updated M2 cost estimates and updated real estate costs to ensure that the alternatives moved forward actually performed as anticipated since the performance of some of these was very close. These included those alternatives identified in Table 3-6 for AOI-2 as well as two additional scales of levee projects in that same location (2% AEP and 0.4% AEP). These additional scales were evaluated in order to further enhance the team's understanding of how net benefits might change as the project increased or decreased in size and to assist in selecting the scale of project generating optimum net benefits. Both scales evaluated for the Helotes Quarry Pond in AOI-5 were also refined. These refined numbers are in Table 3-9 below.

**Table 3-9. Final Economic Performance of Refined Structural Alternatives
(October 2010 Price Levels/4.125% Federal Interest Rate)**

ID	Description	Annual Benefits	Annual Costs	Net Benefits
	2% AEP Levee+Hydraulic Mitigation	\$1,634,340	\$681,642	\$952,698
2B +	1% AEP Levee+Hydraulic Mitigation	\$1,749,500	\$682,387	\$1,067,113
4C	1% AEP Levee+Hydraulic Mit+Bypass	\$1,750,260	\$879,228	\$871,032
	0.4% AEP Levee+Hydraulic Mitigation+Bypass	\$1,935,420	\$866,343	\$1,056,042
3 + 4C	0.2% AEP Levee+Hydraulic Mit+Bypass	\$1,938,090	\$937,227	\$1,000,863
12	Helotes Quarry Pond	\$2,026,620	\$554,625	\$1,471,995
12	Helotes Quarry Pond (Upper Bracket)	\$2,060,580	\$3,791,810	-\$1,731,230

Based on this analysis, the 1% AEP levee, including hydraulic mitigation, produces the greatest net benefits.

The screening and refinement of structural alternatives discussed in the previous section resulted in the identification of two alternatives with the highest positive net benefits with the others being eliminated from further consideration based on economic performance. These alternatives would provide a reduction in flood risk in two separate damage centers within the Leon Creek watershed. Table 3-10 shows the flood damages remaining in the Leon Creek watershed with either Alternative 2B With Mitigation or Alternative 12 in-place. Price levels and interest rates shown are those in effect at the time this analysis was conducted.

**Table 3-10 With-Project Damages throughout the Leon Creek Study Area
(October 2010 Price Levels/4.125% Federal Interest Rate)**

Reach	Alternative 2b+Hyd Mitigation				Alternative 12		
	Without Project	With Project	Benefits	Residual AAE	With Project	Benefits	Residual AAE
Babcock Trib	382.11	382.11	0.00	382.11	382.11	0.00	382.11
Chimenea Creek	1.57	1.57	0.00	1.57	1.57	0.00	1.57
Culebra Creek Reach 1	1,977.59	1,977.59	0.00	1,977.59	662.73	1,314.86	662.73
Culebra Creek Reach 2	85.68	85.68	0.00	85.68	81.39	4.29	81.39
Culebra Creek Trib A	97.94	97.94	0.00	97.94	97.94	0.00	97.94
Culebra Creek Trib C	36.12	36.12	0.00	36.12	36.12	0.00	36.12
Culebra Creek Trib E	18.18	18.18	0.00	18.18	18.18	0.00	18.18
French Creek	266.43	266.43	0.00	266.43	266.43	0.00	266.43
French Creek Trip A	0.01	0.01	0.00	0.01	0.01	0.00	0.01
Helotes Creek	521.52	521.52	0.00	521.52	338.22	183.30	338.22
Helotes Creek Trib A	46.93	46.93	0.00	46.93	46.93	0.00	46.93
Helotes Creek Trib B	0.52	0.52	0.00	0.52	0.52	0.00	0.52
Huebner Creek	471.36	471.36	0.00	471.36	471.36	0.00	471.36
Huebner Creek Trib A	123.45	123.45	0.00	123.45	123.45	0.00	123.45
Huesta Creek	126.47	126.47	0.00	126.47	126.47	0.00	126.47
Indian Creek	89.50	89.50	0.00	89.50	89.50	0.00	89.50
Leon Creek Reach 1	4.14	4.14	0.00	4.14	3.17	0.97	3.17
Leon Creek Reach 2	528.93	528.93	0.00	528.93	486.81	42.12	486.81
Leon Creek Reach 3 Right	0.22	0.19	0.03	0.19	0.16	0.06	0.16
Leon Creek Reach 3 Left	1,937.56	188.52	1,749.04	188.52	1,715.21	222.35	1,715.21
Leon Creek Reach 4	1,165.58	1,165.15	0.43	1,165.15	964.96	200.62	964.96
Leon Creek Reach 5 Right	1,034.32	1,034.32	0.00	1,034.32	976.41	57.91	976.41
Leon Creek Reach 5 Left	310.79	310.79	0.00	310.79	310.67	0.12	310.67

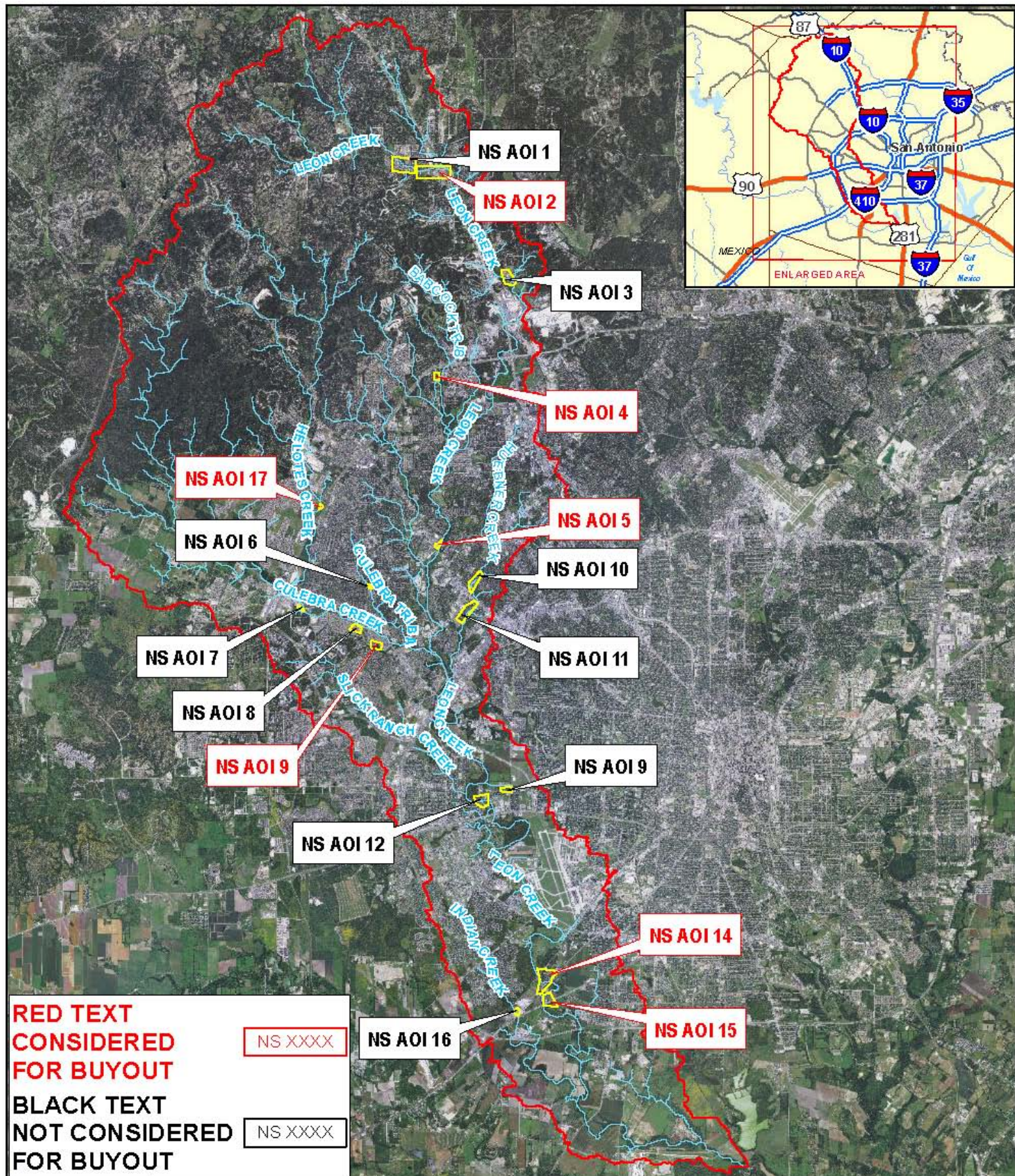
Reach	Alternative 2b+Hyd Mitigation				Alternative 12		
	Without Project	With Project	Benefits	Residual AAE	With Project	Benefits	Residual AAE
Leon Creek Reach 6	1,388.08	1,388.08	0.00	1,388.08	1,388.08	0.00	1,388.08
Leon Creek Reach 7	1,131.71	1,131.71	0.00	1,131.71	1,131.71	0.00	1,131.71
Leon Creek Trib B	0.32	0.32	0.00	0.32	0.32	0.00	0.32
Leon Creek Trib F	133.75	133.75	0.00	133.75	133.75	0.00	133.75
Leon Creek Trib H	0.21	0.21	0.00	0.21	0.21	0.00	0.21
Leon Creek Trib J	0.09	0.09	0.00	0.09	0.09	0.00	0.09
Leon Creek Trib K	181.87	181.87	0.00	181.87	181.87	0.00	181.87
Leon Creek Trib M	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Los Reyes Creek	35.44	35.44	0.00	35.44	35.44	0.00	35.44
Ranch Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Slick Ranch	1,388.67	1,388.67	0.00	1,388.67	1,388.67	0.00	1,388.67
Slick Ranch Trib B	98.29	98.29	0.00	98.29	98.29	0.00	98.29
Westwood Village Creek	8.10	8.10	0.00	8.10	8.10	0.00	8.10
Total (Positive Benefits)	13,593.45	11,843.95	1,749.50	11,843.95	11,566.85	2,026.60	11,566.85

As shown in this table, the refined 2B alternative provides benefits to only one economic reach (Leon Creek Reach 3, Left Bank) while the Helotes Quarry alternative reduces flood risks to at least some degree in nine of the economic reaches. However, 25 of the economic reaches in the study area are unaffected by either alternative. Substantial annual damages remain in a number of reaches, Leon Reaches 4-7 and Slick Ranch, in particular. In addition to these areas, Leon Reach 2 (AOI-1) has a number of single family and mobile homes within the 20% AEP delineation. While the previously described analyses indicated that structural alternatives to reduce flood risk in these reaches could not be economically justified, additional evaluation regarding the possibility of non-structural alternatives was made.

NON-STRUCTURAL ALTERNATIVES

Evaluation of non-structural alternatives focused primarily on removal of susceptible properties from the floodplain (floodplain evacuation). Other types of non-structural alternatives are either being implemented independently by SARA or were estimated to be relatively ineffective in dealing with flood damages. For example, a sophisticated real-time flood warning system is being developed by SARA in partnership with Bexar County; the Leon Creek portion of this flood warning system is expected to be operational in 2013. The flood warning system will be linked to the City and County Emergency Operations Center(s) and will provide updated information every 15 minutes during storm events. The deployment of this system should significantly reduce the risk to human health and safety during flood events, but will have limited effect on the damage caused by flooding to property. Best Management Practices to reduce or manage stormwater outside the floodplain are being encouraged and incentivized for new development by SARA and its jurisdictional partners as discussed in Section 2 previously. Flood proofing of structures in place was not supported by the Sponsor, in part because of concerns related to emergency access by first responders and concerns for placing both residents and those first responders at risk.

Initial screening for floodplain buyout alternatives was conducted by identifying (for each structure in the study area) the most frequent event which resulted in water surface elevations which exceeded the first floor elevation. The subset of the structure file for which the 50%, 20%, 10% and 4% AEP events resulted in water surfaces higher than the first floor elevation were color-coded and mapped for further consideration. This analysis resulted in identification of 16 “clusters” of highly susceptible properties (Areas of Interest) which are displayed in Figure 3-9. Note: The numbering convention for the Areas of Interest is not the same as the Areas of Interest for the structural evaluation and is distinguished by the “NS” nomenclature utilized for this discussion.



**US Army Corps
of Engineers**
Fort Worth District

Project: Leon Creek
Project Manager: Kousa Robbins
Section: OGBM-FEB-PT
Date: June 23, 2011
Author: Dawn Tran
Location: Leon Creek Watershed
Output: Leon Creek Watershed

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**Figure 3-9.
Non Structural
Areas of Interest**



1 in = 4 miles

0 2 4 8 Miles

0 12,500 25,000 50,000 Feet

Preliminary real estate and demolition costs were developed for the initial set of seventeen AOIs. A total of nine scales were evaluated. Six alternatives in three NS AOIs (4, 15, and 17) generated positive net benefits. The 10-year buyout in NS AOI -17 was dropped from consideration because it was a single land owner and the parcel was isolated from all other non-structural areas of interest leaving AOIs -4 and -15 as being carried forward. The preliminary screening of non-structural alternatives is depicted in the following table.

Two alternatives in NS AOI -14, one alternative in NS AOI -5 and one alternative in NS AOI- 9 were also carried forward even though they did not have positive net benefits, because they involved large tracts of land, and or adjacent to NS AOI -15, and the potential for recreation benefits was to be considered. More precise cost estimates were developed for these remaining alternatives. The final array of non-structural alternatives is depicted in Table 3-12. At this level of analysis, NS AOI-4 produced positive net benefits, while NS AOI-14 and NS AOI-15 appeared to be somewhat close to economic justification. The District did a preliminary analysis for NS AOIs -14 and -15 examining the potential for recreational features in these areas. This analysis showed that the benefit-to-cost ratios could be brought to unity (1.0) or slightly above but once costs were further refined they would more than likely be higher making any combination alternatives not economically justified. Therefore, these two NS AOIs were dropped from further consideration.

Table 3-11
Preliminary Screening of Non-Structural Alternatives

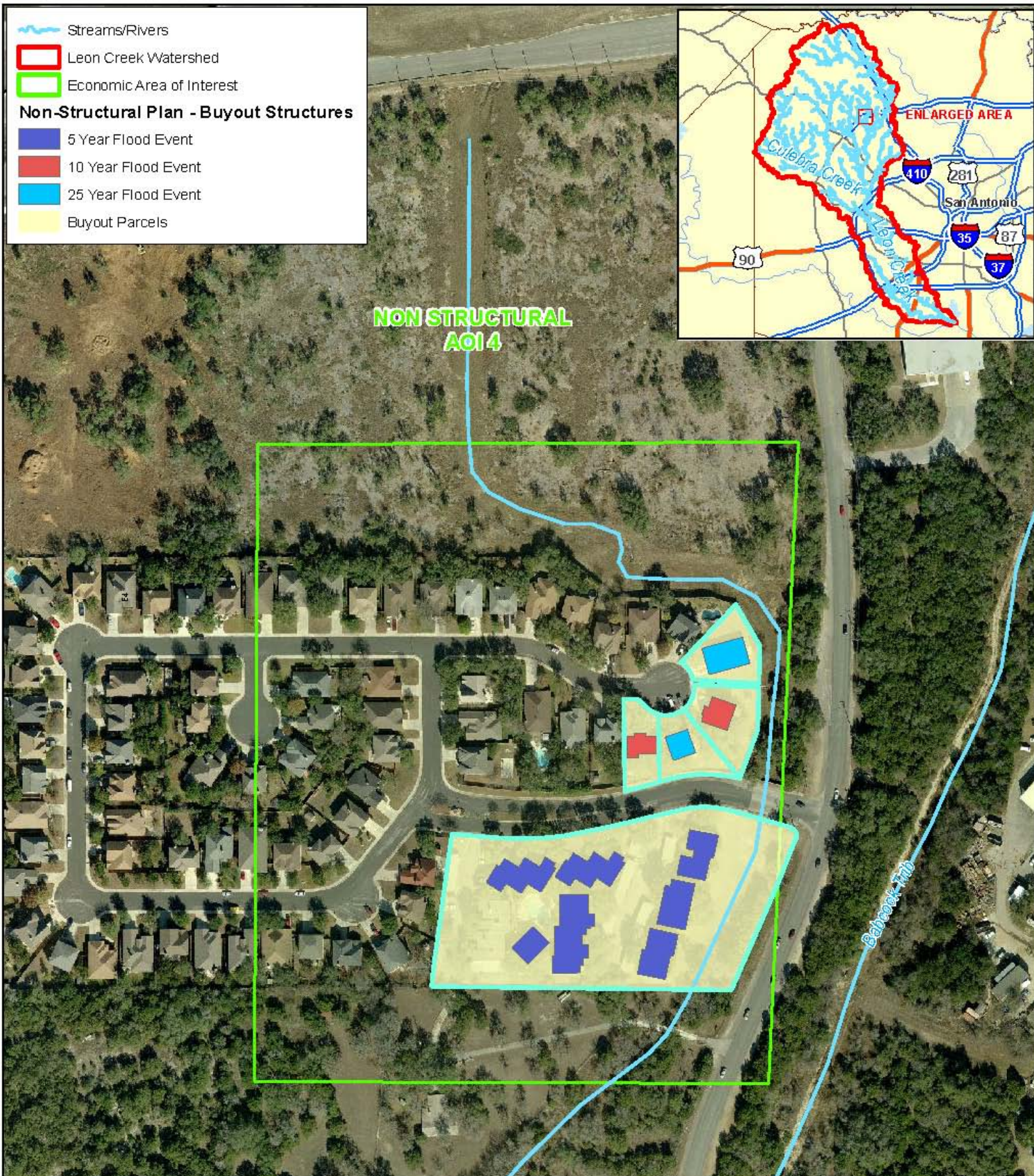
Non-Structural Area of Interest	AEP Event	Annual Benefits	Annual Costs	Annual Net Benefits	Benefit-to-Cost Ratio
NS AOI 1	10	\$265,790	\$278,410	(\$12,620)	0.95
	25	\$1,070,659	637,580	(\$433,079)	0.6
NS AOI 2	10	\$26,060	\$27,595	(\$1,899)	0.93
	25	\$919,270	\$969,036	(\$49,766)	0.95
NS AOI 3	25	\$59,780	\$162,101	(\$102,321)	0.37
NS AOI 4	5	\$322,420	\$71,468	\$250,952	4.51
	10	\$348,160	\$98,832	\$249,328	3.52
	25	\$358,580	\$125,252	\$23,328	2.86
NS AOI 5	25	\$258,690	\$286,421	(\$27,731)	0.9
NS AOI 6	10	\$22,770	\$38,650	(\$15,880)	0.59
	25	\$36,990	\$106,034	(\$69,044)	0.35
NS AOI 7	25	\$17,510	\$49,647	(\$32,137)	0.35
NS AOI 8	25	\$171,400	\$325,183	(\$153,783)	0.53
NS AOI 9	10	\$50,640	\$64,038	(\$13,398)	0.79
	25	\$156,970	\$273,679	(\$116,709)	0.57
NS AOI 10	25	\$40,340	\$131,148	(\$90,808)	0.31
NS AOI 11	25	\$48,800	\$150,291	(\$101,491)	0.32
NS AOI 13	25	\$73,020	\$267,730	(\$194,710)	0.27
NS AOI 14	10	\$275,490	\$369,235	(\$93,475)	0.75
	25	\$293,620	\$411,416	(\$117,796)	0.71
NS AOI 15	10	\$30,440	\$25,170	\$4,730	1.18
	25	\$141,710	\$127,609	\$14,101	1.11
NS AOI 16	5	\$910	\$62,821	(\$61,911)	0.01
	25	\$1,520	\$100,847	(\$99,327)	0.02
NS AOI 17	10	\$47,430	\$26,640	\$20,790	1.78

**Table 3-12 Final Array of Non-Structural Alternatives
(October 2010 Price Levels/4.125% Federal Interest Rate)**

	AOI 4 20% AEP	AOI 4 10% AEP	AOI 4 4% AEP	AOI 5 4% AEP	AOI 9 10% AEP	AOI 14 10% AEP	AOI 14 4%AEP	AOI 15 10% AEP	AOI 15 4% AEP
INVESTMENT									
<i>ESTIMATED FIRST COST</i>	\$1,174,157	\$2,048,758	\$2,801,744	\$9,455,887	\$1,851,643	\$8,569,969	\$9,387,157	\$1,455,581	\$3,663,906
<i>ANNUAL INTEREST RATE</i>	0.04125	0.04125	0.04125	0.04125	0.04125	0.04125	0.04125	0.04125	0.04125
<i>PERIOD OF ANALYSIS (years)</i>	50	50	50	50	50	50	50	50	50
<i>CONSTRUCTION PERIOD (months)</i>	24	24	24	24	24	24	24	24	24
<i>COMPOUND INTEREST FACTOR</i>	24.97	24.97	24.97	24.97	24.97	24.97	24.97	24.97	24.97
<i>CAPITAL RECOVERY FACTOR</i>	0.047551	0.047551	0.047551	0.047551	0.047551	0.047551	0.047551	0.047551	0.047551
<i>INTEREST DURING CONSTRUCTION</i>	\$46,708	\$81,500	\$111,454	\$376,159	\$73,659	\$340,916	\$373,425	\$57,904	\$145,752
<i>INVESTMENT COST</i>	\$1,220,865	\$2,130,258	\$2,913,198	\$9,832,046	\$1,925,302	\$8,910,885	\$9,760,582	\$1,513,485	\$3,809,658
ANNUAL CHARGES									
<i>INTEREST</i>	\$50,361	\$87,873	\$120,169	\$405,572	\$79,419	\$367,574	\$402,624	\$62,431	\$157,148
<i>AMORTIZATION</i>	\$7,693	\$13,423	\$18,356	\$61,952	\$12,131	\$56,147	\$61,501	\$9,536	\$24,005
<i>OPERATION/MAINTENANCE (\$/year)</i>	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
<i>REPLACEMENTS</i>	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
<i>TOTAL ANNUAL CHARGES</i>	\$58,053	\$101,296	\$138,525	\$467,524	\$91,550	\$423,722	\$464,125	\$71,968	\$181,153
ANNUAL BENEFITS									
<i>FLOOD DAMAGE REDUCTION BENEFITS</i>	\$71,468	\$98,832	\$358,580	\$258,690	\$50,460	\$275,490	\$293,620	\$30,440	\$141,710
<i>RECREATION BENEFITS</i>	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
<i>TOTAL ANNUAL BENEFITS</i>	\$71,468	\$98,832	\$358,580	\$258,690	\$50,460	\$275,490	\$293,620	\$30,440	\$141,710
<i>NET BENEFITS</i>	\$13,415	(\$2,464)	\$220,055	(\$208,834)	(\$41,090)	(\$148,232)	(\$170,505)	(\$41,528)	(\$39,443)
<i>BENEFIT-TO-COST RATIO</i>	1.23	0.98	2.59	0.55	0.55	0.65	0.63	0.42	0.78

Plan Formulation and Development of ALTERNATIVES

NS AOI-4 is located south of Loop 1604 and west of Babcock Road. It is subject to flooding from Babcock Creek. The proposed buyout alternatives includes four single-family residential structures (two subject to damages from the 10% AEP event and two subject to damages from the 4% AEP event) and 32 townhouses, all subject to damages from the 20% AEP event. The structures are located on five tracts totaling 3.85 acres. The NS AOI-4 buyout plan is shown in detail in Figure 3-10.



US Army Corps of Engineers
Fort Worth District

Project: Leon Creek
Project Manager: Roger Robbins
Section: C ERM/PT
Date: July 26, 2011
Author: Fawn Tran
Location: Leon Creek
File: Leon Creek Documents

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Figure 3-10.
NS AOI-4
Buyout
Alternative

PROJECTION:
SOUTH CENTRAL TEXAS
STATE PLANE
FIPS 4204 FEET

1 inch = 200 feet

Feet
0 250 500



Non-structural AOI-4 buyout has a first cost of \$2,801,744 (October 2010 price levels.) The total annual benefits for this alternative are estimated at \$358,580, while the annual costs (at 4.125% interest rate) are \$138,525. Net benefits are \$220,055 annually with a Benefit to Cost ratio (BCR) of 2.59.

Preliminary coordination with resource agencies indicates that the buyout of townhouses and residential structures included in this alternative would result in only minimal temporary adverse impacts to the natural environment. Trees adjacent to the structures would be preserved to extent possible, and following demolition and removal of debris, the disturbed areas would be replanted with grasses to stabilize the soil against erosion. Approximately 3.85 acres of floodplain lands would be available for use by the sponsor for open space uses. This alternative is not expected to require environmental mitigation other than compliance with best management practices during demolition to control dust emissions and surface erosion into the aquatic environment.

The PDT has identified the NS AOI-4 buyout as the NED plan for this portion of the study area and recommended its inclusion in the final plan due to annual net benefits of \$220,055.

DEVELOPMENT OF THE RECOMMENDED PLAN

Previous sections of this report have described efforts to identify economically justified alternatives to reduce flood risks in various portions of the Leon Creek watershed. Combination of these alternatives to form comprehensive alternatives requires additional analysis and consideration.

Next-added Increment Analysis

While the three economically justified alternatives are located in different parts of the watershed, the possibility exists that the hydraulic or economic effects of one alternative may interact with those of another, affecting the performance and justification of one or more component. To evaluate this possibility, the PDT conducted a Next-Added Increment analysis.

Of the three alternatives combined to form the final array of alternatives, the Helotes Creek Detention alternative has the most far-ranging effect. Located on an upstream tributary, it can be expected to modify water surface profiles downstream of the Leon Creek confluence and potentially affect the benefits of the AOI-2 levee alternative. Accordingly, the Helotes Creek Detention alternative was considered as the “first-added” increment in the plan. As previously discussed, it is justified as a stand-alone alternative, with net benefits of \$1,471,995 and a BCR of 3.65.

The other alternative affecting water surface profiles is the 100-year Levee with Hydraulic Mitigation in AOI-2. This alternative was considered as the “second-added” increment, forming the two-component alternative. The screening-level analysis of alternatives for AOI-2 did not include mitigation costs, as plan selection was not felt to be sensitive to this cost issue. However, for purposes of ensuring incremental justification of this alternative, a conservative estimate of mitigation costs was developed and included in the incremental analysis. The mitigation estimate was based on use of a mitigation bank to compensate for potential in-stream impacts associated with the channelization included as hydraulic mitigation in this alternative. Credits to mitigate one mile of aquatic channel cost approximately \$2.5 million per mile in geographically-comparable mitigation banks. Based on this, an estimate of \$2.2 million for aquatic mitigation was added to the AOI-2 alternative. This cost increase resulted in an increase in the annual charges to \$794,496 (compared to \$682,387) and a reduction of its net benefits, on a stand-alone basis, to \$955,004 (as compared to \$1,067,113).

Water surface profiles were developed for a with-project condition of the two-component alternative and economic justification assessed. The results are displayed in Table 3-13.

Table 3-13
NED Analysis of Helotes Quarry + AOI-2 Levee

Investment		
Estimated First Cost		\$24,613,988
Interest Rate		.04125
Period of Analysis (years)		50
Construction Period (months)		18
Interest During Construction		\$1,763,785

	Investment Cost	\$26,377,774
Annual Charges		
	Interest	\$1,088,083
	Amortization	\$166,206
	Operation and Maintenance	\$50,000
	Replacements	\$0
	Total Annual Charges	\$1,034,290
Annual Benefits		
	Flood Risk Mgmt Benefits	\$3,513,500
	Recreation Benefits	\$0
	Total Annual Benefits	\$3,513,500
	Net Benefits	\$2,209,210
	Benefit-to-Cost Ratio	2.69

Based on this analysis, the marginal benefits of the AOI-2 Levee alternative are \$737,215, representing the difference between the annual net benefits of the two-component alternative from Table 3-12 above and the annual net benefits of the one-component alternative (first-added increment) (\$1,471,995). This is slightly less (9%) than the net benefits for this alternative when estimated as a stand-alone project, indicating that upstream detention does have some effect as far downstream as AOI-2. However, the marginal net benefits for this increment are larger than its annual costs, yielding revised net benefits of \$54,828 annually and indicating that the alternative comprised of the Helotes Quarry alternative and the AOI-2 levee alternative is incrementally justified.

By definition, the non-structural increment in NS AOI-4 is not expected to have an effect on the hydraulic profiles, only on the economic assessment of damages. As a check, however, the same process described above was followed, using the NS AOI-4 as the third-added increment (3-component alternative). Results are shown in Table 3-14. Note that the project construction period is modified to 24 months to accommodate the slower buyout process.

Table 3-14
NED Analysis of Helotes Quarry + AOI-2 Levee + NS AOI-4

Investment		
	Estimated First Cost	\$27,415,733
	Interest Rate	.04125
	Period of Analysis (years)	50
	Construction Period (months)	24
	Interest During Construction	\$2,266,494
	Investment Cost	\$29,682,227
Annual Charges		
	Interest	\$1,224,392

Amortization	\$187,028
Operation and Maintenance	\$50,000
Replacements	\$0
Total Annual Charges	\$1,461,420
Annual Benefits	
Flood Risk Mgmt Benefits	\$3,872,080
Recreation Benefits	\$0
Total Annual Benefits	\$3,872,080
Net Benefits	\$2,410,660
Benefit-to-Cost Ratio	2.65

The marginal benefits of the non-structural alternative is \$201,450, estimated by the difference between the annual net benefits of the three-component alternative displayed in Table 3-13 and the two-component alternative displayed in Table 3-12. The annual net benefits for the non-structural alternative as analyzed on its own are estimated at \$205,340 -- a negligible difference likely due to the nature of the risk-based calculation with uncertainty within HEC-FDA. This indicates that the non-structural component is incrementally justified as a third-added increment.

Development of the Mitigation Plan

Of the three alternatives discussed above, only the 1% AEP levee (with its hydraulic mitigation component) requires environmental mitigation. Provided that construction activities are properly monitored and managed (additional detail is provided in Section Six, Project Implementation), no adverse effects are anticipated. The other structural alternative of the NED plan is the Helotes Quarry Pond in AOI-5. This is a highly disturbed site that will not require mitigation.

With respect to mitigation for the AOI-2 Levee Component, the construction staging area would temporarily impact approximately 10.4 acres of grasslands which would be replanted with grass following construction with no mitigation required. Modification of the channel itself would permanently impact both aquatic and riparian resources for a total impact of approximately two acres of in-stream habitat and approximately 17 acres of urban riparian woodlands. An initial conservative estimate on the tentatively selected plan was developed and included in the incremental analysis for purposes of ensuring incremental justification of this alternative. This initial estimate was based on use of a mitigation bank to compensate and included as hydraulic mitigation for the 1% AEP levee with hydraulic mitigation. However, further investigation into the availability of a mitigation bank uncovered some uncertainties prompting the District to look at other potential mitigation options. These include the aforementioned mitigation bank, mitigation within the Leon Creek watershed, mitigation along a degraded segment of Martinez Creek in the San Antonio River watershed, and mitigation of a degraded segment of Olmos Creek, also within the adjacent San Antonio watershed. Additional details regarding these mitigation options are laid out as the following:

Option 1 – Onsite Natural Stream Design Channel. Over the last decade, several FRM projects in the City of San Antonio such as the Mission Reach and Eagleland segments of the San Antonio River have been reconstructed to restore the aquatic and riparian ecological function to the channelized streams. This mitigation alternative would utilize the same Natural Channel Design (NCD) concepts used for Mission Reach and the Westside Creeks studies to “self mitigate” impacts to waters of the U.S. The NCD methods utilize vertical and horizontal structures in the form of cross vanes, rock weirs, J-hooks, or other natural material structures to maintain a neutral sediment transport balance for the creek. The NCD structures also recreate pool and riffle habitats with proper substrate to support a diverse community of aquatic organisms. The NCD methodology develops a functional, self-sustaining system providing valuable hydraulic transport, geomorphic functions, and ecological functions. Costs for this option were initially estimated to be \$672,354.

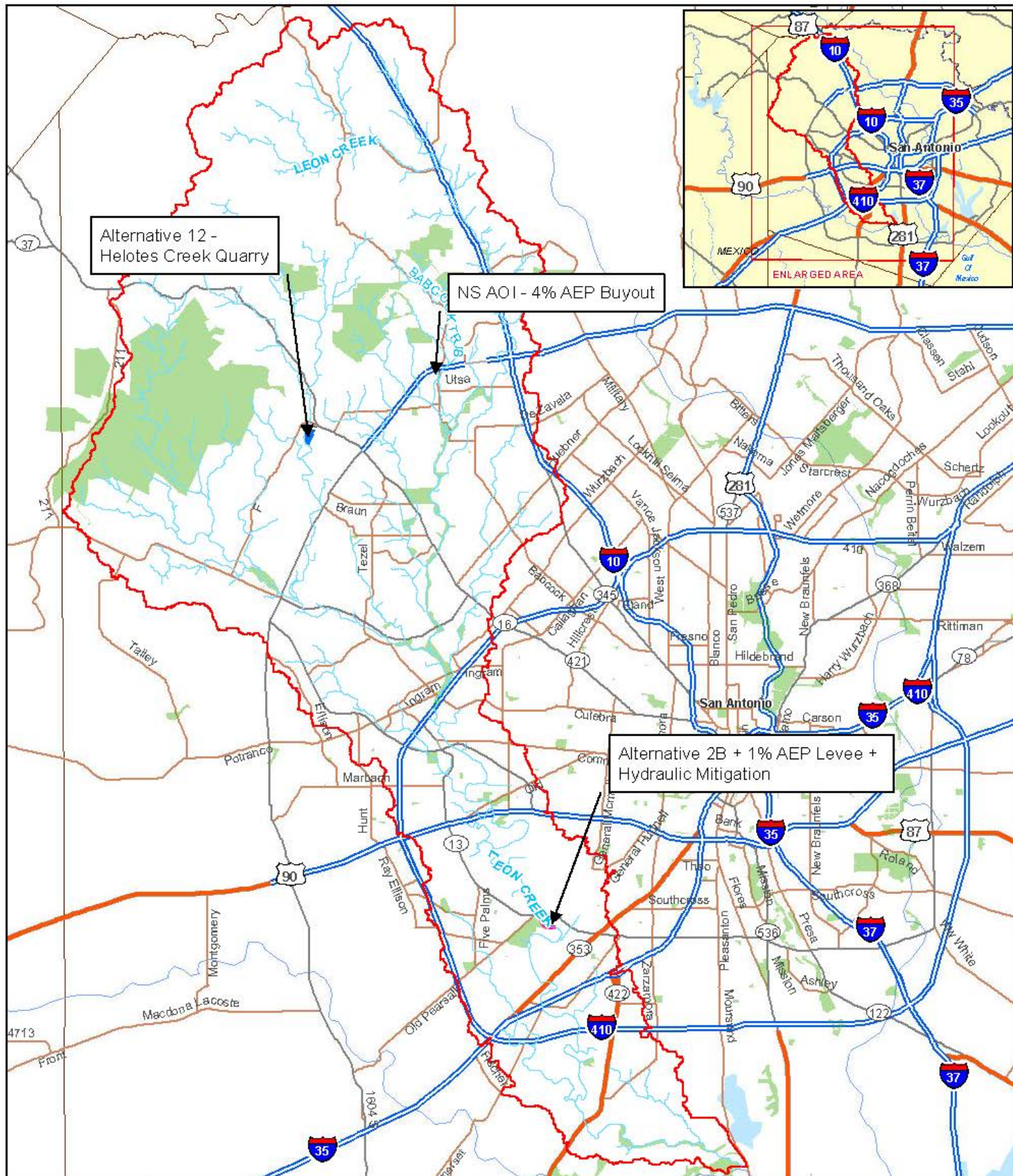
In order to mitigate for the impacts to riparian woodlands, additional channel excavation would be required to accommodate the placement of native riparian woodland vegetation along the riparian corridor of Leon Creek. Additional native riparian plantings would occur in the existing grassland habitats along the southern edge of the lower portion of the constructed NCD channel and downstream of the lower limits of the NCD channel to mitigate for all riparian woodland impacts. Using the Mission Reach and Westside Creek studies as a planning level guide, it is anticipated that an additional 10 acres of riparian woodland would be removed for the channel excavation required to accommodate a density of 70 stems per acre.

Option 2 – within Leon Creek Watershed. Since the area of impact for channelization is at the upper end of the Lower Leon Creek segment, the only segment of the Creek considered a perennial stream, the mitigation for stream impacts within the Leon Creek watershed would be limited to the area downstream of the channelization site to the Creek’s confluence with the Medina River. Two factors make this area problematic for use as stream mitigation. First, the existing aquatic habitat quality in this entire segment is considered high with an overall Rapid Bioassessment Protocols Index (RBPI) of 0.74 (the highest value within the watershed), so to further increase the functional value to an even higher value would require mitigation for a length at least 3 to 5 times greater than the area of impact (8,700-14,500 linear feet). The second limiting factor in this segment is the projected urbanization of the Lower Leon Creek segment in the future that would preclude being able to realize the functional lift in habitat value needed to mitigate the impacts during the 50-year life of the project. Due to these issues, no cost estimates were pursued.

Option 3 – Mitigation Bank. The Straus Medina Mitigation Bank is the only stream/wetland mitigation bank proposed within the study area. The mitigation bank prospectus was submitted to the Fort Worth District (SWF) on 1 June 2011, the Draft Mitigation Bank Instrument was submitted on 20 July 2012, and the Final Mitigation Bank Instrument was submitted on 28 January 2013. Since then, the mitigation bank sponsor has put the project on hold as a result of new mitigation bank permitting guidelines limiting the designation of in-stream mitigation credits established by CESWF in September 2013. Based on these new guidelines, it is possible that the sponsor may revise or withdraw the mitigation bank proposal.

If the sponsor decides to proceed with the mitigation bank proposal, there are still several uncertainties about the applicability of the use of the bank for the mitigation of stream impacts to Leon Creek. The Straus Medina Mitigation Bank is located on one side of the Medina River and does not have the

authority to control land use activities along the opposite bank. As current Fort Worth District (SWF) guidance requires the



US Army Corps of Engineers
Fort Worth District

Project: Leon Creek
Project Manager: Kousa Robbins
Section: O&M/P&E/PT
Date: June 23, 2011
Author: Dawn Tran
Location: Viewfile: \projects\leon_creek\documents\

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**Figure 3-11.
Leon Creek
All Inclusive**



1 in = 4 miles

0 2 4 8 Miles

0 12,500 25,000 50,000 Feet

sponsor to have control of both sides of a stream, creek, or river to be able to generate stream credits for perennial waters, the mitigation bank may not be able to provide compensation for the stream impacts for Leon Creek. Should these issues be resolved and the mitigation bank is able to provide stream credits, a high level of uncertainty remains regarding mitigation credit costs as there are no other established or proposed mitigation banks in the region and no competition to keep the costs of the mitigation credits in check. However, the highest level of uncertainty regarding the use of the mitigation bank centers on when and if the mitigation bank completes the application process. Based on input from the Fort Worth District Regulatory Branch, the estimated mitigation cost for this option was \$2.2 million. However, the availability of this option is very uncertain.

Option 4 – Martinez Creek. The restoration of Martinez Creek was originally evaluated as part of the Westside Creeks Ecosystem Restoration Study, currently in development. Of the four Westside Creeks, Martinez Creek was the only creek where the restoration of the stream channel was not justified by the Cost Effectiveness/Incremental Cost Analysis (CE/ICA) and alternative selection process.

Martinez Creek provides 2.8 miles of potential stream channel restoration opportunities from the headwaters to the confluence with Alazan Creek. The restoration of the natural stream channel design for Martinez Creek provides the hydraulic capacity to include the restoration of riparian woodlands within portions of the 50 acres of the Martinez Creek riparian corridor.

The primary reason the Martinez Creek segment was eliminated from the suite of alternatives was due to the cost of utility relocations required to construct the natural stream channel. However, the San Antonio Water System (SAWS) agreed to a Consent Decree with EPA to address waste-water infrastructure and maintenance. The Consent Decree would result in SAWS investing an additional \$492 million (compared to a 10 year average of \$600 million) over the next 10 years to rehabilitate and maintain its sewer infrastructure. The cost of the Martinez Creek restoration without the utility costs would be approximately \$3.3 million.

Option 5 – Use of one of SARA’s Identified Mitigation Sites. SARA has produced a technical report entitled “Stream and Wetland Mitigation Feasibility Report in the San Antonio Basin” dated April 2010 investigating the environmental and financial benefits of sponsoring mitigation banks within a four-county jurisdictional area (Bexar, Wilson, Karnes and Goliad). The study identified potential mitigation sites and ranked them based on criteria developed by analyzing GIS data and performing field investigations. The most promising sites were evaluated further to assess existing conditions. The study estimated the type and amount of restoration needed for each, calculated potential stream credits based on preliminary geomorphic/biologic investigations and regulatory guidance, analyzed the potential revenue, costs, profit, market demand, etc. and made recommendations for SARA. The study suggests that SARA is in a favorable position to pursue stream mitigation banking in the San Antonio River Basin. Four of the sites investigated have a relatively high potential to serve as potential mitigation banking sites based on linear feet of stream, mitigation potential, landowner interest, distance to development and geographical service area. To date, SARA has only had informal discussions with the Fort Worth District Regulatory Branch mitigation banking point of contact and SARA has not submitted a Mitigation Banking Proposal for USACE review. As a result, no timeline exists for when these sites may be available.

Based on consideration of these options in terms of both cost and confirmed availability, Option 1- Onsite Natural Stream Design Channel is recommended. This option has been coordinated with appropriate resource agencies and concurrence on the appropriateness of this mitigation strategy has been obtained. Since the estimated cost of implementing this strategy is significantly less than the Rough Order of Magnitude cost for a mitigation bank used in project justification, no concerns with economic justification of the AOI-2 Levee alternative are presented by selection of this mitigation option.

Evaluation of Alternative Plans

The Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, more commonly known as the Principles and Guidelines (P&G), specify four evaluation criteria for comparison of alternative plans. These criteria are Acceptability, Completeness, Effectiveness, and Efficiency. These criteria were used by the Project Delivery Team to develop a recommendation and are discussed further below.

Acceptability.

Within the context of the Principles and Guidelines, acceptability refers to the viability of an alternative plan with respect to acceptance by Federal and non-Federal entities, as well as the public. Compatibility with existing laws, regulations, and policies is also an important dimension of acceptability.

Acceptability played a major role in the evaluation and screening of alternatives, as discussed previously in this report. For example, marginally-performing alternatives in Government Canyon were dropped from consideration fairly early in the screening process based on documented concerns about the acceptability of detention features within this important natural resource. Another example of the role played by the acceptability criterion is the consideration given to the non-Federal sponsors concerns about the application of flood –proofing as a non-structural response specific to the Leon Creek flooding concern. All of the economically-justified alternatives used in the development of the alternative plans were considered by the PDT to be “acceptable” in the context of P&G evaluation. That is, they would be implementable, supported by the Local Sponsor and the public, and compliant with laws, regulation, and policy. All three of the final alternatives are comprised entirely of “acceptable” alternatives and were, accordingly, considered to be “acceptable” as well.

Completeness.

Planning guidance describes “completeness” as the extent to which a given alternative plan provides for all necessary investments and actions to ensure realization of the expected result. In general, the alternatives evaluated by the Leon Creek team were formulated to ensure the completeness of each alternative as a stand-alone project increment. An example would be the inclusion of hydraulic mitigation as a feature of the AOI-2 levee to compensate for changes in upstream flood stages induced by the levee. Consideration of “completeness” is likewise shown in the evaluation of downstream effects from channelization; this effort ensured that the channel component did not likewise require additional features to compensate for other unanticipated consequences. Because all measures comprising the alternative plans are considered “complete” in and of themselves, the three alternatives in the final array are likewise considered “complete.”

Effectiveness.

The effectiveness criterion addresses the degree to which an alternative plan alleviates the problems or achieves the objectives developed for the project. To be complexly “effective” a given alternative for Flood Risk Management would virtually eliminate existing and future flood damages. In the case of the Leon Creek watershed, the suite of alternatives to reduce flood damages which could be economically justified was limited, and substantial flood damages would continue to occur after project implementation. However, the project recommend for implementation by the team is the most comprehensive (effective) alternative in the final array. That is, the alternative comprised of all three economically justified alternatives (the AOI-2 levee, the Helotes Quarry, and the buyout in NS-AOI -4) is more “effective” in reducing flood risks than the two-component or single component alternatives.

Efficiency.

The Efficiency criterion describes the degree to which an alternative plan is the most cost-effective means of alleviating the project’s problems and/or achieving the project’s objectives. This criterion is largely incorporated into the evaluation of measures and alternatives through the identification of the National Economic Development (NED) plan – that is the alternative that maximizes net benefits economic benefits consistent with protecting the Nation’s environment. In almost all cases, the NED plan would also be considered the most “efficient” alternative. In the case of the Leon Creek project, each alternative carried forward by the team to build alternative plans was incrementally justified and was the alternative that maximized the NED benefits for that particular portion of the study area. The Next-Added Increment analysis presented in the previous section demonstrates that the addition of each alternative to a plan increases the total net benefits of the project, and that the three-component plan has greater net benefits than either of the other two alternatives in the final array. This indicates that the three-component plan, including required environmental mitigation, is the NED plan as well as the “most efficient” alternative.

Based on consideration of the Principles and Guidelines criteria, the Project Delivery Team recommends implementation of the three-component alternative, comprised of the 100-year levee in AOI-2 with hydraulic mitigation and environmental mitigation, the Helotes Creek quarry, and the buyout (permanent floodplain evacuation) of four single-family homes and 32 townhomes in NS AOI-4.

Description of the Recommended Plan

As described above, the alternative initially recommended by the PDT and supported by the Sponsor consisted of the 100-year Levee with Hydraulic Mitigation in AOI-2, the Helotes Creek Detention site, and the buyout (permanent floodplain evacuation) of four single-family homes and 32 townhomes in NS AOI-4. Storms during May of 2013 resulted in significant flooding in San Antonio and in the Leon Creek watershed. Fieldwork conducted by the team subsequent to this event established the fact that flood flows on Helotes Creek and its minor tributaries had resulted in channel movement in the vicinity of the Helotes Quarry project component. As a result of the channel migration, substantial amounts of flow now move into the quarry naturally. After extensive discussion and qualitative assessment, it was determined that most of the benefits estimated for this alternative were being achieved without further expenditure. As a result, the final Recommended Plan drops this component.

The Recommended Plan consists of the 100-year Levee with Hydraulic Mitigation in AOI-2, as described above, in combination with the buyout in NS-AOI-4. The proposed earthen levee at AOI-2 extends approximately 3,700 linear feet from high ground on the southeast side of the Test Cell area and wraps around to S.W. Military Drive. A twelve-foot top width will provide a maintenance/patrol access route along the top with 3.5:1 (H:V) side slopes. The levee is aligned to provide adequate benching between the riverside toe and the Leon Creek channelization for stability reasons, as well as to avoid existing buildings on the Test Cell site. The grading of landside toe ditches to a proposed sump area will convey interior runoff. Also, included at the Test Cell area is a soil-bentonite slurry wall to provide additional seepage control along the full length of the levee. Channelization at Leon Creek will extend approximately 2,850 linear feet and reduced to a 60-foot bottom width with no impacts to hydraulic conveyance.

The Recommended Plan includes mitigation for aquatic impacts associated with the channelization work in AOI-2; this mitigation plan would utilize the same Natural Channel Design (NCD) concepts used in the Mission Reach and the Westside Creeks project to “self-mitigate” impacts to waters of the U.S. The NCD methods use vertical and horizontal structures in the form of cross vanes, rock weirs, J-hooks, or other natural material structures to maintain a neutral sediment transport balance for the creek. The NCD structures also recreate pool and riffle habitats with proper substrate to support a diverse community of aquatic organisms. Woodland vegetation would also be placed along the riparian corridor in order to mitigate for impacts to riparian woodlands. Additional native riparian plantings would occur in the existing grassland habitats along the southern edge of the lower portion of the constructed channel and

downstream of the lower limits to mitigate for all riparian woodland impacts. The channel work included in the Recommended Plan will include 2,850 linear feet of naturally-designed channel, including one large and four small in-stream structures, and 20 acres of riparian vegetation planting and invasive species control.

The Recommended Plan has an estimated first cost of \$28,965,866 and produces flood risk reduction benefits estimated at \$2,128,340 annually with net benefits of \$698,770. The Recommended Plan minimizes damages at the 1% AEP level for the Test Cell area (AOI-2), and reduces flood damages at the 4% AEP level in NS AOI-4. It has only minor environmental effects and a benefit-to-cost ratio of 1.49 to 1.0. Identification of this plan is consistent with the emphasis on sustainability embodied in the Corps' updated Environmental Operating Principles. The following tables shows the costs and benefits of the recommended plan, first as separable elements and then combined at both the FY13 interest rate and at 7 percent.

**Table 3-15
AOI-2 Levee**

	at 3.75%	at 7.0%
Investment		
Estimated First Cost	\$24,726,489	\$24,726,489
Interest Rate	0.0375	0.0700
Period of Analysis (years)	50	50
Construction Period (months)	18	18
Interest During Construction	\$1,608,338	\$3,041,570
Investment Cost	\$26,334,827	\$27,768,059
Annual Charges		
Interest	\$987,556	\$1,943,764
Amortization	\$186,298	\$68,304
Operation and Maintenance	\$50,000	\$50,000
Replacements	\$0	\$0
Total Annual Charges	\$1,223,854	\$2,062,068
Annual Benefits		
Flood Risk Mgmt Benefits	\$1,757,330	\$1,698,100
Recreation Benefits	\$0	\$0
Total Annual Benefits	\$1,757,330	\$1,698,100
Net Benefits	\$533,476	(\$363,968)
Benefit-to-Cost Ratio	1.44	0.82

NS AOI-4

	at 3.75%	at 7%
Investment		
Estimated First Cost*	\$4,239,377	\$4,239,377
Interest Rate	0.0375	0.0700
Period of Analysis (years)	50	50
Construction Period (months)	24	24
Interest During Construction	\$290,723	\$552,565

Investment Cost	\$4,167,100	\$4,428,942
Annual Charges		
Interest	\$156,266	\$310,026
Amortization	\$29,479	\$10,894
Operation and Maintenance	\$9,000	\$9,000
Replacements	\$0	\$0
Total Annual Charges	\$194,745	\$329,920
Annual Benefits		
Flood Risk Mgmt Benefits	\$371,010	\$350,710
Recreation Benefits	\$0	\$0
Total Annual Benefits	\$371,010	\$350,710
Net Benefits	\$176,265	\$20,790
Benefit-to-Cost Ratio	1.91	1.06

* Financial Costs that include \$363,000 for relocation assistance not included in Economic Costs

AOI-2 Levee + NS AOI-4

	at 3.75%	at 7.0%
Investment		
Estimated First Cost*	\$28,965,866	\$28,965,866
Interest Rate	0.0375	0.0700
Period of Analysis (years)	50	50
Construction Period (months)	24	24
Interest During Construction	\$2,145,179	\$4,077,243
Investment Cost	\$30,748,045	\$32,680,109
Annual Charges		
Interest	\$1,153,052	\$2,287,608
Amortization	\$217,518	\$80,387
Operation and Maintenance	\$59,000	\$59,000
Replacements	\$0	\$0
Total Annual Charges	\$1,429,570	\$2,426,994
Annual Benefits		
Flood Risk Mgmt Benefits	\$2,128,340	\$2,048,810
Recreation Benefits	\$0	\$0
Total Annual Benefits	\$2,128,340	\$2,048,810
Net Benefits	\$698,770	(\$378,184)
Benefit-to-Cost Ratio	1.49	0.84

* Financial Costs that include \$363,000 for relocation assistance not included in Economic Costs

Risk and Uncertainty Assessment

Engineer Regulation 1105-2-101 states that risk and uncertainty are intrinsic in water resources planning and design with inaccuracy in all measured or estimated values in project planning and design to some varying degrees. Invariably the true values are different from any single, point values presently used in project formulation, evaluation, and design. The best estimates of key variables, factors, parameters, and data components in the planning and design of flood damage reduction projects are considered the "most likely" values. These values however are frequently based on small periods of record, sample sizes and measurements that are subject to error.

The ER also states that risk analyses “captures and quantifies the extent of the risk and uncertainty in the various planning and design components of an investment project. The total effect of uncertainty on the project's design and economic viability can be examined and conscious decisions made reflecting an explicit tradeoff between risks and costs. Risk analysis can be used to compare plans in terms of the variability of their physical performance, economic success, and residual risks.”

Engineer Manual 1110-2-1619 identifies a number of potential sources of uncertainty. These include (1) uncertainty about future hydrologic events such as stream flow and rainfall; (2) uncertainty arising from the use of simplified models to describe complex hydraulic phenomena; (3) economic and social uncertainty, particularly the relationship between depth and inundation damage, inaccuracies in estimates of structure values and locations, and the predictability of how the public will respond to a flood; and (4) uncertainty about structural and geotechnical performance of water-control measures when subjected to rare storm events.

Uncertainty in the hydrology and hydraulics is addressed primarily by utilizing graphical exceedance probability functions which sets confidence limits for discharges at each discrete exceedance probability based on the equivalent record length. Uncertainty for hydrology and hydraulics is also addressed by assigning distributions to stage-damage functions. In the case of this study, the equivalent record length is set at 30 years and the error for the stage-damage functions is set at 0.5 feet. No fragility curves are assigned to the proposed levee since flooding durations are short and it would be overtopped regardless for those rare events. Economic uncertainties are similarly managed with normal distributions with standard errors assigned to the depth-damage functions and by defining uncertainty parameters for first floor corrections, structure and content values. Uncertainties are further handled by changing, if necessary, the number of Monte Carlo simulations and by varying the range of ordinates in the aggregated stage-damage functions.

HEC-FDA produces project performance reports to display the hydrologic and hydraulic performance of a particular plan. Table 3-15 shows the project performance for the proposed Test Cell levee and its impact on risk for the main stem of Leon Creek. The Leon Creek Reach 3 is the reach predominantly impacted by implementation of the proposed levee feature in AOI-2. For the future without-project condition, significant damages begin at approximately the four-year event based on the annual expected target stage of 634.3. Putting in the proposed levee reduces the recurrence interval to approximately a 132-year event. Long-term performance shows that this levee would have an approximately 7 % chance of being exceeded in 10 years, a 17 % chance of being exceeded in 30 years, and thirty-two % chance of being exceeded in 50 years. The project performance report also shows that the proposed levee would have a 99 % chance of containing the 10-year event, a 95 % chance of containing the 25-year event, an 88 % chance of containing the 50-year event, an 80 % chance of containing the 100-year event, 66 % for the 250-year event, and 52 % for the 500-year event. From a sensitivity perspective, a direct risk comparison of the initial 100- and 500-year levees is also displayed on the table. For the left overbank on Reach 3, the initial 100-year levee has a recurrence interval of a 63-year event. The 500-year levee has a recurrence interval of 10,000 years for the left overbank.

Table 3-16
Risk Performance of Proposed Levee

Without Project										
		Long-Term Exceedance Probability (years)			Assurance by Event					
Damage Reach	Expected AEP	10	30	50	10%	4%	2%	1%	0.40%	0.20%
LC R1	3.1%	27.1%	54.7%	79.5%	93.8%	71.5%	52.8%	36.9%	21.7%	12.2%
LC R2	27.2%	95.8%	100.0%	100.0%	2.8%	0.5%	0.2%	0.1%	0.0%	0.0%
LC R3R	10.1%	65.4%	93.0%	99.5%	52.9%	23.9%	13.1%	7.6%	3.4%	1.5%
LC R3L	26.9%	95.7%	100.0%	100.0%	3.0%	0.5%	0.2%	0.1%	0.0%	0.0%
LC R4	19.3%	88.3%	99.5%	100.0%	13.9%	3.5%	1.4%	0.6%	0.2%	0.1%
LC R5R	13.6%	76.8%	97.4%	99.9%	34.7%	11.4%	4.6%	1.8%	0.6%	0.2%
LC R5L	4.4%	35.9%	67.2%	89.2%	87.9%	60.4%	39.4%	24.1%	11.7%	5.9%
LC R6	10.5%	67.1%	93.8%	99.6%	49.1%	16.1%	7.4%	3.6%	1.2%	0.5%
LC R7	15.8%	82.2%	98.7%	100.0%	29.3%	14.9%	8.6%	5.3%	2.7%	1.6%

With Project - AOI-2 Levee w/Hydraulic Mitigation										
		Long-Term Exceedance Probability (years)			Assurance by Event					
Damage Reach	Expected AEP	10	30	50	10%	4%	2%	1%	0.40%	0.20%
LC R1	3.1%	27.4%	55.0%	79.8%	93.6%	71.2%	52.4%	36.5%	21.5%	12.0%
LC R2	27.2%	95.8%	100.0%	100.0%	2.8%	0.4%	0.2%	0.1%	0.0%	0.0%
LC R3R	9.2%	61.8%	91.0%	99.2%	58.0%	27.4%	15.2%	9.1%	4.1%	1.8%
LC R3L	0.8%	7.3%	17.3%	31.7%	99.5%	95.2%	88.2%	79.6%	66.0%	51.8%
LC R4	19.4%	88.5%	99.6%	100.0%	13.4%	3.4%	1.4%	0.6%	0.2%	0.1%
LC R5R	15.9%	82.3%	98.7%	100.0%	24.9%	6.9%	2.5%	1.0%	0.3%	0.1%
LC R5L	5.0%	39.9%	72.0%	92.1%	84.6%	55.0%	34.3%	20.2%	9.4%	4.6%
LC R6	10.7%	67.8%	94.1%	99.7%	47.9%	15.4%	7.0%	3.3%	1.1%	0.5%
LC R7	16.5%	83.6%	98.9%	100.0%	27.0%	13.4%	7.6%	4.7%	2.3%	1.4%

100-Year vs. 500-year Levee

		Long-Term Risk (years)			Assurance by Event					
Damage Reach	Expected AEP	10	30	50	10%	4%	2%	1%	0.40%	0.20%

100-Year

LC R3R	16.7%	83.8%	99.0%	100.0%	22.1%	6.5%	2.8%	1.4%	0.5%	0.2%
LC R3L	1.6%	14.8%	33.0%	55.1%	97.9%	87.4%	75.1%	63.0%	45.0%	30.0%

500-Year

LC R3R	16.2%	83.0%	98.8%	100.0%	23.5%	7.1%	3.1%	3.1%	0.6%	0.2%
LC R3L	0.0%	0.1%	0.2%	0.5%	100.0%	99.9%	99.8%	99.7%	99.5%	99.3%

Residual Risk

While the Recommended Plan includes all alternatives identified by the team as economically justified, substantial flood risk will remain after the project is constructed and operational. Table 3-16 indicates the residual damages predicted to be remaining in the study area after the project is implemented.

Table 3-17
Residual Damages – Project Implementation
 October 2012 Price Level 3.75% (\$1,000s)

Reach	Full Project Implementation			
	Without Project	With Project	Benefits	Residual EAD
Babcock Trib	395.19	24.18	371.01	24.18
Chimenea Creek	1.61	1.61	0	1.61
Culebra Creek Reach 1	2,012.71	2,012.71	0	2012.71
Culebra Creek Reach 2	87.76	87.76	0	87.76
Culebra Creek Trib A	100.34	100.34	0	100.34
Culebra Creek Trib C	37.13	37.13	0	37.13
Culebra Creek Trib E	18.59	18.59	0	18.59
French Creek	272.17	272.17	0	272.17
French Creek Trip A	0.01	0.01	0	0.01
Helotes Creek	533.22	533.22	0	533.22
Helotes Creek Trib A	48.12	48.12	0	48.12
Helotes Creek Trib B	0.52	0.52	0	0.52
Huebner Creek	480.77	480.77	0	480.77
Huebner Creek Trib A	126.44	126.44	0	126.44
Huesta Creek	129.88	129.88	0	129.88
Indian Creek	91.5	91.50	0	91.5
Leon Creek Reach 1	4.23	4.23	0	4.23
Leon Creek Reach 2	542.76	542.76	0	542.76
Leon Creek Reach 3 Right	0.22	0.19	0.03	0.19
Leon Creek Reach 3 Left	1,944.73	187.86	1756.87	187.86
Leon Creek Reach 4	1,182.77	1,182.34	0.43	1182.34
Leon Creek Reach 5 Right	1,057.50	1,057.50	0	1057.5
Leon Creek Reach 5 Left	316.78	316.78	0	316.78
Leon Creek Reach 6	1,427.89	1,427.89	0	1427.89
Leon Creek Reach 7	1,157.99	1,157.99	0	1157.99
Leon Creek Trib B	0.33	0.33	0	0.33
Leon Creek Trib F	137.78	137.78	0	137.78
Leon Creek Trib H	0.21	0.21	0	0.21

Reach	Full Project Implementation			
	Without Project	With Project	Benefits	Residual EAD
Leon Creek Trib J	0.09	0.09	0	0.09
Leon Creek Trib K	186.81	186.81	0	186.81
Leon Creek Trib M	0	0.00	0	0
Los Reyes Creek	36.48	36.48	0	36.48
Ranch Creek	0	0.00	0	0
Slick Ranch	1,081.14	1,081.14	0	1081.14
Slick Ranch Trib B	101.01	101.01	0	101.01
Westwood Village Creek	8.29	8.29	0	8.29
Total (Positive Benefits)	13,522.97	11,394.63	2,128.34	11,485.34

Substantial annual damages, approaching or exceeding one million dollars, remain in each of the Leon Creek 4, 5, 6, and 7 reaches as well as the Slick Ranch Creek reach. Numerous other reaches have residual damages amounting to several hundred thousand dollars annually.

Floodplain management is highly effective in controlling future development of the floodplain and assuring that existing flood risks do not increase. The City of San Antonio and Bexar County presently participate in the National Flood Insurance Program and enforce zoning regulations for development in the floodplain. Best Management Practices for stormwater and Low Impact Development (LID) are encouraged and incentivized. However, floodplain management cannot, by itself, significantly reduce existing flooding conditions within a highly urbanized floodplain. San Antonio's floodplain management program can be expected to complement the Leon Creek flood risk reduction projects by stabilizing future damage conditions and preventing significant future increases in residual risk.

Implementation of the Recommended Plan will substantially reduce monetary flood damages in the Leon Creek watershed but will do relatively little to modify the fundamental nature of the flood hazard in the watershed. As a consequence, the risk to human health and safety resulting from the "flashy" nature of flooding in the study area is reasonably unchanged in the with-project condition. It will be critically important for the local sponsor to proactively communicate remaining flood hazards to residents and stakeholders within the watershed.

The project sponsor, SARA, is currently in the process of implementing a regional flood warning system. This system will include real-time weather and stream gage information and will be directly linked to local emergency response communications and specified media outlets. The intent is to provide real-time information as to the location and severity of the flash flood hazards that pose the greatest risk to human health and safety during rainfall events. This flood warning system is being implemented independent of the Leon Creek project and is expected to be operational in calendar year 2013.

The redundancy and resiliency of the Leon Creek project will be substantially enhanced by the implementation of the sponsor's Flood Warning System. Additional design features to enhance robustness and safety assurance will be explored during the design phase of the project.

Value Engineering

A Value Management Study was conducted 31 March – 1 April 2011 with the following objectives:

- Validate that the PDT is on the right track relative to design strategies
- Gather information to help prepare the Alternative Formulation Briefing (AFB) report.
- Consider whether anything has been missed in the analysis
- Identify a list of evaluation criteria for use in rating alternative solutions

Per the study report, the team determined that all creative ideas had been previously identified during the prior project phase. The VE team identified four key project functions that are affected by each of the alternatives considered. These functions are:

- Divert Flow
- Bypass Flow
- Maintain or Improve Environment
- Detain Flow

The team then discussed each of the project alternatives considered during the preliminary analysis of alternatives and how they perform relative to the functions identified. This analysis confirmed that the preliminary analysis of alternatives had been effective in narrowing down the list of alternatives to those most likely to fulfill project objectives. The team further determined that there were no additional alternatives that should have been considered. Finally, the team identified seven criteria to be used in the future detailed investigation of alternatives:

- Downstream inducements
- Adverse impacts
- Environmental justice (fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income)
- Sponsor expectations
- Construction feasibility (constructability)
- Risk of flooding

- Recreational benefits

SECTION FOUR

ALTERNATIVE IMPACT ASSESSMENT

As described in previous sections of this report, a wide variety of alternatives to reduce flood risks within the Leon Creek watershed have been considered. These alternatives were screened for economic justification and potentially unacceptable or problematic environmental effects. The alternatives carried forward for final consideration were all determined to be economically justified (i.e. have annual benefits greater than the annual costs) and environmentally acceptable. Based on the “next-added increment” analysis, the alternatives were established to be economically justified in combination with each other as well as on a stand-alone basis. The alternative plan with the greatest net benefits to society was identified as the combination of the 1% AEP levee protecting the Jet Cell Test Facility in AOI-2, including the hydraulic mitigation for that levee, in combination with a buyout of the 25-year floodplain in NS-AOI-4. This plan is referred to in the analysis below as the Proposed Action. For purposes of compliance with the National Environmental Policy Act, the reasonably foreseeable consequences of the Proposed Action are compared and contrasted with the No Action alternative in the analysis below.

PRIME FARMLAND SOILS

No Action

Under the No Action alternative, conversion of farmlands, rangelands and undeveloped lands to urban use is expected to continue and may adversely impact prime farmland soils.

Proposed Action - Levee Component

Implementation of the levee component of the proposed alternative (including the associated hydraulic mitigation feature) would occur within the boundary of the former Kelly AFB and within the city limits of San Antonio. Section 1541(b) of the Farmland Protection Policy Act of 1980 and 1995, 7 U.S.C. 4202(b), does not apply to urban areas; therefore, no prime farmland soils covered by FPPA would be adversely affected by implementation of the levee alternative.

Proposed Action - Buyout Component

The proposed site for the buyout component of the proposed alternative is located with an urban residential area in the city limits of San Antonio and, similar to above, the FPPA does not apply to urban areas so there would be no adverse impact to prime farmland soils as a result of implementation of the buyout component.

LAND USE

No Action

Under the No Action alternative, changes in the land use within the proposed project area would continue to occur since increased urbanization is expected.

Proposed Action - Levee Component

After completion of the Levee Component of the Proposed Action, the Jet Engine Test facility would continue to operate within the proposed project area and Leon Creek would be restored to a naturally functioning stream system. No changes in land use would occur.

Proposed Action - Buyout Component

Land use within the proposed AOI-4 buyout area would change from residential to open space. The acquired land would function as a floodplain and provide localized water quality benefits by capturing sediments and nutrients from stormwater runoff and floodwaters.

AIR QUALITY

No Action

Under the No Action alternative, there would be no changes to air quality within the study area different from those predicted for the Future Without-Project Condition.

Proposed Action - Levee Component

During construction of the levee and modification of the Leon Creek pilot channel, short-term, inconsequential impacts to air quality would occur. Construction would generate fugitive dust from ground disturbing activities (e.g., excavation, grading, soil piles, etc.) in addition to the emissions of all criteria pollutants from the combustion of fuels in construction equipment. Fugitive dust emissions would be greatest during the initial site preparation activities and would vary from day-to-day depending on the construction phase, level of activity, and prevailing weather conditions. The quantity of uncontrolled fugitive dust emissions from a construction site would be proportional to the area of land being worked and the level of construction activity. Emissions would be temporary in nature. The use of Best Management Practices (BMPs) during construction (e.g. application of water for dust control, use of cleaner-burning fuels, energy efficient equipment) would minimize these emissions.

Proposed Action - Buyout Component

During demolition of the buyout area, short-term, inconsequential impacts to air quality would occur. Construction activities would generate fugitive dust resulting from demolition and ground disturbing activities (e.g., demolition, grading, soil piles, etc.) in addition to the emissions of all criteria pollutants from the combustion of fuels in construction equipment. Fugitive dust emissions would vary from day-to-day depending on the construction phase, level of activity, and prevailing weather conditions. The quantity of uncontrolled fugitive dust emissions from a construction site would be proportional to

the area of land being worked and the level of construction activity. Emissions would be temporary in nature. The use of BMPs during construction (e.g. application of water for dust control, use of cleaner-burning fuels, energy efficient equipment) would minimize these emissions.

NOISE

No Action

Under the No Action alternative, there would be no changes to noise receptors within the study area different from those expected under the Future Without-Project Condition.

Proposed Action - Levee Component

Construction equipment such as backhoes, front-end loaders, and cement and dump trucks would cause short-term, localized increases in noise levels. These short-term increases are expected to be in compliance with City noise ordinances and not expected to substantially affect adjacent noise sensitive receptors. Construction activities would increase noise levels temporarily at locations immediately adjacent to the study area, but impacts would be attenuated by distance, topography, and vegetation.

Proposed Action - Buyout Component

Construction equipment such as front-end loaders and dump trucks would cause short-term, localized increases in noise levels. Although noise levels to receptors in the adjacent community would temporarily increase during demolition activities, construction activities would comply with City noise ordinances.

Noise levels created by construction equipment for the recommended action would vary greatly depending on factors such as the type of equipment, the specific model, the operation being performed, and the condition of the equipment. The equivalent sound level of the construction activity also depends on the fraction of time that the equipment is operated over the period of time of the construction. Construction would occur during daylight hours, thus reducing the Day-Night Average Sound Levels and the chances of causing annoyances. The use of BMPs such as keeping equipment in good operating condition, proper training, and providing appropriate health and safety equipment would minimize the potential noise impacts associated with the Proposed Action.

GROUNDWATER

No Action

Under the No Action alternative, existing water demands in the study area would continue to draw upon the groundwater resources in the San Antonio area. Groundwater usage and restrictions would continue to be regulated by the Edwards Aquifer Authority to prevent unacceptable drawdown of the aquifer or degradation of groundwater quality.

Proposed Action – Levee component

The construction of the levee foundation would temporarily impede site-specific subsurface flows from the project area, before reaching areas influenced by subsurface flows associated with Leon Creek. However, the levee area is located outside of the contributing and recharge zones of the Edward's Aquifer. Therefore, the proposed project would not substantially affect groundwater resources in the project area.

Proposed Action - Buyout Component

The acquisition and demolition of properties within the AOI-4 site would have no impact on groundwater resources within the project area.

HYDROLOGY AND HYDRAULICS

No Action

Under the No Action alternative, no impacts are expected to the hydrology and hydraulics of Leon Creek. However, flooding would still occur throughout the watershed and damages would continue to occur at the proposed levee site (AOI-2) and the proposed buyout area (AOI-4).

Proposed Action - Levee Component

The construction of the levee at the Jet Engine Test Cell Facility would affect the hydraulics of Leon Creek by increasing the water surface elevations outside of the areas protected by the proposed levee. In order to maintain existing water surface elevations outside of the levee area, the Leon Creek channel would be widened from SW Military Drive to approximately 2,850 linear feet downstream. The channel modifications would mitigate the impacts that the proposed levee would have on the hydraulics of Leon Creek.

Proposed Action - Buyout Component

The acquisition of properties within the AOI-4 site would have no impacts on the hydrology or hydraulics of Leon Creek.

TERRESTRIAL RESOURCES

Wildlife

No Action

Under the No Action alternative, the wildlife habitat conditions associated with Leon Creek would remain unchanged from the Future Without-Project condition.

Proposed Action - Levee Component

The channel modifications would impact approximately 20 acres of low to moderate quality upland forest/grassland habitats. Urban wildlife within the areas planned for construction would be

temporarily displaced due to noise and other disturbances to adjacent habitats during the construction process. Such displacement would result in increased competition for breeding, nesting, cover, and foraging habitat in adjacent undisturbed habitats. However, the planned replacement of woody vegetation along the channelized portion of Leon Creek as part of the environmental mitigation plan would restore the wildlife habitat within the proposed project area back to, or better than, existing conditions.

Proposed Action - Buyout Component

The buyout component of the Recommended Action would return approximately 3.85 acres of residential area to native floodplain habitats. Wildlife in adjacent areas would immigrate into restored habitats and the buyout area would provide buffer habitats for species utilizing the aquatic and riparian corridor of Leon Creek.

Threatened and Endangered Species

A number of threatened or endangered species were identified as having the potential to occur in Bexar County, including the Leon Creek watershed. However, based on habitat requirements and field observations, no Federal or State-listed species are expected to occur within the proposed project area. Therefore, impacts to threatened and endangered species resulting from the proposed project alternatives are not anticipated under either the No Action alternative or the Proposed Action.

AQUATIC RESOURCES

Water Quality

No Action

As described in Section 2, Segment 1906 (Lower Leon Creek) exceeds State water quality standards for bacteria, PCBs in edible fish tissues, and dissolved oxygen. Stormwater, which is important to surface water quality, has the potential to introduce sediments and other contaminants (petroleum products, chemicals, etc.) into lakes, rivers, and streams. Generally, higher densities of development (i.e. urban areas such as the Westside Creeks study area) require greater degrees of storm water management due to higher proportions of impervious surfaces, and rapid runoff that occurs following a storm. Under the No Action alternative, these trends are expected to continue.

Proposed Action - Levee Component

Implementation of the levee component of the Proposed Action would directly impact surface waters in the project area during construction as a result of the excavation and recontouring of pilot channels and development of riffle/run/pool complexes within the proposed channelized section of Leon Creek. During the construction period, these impacts are expected to temporarily degrade water quality as a result of ground disturbing activities. Erosion and sedimentation controls, such as silt fencing and sediment traps, the application of water sprays, and the prompt revegetation of disturbed areas would be required during construction to reduce and control siltation or erosion impacts. In addition, every

construction project poses a potential contamination risk from petroleum or chemical spills. The contractor would be required to prepare and follow a site specific Spill Prevention Plan during construction, which would include use of BMPs such as proper storage, handling, and emergency preparedness, reducing the risk of such contamination. Thus, impacts to surface waters during construction are considered to be temporary and not substantial.

The proposed pilot channel would be constructed utilizing natural channel design principles and revegetated with native aquatic, wetland, and riparian species. The reestablishment of aquatic plants and revegetation of the stream banks with native grasses, forbs, and woody species would act as an effective vegetative filter. The restored aquatic system would reduce the amount of sediments and other contaminants that would otherwise flow directly into/through Leon Creek in the immediate area back to existing conditions. However, overall water quality of Leon Creek (Segment 1906) would remain substantially unchanged.

Proposed Action - Buyout Component

Implementation of the buyout would not impact surface waters in the study area during demolition. Indirect impacts associated with stormwater runoff from the site would be mitigated by utilizing erosion and sedimentation controls, such as silt fencing and sediment traps, the application of water sprays, and the prompt revegetation of disturbed areas after demolition. The contractor would be required to prepare and follow a site specific Spill Prevention Plan during demolition activities, which would include use of BMPs such as proper storage, handling, and emergency preparedness, reducing the risk of such contamination. Therefore, no impacts to surface waters during demolition activities are anticipated.

AQUATIC HABITAT

No Action

Under the No Action alternative, aquatic habitats associated with Leon Creek are expected to degrade slightly as a result of urbanization. Reduction in riparian corridor scope and functionality and increases in the presences of invasive species are anticipated.

Proposed Action - Levee Component

The channel modifications associated with the Levee Component of the Proposed Action would temporarily impact aquatic habitat during construction activities. Fish and aquatic organisms would be displaced into adjacent upstream or downstream habitats during construction; however, the construction of the pool/riffle/run/glide habitats of the natural stream design channel would restore the aquatic habitat back to a condition generally better than under existing conditions. In addition, the reestablishment of site-specific native plant species would restore the aquatic habitat for aquatic organisms.

Proposed Action - Buyout Component

The Buyout Component of the Proposed Action would occur in upland areas; therefore, aquatic habitats associated with Leon Creek within the proposed project AOI-4 area would not be impacted.

Wetlands

No Action

Under the No Action alternative, wetland habitats associated with Leon Creek within the proposed project area would not be impacted.

Proposed Action - Levee Component

Leon Creek is a jurisdictional water of the U.S., and activities that would disturb the creek would be subject to Section 404 of the Clean Water Act. Section 404 requires mitigation for impacts to waters of the U.S. by avoiding, minimizing, and then compensating for any unavoidable impacts. Impacts to Leon Creek were minimized by limiting the channelization activities to a 2,850-foot section of Leon Creek below SW Military Drive. Although the modifications to the Leon Creek channel would impact waters of the U.S., the restoration of Leon Creek utilizing natural stream channel design would return the creek to existing or better condition. Therefore, impacts to waters of the U.S. would be temporary and the proposed channelization of Leon Creek in the proposed project area would be considered “self-mitigating”. See Appendix B, 404 (b)(1) Analysis for additional detailed information.

Proposed Action - Buyout Component

The Buyout Component is comprised of actions entirely located in upland areas. No wetland habitats associated with Leon Creek in the proposed AOI-4 project area would be impacted by activities associated with this component of the Proposed Action.

CULTURAL RESOURCES

No Action

Under the No Action alternative, no impacts to cultural resources within the proposed project area are anticipated.

Proposed Action - Levee Component

Archaeological Resources. A search of the Texas Historical Commission’s Archaeological Sites Atlas reveals that many cultural resources investigations have been conducted within a mile of the proposed levee project area, especially on the former Kelly Air Force Base. Four archaeological sites have been identified within a one-mile radius of the project area; however, the eligibility of these resources for inclusion in the National Register of Historic Places (NRHP) is undetermined at this time. These four were identified in 2012 when a linear survey for a sewer line was conducted along the eastern edge of the proposed levee location. While the sites are outside of the currently proposed project area, this survey indicates a high probability of finding archaeological sites in the area. An archaeological survey will be conducted along the proposed levee alignment prior to construction to determine if

significant cultural resources are located within the proposed project area. Should any archeological properties be identified, coordination with the State Historic Preservation Officer will be initiated to determine the appropriate mitigation requirements.

Architectural Resources. In addition to the archaeological sites, the federal government must evaluate above-ground resources such as buildings and structures that may be of historical significance within the project footprint or that may be indirectly affected by the project. (An example of an indirect impact may be a change to the property viewshed that diminishes the historical integrity, setting or feel of the property.) The buildings and structures within one-half mile of the proposed levee that would be potentially indirectly impacted by its construction date from the mid-1990s. As such, these resources do not meet the criteria for inclusion in the NRHP. No above-ground historic properties will be impacted by the levee alternative.

Proposed Action - Buyout Component

Archaeological Resources. There has been no archaeological survey conducted in the area proposed for buyout; however, the acquisition and removal of structures from the floodplain in this area would not be expected to impact archeological resources since cultural deposits that may have existed would have been destroyed by the construction of the structures involved in the buyout.

Architectural Resources. The buildings and structures located within the buyout area date to 1995 and newer. As such, these above ground resources do not meet the criteria for inclusion in the NRHP. No above ground historic properties will be impacted by the buyout alternative.

HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

No Action

No specific threats related to hazardous, toxic, and radioactive wastes are expected in the project area under the No Action alternative.

Proposed Action - Levee Component

Provided that construction activities are properly managed, no impacts or concerns related to hazardous, toxic, and radioactive wastes are expected to occur in the project area during implementation of the Proposed Action. The following description is illustrative of the actions that would comprise “proper management” from an HTRW perspective:

To minimize potential impacts from hazardous and regulated materials during construction, all fuels, waste oils, and solvents would be collected and stored in tanks or drums within a secondary containment system that consists of an impervious floor and bermed sidewalls capable of containing the volume of the largest container stored therein. The refueling of machinery would be done following accepted guidelines, and all vehicles would have drip pans, when not in use, to contain minor spills and drips. Although it would be unlikely for a major spill to occur, any spill of five gallons or more would be contained immediately within an earthen dike, and the application of an absorbent (e.g., granular, pillow, sock, etc.) would be used to absorb and contain the spill. Any major

spill of a hazardous or regulated substance would be reported immediately to SARA and USACE environmental personnel who would notify appropriate Federal and State agencies. Additionally, all construction personnel would be briefed as to the correct procedures for preventing and responding to a spill. All waste oil and solvents would be recycled if practicable. All non-recyclable hazardous and regulated wastes would be collected, characterized, labeled, stored, transported, and disposed of in accordance with all Federal, State, and local regulations, including proper waste manifesting procedures. A Spill Prevention Plan would be in place prior to the start of construction, and all personnel shall be briefed on the implementation and responsibilities of this plan. Adoption and full implementation of the construction measures described above would reduce adverse hazardous/regulated substances impacts to insignificant levels.

Proposed Action – Buyout Component

Demolition activities associated with the Buyout component of the Proposed Action would be managed consistent with the procedures outlined above, and are not expected to present concerns in that project area relative to hazardous, toxic, and radioactive wastes.

RECREATIONAL RESOURCES

No Action

Under the No Action alternative, recreational opportunities would essentially remain the same as predicted for the Future Without-Project condition.

Proposed Action – Levee Component

No recreational measures are proposed for the Levee Component and it is not expected to have any positive or negative effects on the recreation resources of the neighborhoods proximate to this portion of the proposed action.

Proposed Action – Buyout Component

No recreational measures are proposed for the buyout component. However, the removal of structures associated with the buyout would provide limited open space suitable for recreational opportunities if developed by the Sponsor or others at some future date.

SOCIOECONOMICS

No Action

Under the No Action alternative, economic damages from flooding would continue within the proposed project area as described in the Future Without-Project condition. Other socio-economic trends would likewise remain unchanged.

Proposed Action - Levee Component

The project area for the Levee Component of the proposed action is located primarily on lands already dedicated to industrial uses. Economic losses due to flooding at the Jet Engine Test Cell facility would be substantially reduced. Although acquisition of a small portion of property would be required for the modification to the Leon Creek stream channel adjacent to the Jet Engine Test Cell property, no relocations would be required.

Proposed Action - Buyout Component

This alternative would reduce economic damages associated with frequent flooding by removal of four single-family residences and seven multi-family structures contained in the 25-year floodplain. Removal of these structures would reduce risks to health and safety as well as reducing the need for emergency services in the event of flooding. In accordance with Federal requirements, individuals directly affected by the buyout would be eligible for relocation assistance in addition to compensation for any real estate interest they may have in the purchased property.

The structures targeted for removal are in an area that does not have significant minority or low-income populations that could be disproportionately impacted by evacuation. Consistent with the provisions of Executive Order 12898, the proposed project would not substantially affect human health or the environment in a negative manner. Furthermore, the proposed project would not have the effect of excluding persons from participation in, deny persons the benefit of, or subject persons to discrimination under the proposed project because of their race, color, or national origin.

LIGHT

No Action

Under the No Action alternative, no changes in ambient lighting levels from the Future Without-Project Condition are anticipated.

Proposed Action - Levee Component

The Levee Component would not introduce additional lighting to the Leon Creek project area. Construction would occur during daylight hours, and no construction lighting would be required. Therefore, no adverse impacts from lighting would be anticipated.

Proposed Action - Buyout Component

The Buyout Component of the Proposed Action would not introduce additional lighting to the Leon Creek project area. Demolition would occur during daylight hours and no construction lighting would be required. Therefore, no adverse impacts from lighting would be anticipated.

PUBLIC FACILITY AND SERVICE

No Action

Under the No Action alternative, San Antonio and Bexar County “first responders” would continue to respond to emergency needs for traffic control, search and rescue, and other public services during flood events.

Proposed Action - Levee Component

During construction of the Levee Component of the Proposed Action, short-term, insignificant impacts to traffic volumes would be a result of haul traffic and other construction activities. Local roads are well designed and are capable of handling a large volume of vehicles. However, during construction, traffic congestion could occur, particularly during the morning and evening rush hour as construction vehicles enter and exit the proposed project area. Road closures or restricted access would not be anticipated; however, temporary detours or traffic control may be needed during working hours. A traffic control plan would be prepared by the construction contractor and submitted for approval to Federal and local officials prior to the start of any construction activities.

Proposed Action - Buyout Component

Short-term, insignificant impacts to traffic volumes would be expected during demolition activities associated with the Buyout Component of the Proposed Action. Local roads are well designed and are capable of handling a large volume of vehicles. However, during construction, traffic congestion could occur, particularly during the morning and evening rush hour as construction vehicles enter and exit the proposed project area. Road closures or restricted access would not be anticipated; however, temporary detours or traffic control may be needed during working hours. A traffic control plan would be prepared by the construction contractor and submitted for approval to Federal and local officials prior to the start of any demolition activities.

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

The proposed project would not entail any substantial irretrievable or irreversible commitments of resources. Construction activities would require minor consumption of petroleum products, and importing of materials such as rock, soil, gravel, and vegetation. However, the proposed project would entail long-term commitment and environmental stewardship to ensure long-term sustainability of the levee and channel modifications.

CUMULATIVE IMPACTS

Cumulative impacts are the impacts on an environmental resource which results from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions regardless of which agency or person undertakes the actions. The Council on Environmental Quality (CEQ) provides an 11-step process for cumulative impact assessment:

1. Identify the significant cumulative effects issues associated with the proposed action and define assessment goals.

2. Establish the geographic scope for the analysis.
3. Establish the time frame for the analysis.
4. Identify other actions affecting the resources, ecosystems, and human communities of concern.
5. Characterize the resources, ecosystems, and human communities identified during the scoping in terms of their response to change and capacity to withstand stresses.
6. Characterize the stresses affecting these resources, ecosystems, and human communities and their relation to regulatory thresholds.
7. Define a baseline condition for the resources, ecosystems, and human communities.
8. Identify the important cause and effect relationships between human activities and resources, ecosystems, and human communities.
9. Determine the magnitude and significance of cumulative effects.
10. Modify or add alternatives to avoid, minimize, or mitigate significant cumulative effects.
11. Monitor the cumulative effects of the selected alternative and adapt management.

The identification of major cumulative effects issues involves identifying three items: 1) the direct and indirect effects of the proposed action, 2) which resources, ecosystems, and human communities are affected, and 3) which effects on these resources are important from a cumulative effects perspective. In order for an action to contribute to the cumulative impacts on a resource, the action must have either a significant impact on the resource or any impact on a resource that is in poor or declining condition.

The direct and indirect impacts of the project on each study resource have been described in previous sections of this report. Of the resources identified in the impacts section, potential impacts to the aquatic habitat and cultural resources were identified as associated with the levee component and potential impacts to the community resources were considered with the buyout component. However, measures to fully mitigate these impacts are included in the proposed project. These measures include natural channel design and revegetation as well as appropriate cultural resources survey and documentation in AOI-2 and relocations assistance for persons affected by the buyout in NS AOI-4. Therefore, the proposed action would have no significant impacts on area resources. Because there would be no unmitigated direct or indirect impacts to area resources, there are virtually no cumulative impacts to carry the cumulative impacts analysis past Step 1 described above.

SECTION FIVE

PROJECT IMPLEMENTATION

STATUS OF ENVIRONMENTAL COMPLIANCE

Table 5-1 presents the status of compliance with all environmental laws and regulations for the Proposed Action.

Table 5-1. Relationship of Plan to Environmental Protection Statutes and Other Environmental Requirements

Policies	Compliance of Plan
<i>Public Laws</i>	
Archeological and Historic Preservation Act, 1974, as amended	Not Applicable
Archeological Resources Protection Act, 1979, as amended	Not Applicable
Clean Air Act, 1977, as amended*	Compliant
Clean Water Act, 1972, as amended*	Compliant
Coastal Zone Management Act, 1972, as amended	Not Applicable
Endangered Species Act, 1973, as amended*	Compliant
Farmland Protection Policy Act	Compliant
Fish and Wildlife Coordination Act, 1958, as amended*	In Progress
Magnuson Fisheries Conservation and Management Act	Not Applicable
Migratory Bird Treaty Act, 1918, as amended	Compliant
National Environmental Policy Act, 1969, as amended	In Progress
National Historic Preservation Act, 1966, as amended	In Progress
Native American Graves Protection and Repatriation Act, 1990	Not Applicable
Rivers and Harbors Act, 1899	Compliant
Wild and Scenic Rivers Act, as amended	Compliant
<i>Executive Orders</i>	
Environmental Justice (E.O. 12898)*	Compliant
Flood Plain Management (E.O. 11988)	Compliant
Protection of Wetlands (E.O. 11990)	Compliant
Protection of Children from Environmental Health Risks (E.O. 13045)	Compliant
Invasive Species (E.O. 13112)*	Compliant
Migratory Birds (E.O. 13186)*	Compliant
<i>Others</i>	
FAA Advisory Circular 150-5200-33*	In Progress

* For additional information, see the following sections

Environmental Justice, Executive Order 12898

The permanent evacuations in the recommended plan do not disproportionately target or impact minority populations within the project area. Comparable housing availability should not be an issue. Housing of last resort, which may involve the use of replacement housing payments that exceed Uniform Act amounts or other methods of providing comparable decent, safe, and sanitary housing within a person's financial means, might be necessary however, to provide adequate replacements for those being permanently evacuated.

Invasive Species, Executive Order 13112

Executive Order (EO) 13112 recognizes the significant contribution native species make to the well-being of the Nation's natural environment and directs Federal agencies to take preventive and responsive action to the threat of the invasion of non-native plants and wildlife species in the United States. This EO establishes processes to deal with invasive species, and among other items establishes that Federal agencies "will not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions."

The riparian and aquatic vegetation associated with the revegetation of the Leon Creek channel adjacent to the levee would be comprised of plant species native to the San Antonio area. Similarly, revegetation of the demolition site of the proposed buyout area would utilize site-specific native vegetation. During establishment of the native vegetation, invasive species control measures, chemical and/or mechanical, would be in place to reduce the chance of non-native species becoming established in revegetated areas. Because of slope and soils stability requirements, Bermudagrass (*Cynodon dactylon*) may be required to stabilize the levee slopes. Should a native plant species be identified that meets the levee vegetation stability requirements, the use of the native species will be considered in compliance EO 13112.

Clean Water Act

USACE under direction of Congress regulates the discharge of dredged and fill material into all waters of the United States, including wetlands. Although USACE does not issue itself permits for construction activities that would affect waters of the United States, USACE must meet the legal requirement of the CWA. The buyout alternative would not result in the discharge of dredged and fill material into waters of the U.S. However, the channel modifications associated with the levee alternative would require the disturbance of approximately 2,850 linear feet of Leon Creek. The proposed natural channel design of the channel modifications and the restoration of aquatic and riparian vegetation would result in no net loss of wetlands or waters of the U.S. and no net loss of aquatic function to Leon Creek. Discussion with the Fort Worth USACE Regulatory staff concur that the proposed aquatic and riparian habitat mitigation would result in the "self" mitigation of the action.

A section 404(B)(1) was drafted and is included in the Environmental Appendix. Water quality certification under Section 401 of the Clean Water Act is being coordinated with TCEQ. Water quality certification will be obtained before the signing of the Finding of No Significant Impact (FONSI).

Section 176(c) Clean Air Act

Federal agencies are required by this Act to review all air emissions resulting from Federal funded projects or permits to ensure conformity with the State Implemented Plans (SIP) in non-attainment areas. The San Antonio metropolitan area is currently in attainment for all air emissions; therefore, the proposed study would be in compliance with the Clean Air Act.

Section 106 Compliance

Letters were mailed to the State Historic Preservation Office and appropriate Indian Tribes in February 2008 to initiate Section 106 coordination (see Appendix H “Correspondence”). No responses have been received to date. In addition, letters, along with a Notice of Availability, will be sent to the SHPO and appropriate Indian Tribes at the initiation of the required public review period prior to finalization of the NEPA process.

Advisory Circular - Hazardous Wildlife Attractants on or Near Airports

The advisory circular provides guidance on locating certain land uses having the potential to attract hazardous wildlife in the vicinity of public-use airports. The circular provides guidance on wetlands in and around airports and establishes notification procedures if reasonably foreseeable projects either attract or may attract wildlife.

In response to the Advisory Circular, the United States Army as well as other Federal agencies, signed a Memorandum of Agreement (MOA) with the Federal Aviation Administration (FAA) to address aircraft-wildlife strikes. The MOA establishes procedures necessary to coordinate their missions to more effectively address existing and future environmental conditions contributing to aircraft-wildlife strikes throughout the United States.

The proposed action would not result in an increase of the extent of aquatic or riparian habitat that would attract hazardous wildlife. Because the land use and habitat types would not change, no increased aircraft-wildlife strikes are anticipated. USACE is coordinating with the FAA and the Animal and Plant Health Inspection Service (APHIS) of the U.S. Department of Agriculture to ensure the proposed action complies with the Advisory Circular.

Fish and Wildlife Coordination Act

USACE and the U.S. Fish and Wildlife Service have been coordinating in accordance with the Fish and Wildlife Coordination Act. USFWS is part of the project delivery team and has attended several meetings and field trips, as discussed under the subsection entitled “Resource Agency Coordination.” Coordination with USFWS has been ongoing and will continue to be so throughout the study.

- In March 2009, USACE received a draft Planning Aid Letter from USFWS in regard to the habitat evaluations completed by USACE, USFWS, and TPWD.
- On November 13, 2009, USACE received further comments and planning assistance in an official letter from USFWS.

Migratory Bird Treaty Act/Executive Order 13186

The importance of migratory non-game birds to the nation is embodied in numerous laws, executive orders, and partnerships. The Fish and Wildlife Conservation Act demonstrates the Federal commitment to conservation of non-game species. Amendments to the Act adopted in 1988 and 1989 direct the Secretary to undertake activities to research and conserve migratory non-game birds. EO13186 directs Federal agencies to promote the conservation of migratory bird populations, including restoring and enhancing habitat. In order to ensure compliance with the Migratory Bird Treaty Act, the clearing of vegetation associated with Leon Creek channel modifications and demolition activities associated with the buyout alternative would occur outside of the migratory bird nesting season (March through August).

Endangered Species Act

USACE and the U.S. Fish and Wildlife Service have been coordinating regarding the Endangered Species Act. No threatened and endangered species or critical habitats occur within the area of the Proposed Action. Therefore, no further coordination is required under Section 7 of the Endangered Species Act (ESA).

PROJECT IMPLEMENTATION

Project implementation is composed of two phases: Pre-construction Engineering and Design (PED) and Construction. This section describes these phases, which would occur according to the Project Implementation Schedule, developed under the assumption that Federal and local funds will be available.

Preconstruction Engineering and Design

After the project has been approved for construction by a Water Resources Development Act (WRDA) or other authorization and funds have been appropriated for the pre-construction engineering and design (PED) phase, a number of activities would take place, including completion of a design agreement, detailed design report, and value engineering study, development of plans and specifications, and development of a Project Partnership Agreement.

Design Agreement

The Design Agreement is the first action during PED. The design agreement is a contract between the Federal Government and the non-Federal sponsor that describes the rights and responsibilities of each party during project design, including cost sharing.

Detailed Design Report

The Detailed Design Report (DDR) includes completing the project feature final design. As part of the DDR, remaining ground surveys, utility surveys, and cultural surveys will be completed. The final weir, recreation amenity, and maintenance road locations will be verified based on the final hydraulic analyses. Design parameters for all project features will be defined for development of the plans and specifications. All cultural resource investigations and mitigation requirements will be finalized prior to the final project design. The DDR will be completed within one year of the initiation of PED.

Value Engineering Study

As stated earlier, ER 11-1-321 provides for the execution of the Value Engineering (VE) elements within the Project Management Business Process (PMBP) of the U.S. Army Corps of Engineers and that Value Management (VM) shall be done by implementing the Value Management Plan (REF8023G) from the U.S. Army Corps of Engineers Business Process Manual. A Value Engineering Study will be conducted during the design and construction phase in accordance to ER 11-1-321.

Plans and Specifications

Plans and specifications (P&S) include the development of project construction drawings, project construction specifications, estimation of final quantities, and the government cost estimate. These documents (with the exception of the government cost estimate) are made available to contractors interested in bidding on the construction of the proposed project. It is anticipated that up to four sets of P&S will be developed for the demolition of structures, recreational amenities, special aquatic features, and riparian vegetation. All cultural resource investigations and mitigation requirements will be finalized prior to the final project design.

Project Partnership Agreement and Items of Non-Federal Responsibility

After funds have been appropriated for construction, the construction phase can begin. The first action in the construction phase is to execute the Project Partnership Agreement (PPA). The PPA is a contract between the Federal Government and the non-Federal sponsor describing the rights and responsibilities of each party during project construction, including cost sharing. It is typically developed during the design phase, but closely follows a national model agreement. The PPA will typically be executed after funds have been appropriated for construction.

Federal implementation of the recommended plan project is subject to the non-Federal sponsor agreeing to comply with applicable Federal laws and policies, including but not limited to the following:

- a. Provide 35 percent total non-structural flood risk management costs as further specified:

1. Provide 25 percent of design costs allocated by the Government to non-structural flood risk management in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;
2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to non-structural flood risk management;
3. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the non-structural flood features;
4. Provide, during construction, any additional funds necessary to make its total contribution for non-structural flood risk management equal to 35 percent of total non-structural flood risk management costs;

Real Estate Acquisition

The non-Federal sponsor is responsible for acquiring all privately owned, as well as local government or publicly owned, lands, easements, rights-of-way, relocations, and disposal areas (LERRD) required for project construction, operation, and maintenance. Following the execution of the PPA, the non-Federal sponsor will be provided a map delineating the right-of-way to be acquired for project purposes. The non-Federal sponsor will coordinate the real estate acquisition with the Corps, and the Corps will certify all LERRDs prior to issuing a construction contract advertisement.

PROJECT CONSTRUCTION

Contract Advertisement and Award

After the PPA is executed, a set of plans and specifications have been developed, and LERRDs have been certified, the Corps will issue a solicitation and award a construction contract. Prior to awarding the contract, the non-Federal sponsor must provide any applicable cash contribution. Per the implementation schedule on page 128, several construction contracts might be required to accomplish the work.

The first contract would be for demolition of structures. The second contract would be to plant in disturbed areas. A third contract would be to construct the channel modification, relocate utilities, and construct drainage improvements, slurry wall, and sump. The fourth contract would put in the mitigation features for the test cell channelization. Some of these contracts may run concurrently or may ultimately be combined or split into smaller contracts due to timing and need constraints. Additional contracts will be necessary for the clearing and grubbing and the planting of trees.

Construction contract language will require compliance with Stormwater Pollution Prevention requirements to control runoff and protect water quality. Standard requirements also include control of invasive vegetation on disturbed areas during and immediately following construction.

MONITORING AND ADAPTIVE MANAGEMENT

ER 1105-2-100 allows for project monitoring and adaptive management during and after construction. Adaptive management for complex, specifically authorized projects may be recommended, particularly those projects that include Ecosystem Restoration as a project purpose. When recommended, the cost of adaptive management is limited to three percent of the total project cost excluding monitoring costs. No project-specific ecological monitoring or adaptive management measures are included as part of the Proposed Action for the Leon Creek Project.

OPERATION, MAINTENANCE, REPAIR, REPLACEMENT, AND REHABILITATION

Under the terms of the Project Partnership Agreement, the San Antonio River Authority would accept the project following completion of construction and ensure its operation, maintenance, repair, rehabilitation, and replacement (OMRRR), in accordance with Federal regulations. The major OMRRR items include the following:

- Regular maintenance of facilities
- Debris cleanup
- Invasive species control

OMR&R costs are currently estimated at \$59,000 per year. After completion of the project, an Operation and Maintenance Manual for the Authority would be prepared by the Corps, and periodic inspections would be conducted to ensure that all required maintenance was being performed.

PROJECT IMPLEMENTATION SCHEDULE

	Leon Creek			
Work to be done by Contract		Start Year	End Year	Duration
Planning and Design		2015	2017	
Relocations		2017	2017	
Channel Modification		2017	2018	
Levee		2018	2019	
Fish and Wildlife (includes 2 yr adaptive Management)		2017	2020	
Construction Management		2017	2019	
	Non - Structural Buyout Area			
Work Completed				
Planning and Design		Mar-15	Feb-17	
Relocations (Demo buildings and cap Utilities)		May-17	Jul-17	10 Weeks (Assume a 5 - 3 man crews)
Fish and Wildlife (Grass plantings in disturbed areas)		Jul-17	Sep-17	5 Weeks (Assume a 3 - 2 man crews)
Construction Management		May-17	Sep-17	
	Test Cell Area			
Planning and Design		Mar-15	Feb-17	
Utility Relocation		May-17	Jun-17	6 Weeks (Assume 2 - 5man crews)
Channel Modification		Jul-17	Oct-18	

Site Work (Prep and Demo)		Jul-17	Oct-17	14 weeks (Assume 4 - 3 man crews)
Channel Improvement		Oct-17	Apr-18	27 weeks (Assume 3 - 4 man crews)
Storm Drainage Improvements/ Sluice Gate		Apr-18	Jun-18	9 Weeks (Assume 2 - 5 man crews)
Sump		Apr-18	Oct-18	25 Weeks (Assume 4 - 4man crews)
Fish and Wildlife		Oct-17	May-20	
Excavation		Oct-17	Nov-17	3 weeks (Assume 4 - 4 man crews)
In-stream Structures		Apr-18	Apr-18	2 days (Assume 1 - 4 man crew)
Trees		Apr-18	May-18	5 weeks (Assume 2 - 2 man crews)
Clearing and grubbing (Is included in Site Work Prep)				
Adaptive Management		May-18	May-20	2 years
Levee		Oct-18	Mar-20	73 weeks (Assume 4 - 3 man crews)
Construction Management		May-17	Mar-20	

TOTAL PROJECT COST

The total project cost for the Recommended Plan is \$28,966,000. This includes \$5,886,000 for the non-structural alternative and \$23,080,000 for the structural alternative at the Jet Engine Test Cell facility. The base cost of the Recommended Plan \$23,715,000 with a contingency \$5,251,000.

COST SHARING

The provisions of the Water Resources Development Act of 1986 as amended by the Water Resources Development Act 1996 stipulates cost sharing requirements that local sponsors must meet for the Federal government to be involved with water resource projects. This section outlines the cost sharing provisions for flood risk management purposes.

Under the provisions set forth in Public Law 104-303, as amended, the designated Sponsor, in this case the San Antonio River Authority, is required to formally approve the recommendations of the Feasibility Report before initiating the Preconstruction, Engineering, and Design Phase of the project.

For non-structural flood risk management projects, the non-Federal cost would be at least 35 percent of the total project flood risk management costs. The non-Federal sponsor would be responsible for 100 percent of the operation, maintenance, repair, rehabilitation, and replacement costs for the flood risk management portion of the project. The apportionment of costs is portrayed in Table 5-2 below.

**Table 5-2
Cost Apportionment
October 2012 Prices**

Feature	Federal	Non-Federal	Total
Non Structural Alternative			
Lands & Damages		\$4,779,000	\$4,779,000
Utility Relocations		745,000	745,000
Fish and Wildlife	\$100,000		100,000
Planning, Engineering & Design	156,000		156,000
Construction Management	106,000		106,000
Unadjusted Total	362,000	5,524,000	5,886,000
Adjustment to Achieve 50/50	2,581,000	(2,581,000)	
Non Structural Subtotal	2,943,000	2,943,000	5,886,000
Structural Alternative			
Lands & Damages		2,632,000	\$2,632,000
Relocations		561,000	561,000
Channels and Canals	8,613,000		8,613,000
Levee and Floodwalls	6,025,000		6,025,000
Fish and Wildlife Facilities	859,000		859,000
Preconstruction, Engineering & Design	2,618,000		2,618,000
Construction Management	1,772,000		1,772,000
Unadjusted Total	19,887,000	3,194,000	23,080,000
5% Cash Contribution	(1,154,000)	1,154,000	

Structural Subtotal	18,733,000	4,348,000	23,080,000
Sub-total	21,675,000	7,290,000	28,966,000
Adjustment to Achieve 65/35	(2,848,000)	2,848,000	
Total Cost Apportionment	\$18,828,000	\$10,138,000	\$28,966,000
Cost Percentage	65	35	

FINANCIAL CAPABILITY ASSESSMENT

Sponsor Self-Certification of Financial Capability

The non-Federal sponsor, the San Antonio River Authority, is to provide a statement that attests to their capability to meet their financial responsibilities related to this project as agreed and described in this report. This section will contain that information as soon as SARA provides it to the Corps.

FULLY FUNDED COST ESTIMATE

The fully funded cost estimate is intended to provide an indication of total project costs when inflation is taken into account. Inflation rates are based on rates developed as part of the Corps budgeting process. The estimated first cost is \$28,996,000, and the fully funded cost estimate for the Recommended Plan is \$31,560,000. See Table 5-3 below for the detailed annual costs.

Table 5-3
Fully Funded Cost Estimate

Feature	Total	Mid-Point Date	Inflation	Fully Funded Cost
Relocations	\$1,306,000	2017Q3	9.0%	\$1,424,000
Fish & Wildlife Facilities	\$959,000	2018Q2	10.5%	\$1,060,000
Channels & Canals	\$8,613,000	2018Q2	10.5%	\$9,517,000
Levees & Floodwalls	\$6,025,000	2019Q3	13.1%	\$6,814,000
Construction Estimate Subtotals	\$16,903,000			\$18,815,000
Lands and Damages	\$7,411,000	2013Q4	1.6%	\$7,530,000
Planning, Engineering, & Design				
Project Management	\$308,000	2015Q4	8.8%	\$335,000
Planning & Environmental Compliance	\$154,000	2015Q4	8.8%	\$168,000
Engineering & Design	\$962,000	2015Q4	8.8%	\$1,047,000
Reviews, ATRs, IEPRs, VE	\$154,000	2015Q4	8.8%	\$168,000
Life Cycle Updates (cost, schedule, risks)				
Contracting & Reprographics	\$154,000	2015Q4	8.8%	\$168,000
Contracting & Reprographics	\$154,000	2015Q4	8.8%	\$168,000
Engineering During Construction	\$463,000	2018Q4	23.4%	\$571,000

Planning During Construction	\$270,000	2018Q4	23.4%	\$333,000
Project Operations	\$154,000	2015Q4	8.8%	\$168,000
Planning, Engineering, & Design Subtotal	\$2,773,000			\$3,126,000
Construction Management				
Construction Management	\$1,251,000	2018Q4	11.4%	\$1,394,000
Project Operation:	\$313,000	2018Q4	11.4%	\$349,000
Project Management	\$313,000	2018Q4	11.4%	\$349,000
Construction Management Subtotal	\$1,877,000			\$2,092,000
Fully Funded Cost Total	\$28,966,000			\$31,560,000

VIEWS OF THE LOCAL SPONSOR

The local sponsor, San Antonio River Authority (SARA), has been an integral team member and has actively participated in plan formulation, alternative screening, and plan selection. The local sponsor supports the Recommended Plan and intends to participate in its implementation. A Letter of Intent stating their support and their intention to participate in the project implementation will be included in the Final Report.

RESOURCE AGENCY COORDINATION

The EPA, USFWS, and TCEQ were invited to be Cooperating Agencies, because they have been conducting relevant work within the Edwards Plateau and specifically, the Leon Creek Watershed. The Kiowa Tribe of Oklahoma was also invited to participate. Scoping letters were mailed to the resource agencies in February 2008 (see Appendix H “Correspondence”).

Several meetings and site visits have been held with the resource agencies, specifically Texas Parks and Wildlife Department (TPWD) and USFWS. Field site visits for the Habitat Evaluation Procedures (HEP) were conducted March 18–20, 2008, and included staff from the USFWS and TPWD.

Subsequent conversations and emails occurred in regard to the HEP results. Appendix D “USFWS Coordination” contains the official Planning Aid Letter from USFWS.

The resource agencies have been invited to the monthly working meetings and have participated at a few of these meetings. Correspondence by e-mail and phone with the resource agencies has also occurred throughout study development. Ongoing coordination with USFWS is discussed in the subsection entitled “Fish and Wildlife Coordination Act.”

PUBLIC INVOLVEMENT

USACE and SARA have held multiple public communication events with local citizens regarding the Leon Creek Watershed Integrated Feasibility Study (IFS). Details regarding some of the public

involvement activities that have already taken place are presented below along with a summary of the remaining steps to be completed as part of the NEPA process.

Pre-Study Public Involvement

Even before the formal outset of the present feasibility study, the results of Phase I of the sponsor's Leon Creek Watershed Master Plan (LCWMP) and initial plans for the feasibility study were aired in a public forum held on March 7, 2009 at Government Canyon State Natural Area. The meeting was a monthly meeting held between SARA and USACE; but for this particular meeting, representatives of TPWD, USFWS, and Friends of Government Canyon (FOGC – a citizens' environmental group) were also invited and in attendance. The focus of this meeting was to share information about the Regional Storm Water Detention Facilities (RSWFs) identified in the LCWMP Phase I report, which identified Government Canyon as potential site for such a facility. A flood detention facility in this location could provide significant FRM benefits downstream, and possible aquifer recharge benefits. These potential benefits would risk environmental consequences, however. Government Canyon, home to several endangered species and site of critical habitat for these species, has been set aside as a State Natural Area. There is also likelihood that there are significant cultural resources in Government Canyon. The primary objective of this meeting was therefore to ensure that interested parties were informed that the feasibility study would weigh the possibility of a Governmental Canyon FRM alternative, at least preliminarily.

Public Scoping Meetings

For initiation of the Leon Creek Watershed IFS, three Public Scoping meetings were held to ensure that as many interested citizens as possible would be able to attend. Each of these meetings featured presentations by USACE, SARA, and city of San Antonio. Meeting 1 was on May 26, 2009 at Helotes Elementary School; Meeting 2 was on June 2, 2009 at Leon Springs Elementary School. A total of approximately 70 local citizens attended these two meetings. A third meeting, also well attended, was held on July 1, 2009 at the Woodlawn Theatre, where a large number of members of the FOGC organization appeared and spoke out against any alternative that would negatively affect Government Canyon.

During the Scoping meetings, the results of the Phase I of the LCWMP and plans for the feasibility study were again reviewed for the public. Though various concerns were brought up by citizens in attendance, the primary concern voiced was: Why is money being spent studying flooding problems, while additional construction in floodplains is being allowed?

Mid-Study Public Involvement

An additional Public Meeting was held on June 8, 2011 at the SARA main office in San Antonio. The purpose of this meeting was to inform the public of study progress to date by reviewing goals and objectives of the study, methodology, synopsis of projects with Federal interest, and next steps. Presentations were made by SARA, USACE, and Halff Associates. Like some of the previous meetings, opposition to a Government Canyon FRM alternative was expected, so an additional agenda

item was discussion of this possibility. USACE's presentation stated that, due to potential environmental and cultural impacts and likely mitigation costs, the Federal government would not pursue an FRM alternative in Government Canyon as part of the present study. On the other hand, the sponsor indicated that they will continue to evaluate Government Canyon as a potential RSWF site, despite the Federal position.

Public Review Period

A copy of the draft report and integrated environmental assessment, along with a copy of the Notice of Availability (NOA) will be mailed to the following resource agencies for review and comment in accordance with requirements as set forth by NEPA: Texas Parks and Wildlife Department, U.S. Fish and Wildlife Service, Environmental Protection Agency (Region 6), the Texas Historical Commission, and the Texas Commission on Environmental Quality as well as appropriate Indian tribes. In addition, a Notice of Availability will be mailed to large group of local citizens and stakeholders who have indicated an interest in receiving and reviewing the document. Comments received during the 30-day public review period, and respective responses will be included in Appendix H, along with the Agency Coordination Letters and the NOA.

CONCLUSIONS

The following conclusions were reached based on the results of the investigations conducted for this study.

1. A significant need exists to provide flood risk management alternatives within the Leon Creek study area.
2. The Recommended Plan offers a solution consisting of structural and nonstructural alternatives with an estimated first cost of approximately \$28.966 million, with a Federal cost share of approximately \$18.828 million (65 percent) and a non-Federal cost share of approximately \$10.138 million (39 percent). The Recommended plan has an annual cost of \$1,429,570 and annual net benefits of \$698,770.
3. The San Antonio River Authority has agreed to serve as the local sponsor for the construction of the project.
4. As documented in the Environmental Assessment, no significant environmental impacts would occur as a result of implementation of the Recommended Plan. Pending completion of public and State and Agency Review, a Finding of No Significant Impact (FONSI) will be prepared as part of the District Engineer's recommendation.
5. Additional evaluation, including Value Engineering, will be conducted during the preconstruction, engineering and design phase. The results of these studies may alter the project materials, design, costs, and cost apportionment or the amount of Federal participation in the project.

DRAFT FINDING OF NO SIGNIFICANT IMPACT

Leon Creek is located in Bexar County, Texas originating in northwestern Bexar County and flowing south to the confluence with the Medina River. At the request of the San Antonio River Authority, and under authority of the Guadalupe and San Antonio Rivers and Tributaries, Texas, Resolution adopted by the Committee on Transportation and Infrastructure, U.S. House of Representatives, House Resolution docket 2547, 11 March 1998, the Fort Worth District Corps of Engineers conducted an interim feasibility study to evaluate potential flood risk management solutions associated with Leon Creek in Bexar County. Study results are presented in an Interim Feasibility Study with Integrated Environmental Assessment (EA).

Structural and nonstructural alternatives were evaluated for consideration including flood regulation, floodplain management, permanent relocations, detention ponds, levees, and hydraulic channels at 35 Areas of Interest (AOI). The recommended plan includes the construction of a 100-year levee in AOI-2 with hydraulic mitigation (channel improvements) utilizing natural channel design concepts. In addition, recommended plan includes the buyout (permanent floodplain evacuation) of four single-family residential structures and 32 townhouses in AOI-4 subject to damages from a 4% annual exceedance probability event.

The recommended plan would have no effect on federally listed threatened and endangered resources. The channel improvement measure of the recommended plan would impact waters of the United States and is subject to provisions of Section 404 of the Clean Water Act. Because the channel improvements would utilize natural channel design and incorporate the restoration of native riparian vegetation along the channel, the channel improvements would restore the structure and function of the waters of the United States and would be considered self mitigating.

In accordance with 36 CFR Part 800.6(b), should adverse impacts to any cultural or historic resources throughout the project corridor be unavoidable, an appropriate mitigation plan will be sought in consultation with the Texas Historical Commission and other interested parties and agencies, and fully implemented prior to project construction. Cultural resources compliance issues for the project area are being addressed through on-going consultation with the Texas State Historic Preservation Office (SHPO) in accordance with Section 106 of the National Historic Preservation Act.

Based on a review of the information, it is determined that the implementation of the Proposed Action is not a major federal action which would significantly affect the quality of the human environment within the meaning of Section 102(2)(c) of the National Environmental Policy Act of 1969, as amended. Therefore, the preparation of an Environmental Impact Statement is not required.

Charles H. Klinge, Jr.
Colonel, Corps of Engineers
District Engineer

RECOMMENDATIONS

Therefore, I recommend that the flood risk management alternatives identified as the Recommended Plan for the Leon Creek study area be authorized for construction.

This recommendation is made with the provision that prior to project implementation, the non-Federal sponsors shall enter into a binding Project Partnership Agreement (PPA) with the Secretary of the Army to perform the items of local cooperation, as specified under “Non-Federal Responsibilities (Items of Local Cooperation).”

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

Charles H. Klinge, Jr.
Colonel, Corps of Engineers
District Engineer

SECTION SEVEN

REFERENCES

This section contains a list of references cited throughout this report (in addition to those listed in “Prior Studies and Reports” in Section 1.

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