PECAN CREEK, GAINESVILLE, TEXAS

DETAILED PROJECT REPORT
AND
INTEGRATED ENVIRONMENTAL ASSESSMENT

OCTOBER 2005

GAINESVILLE
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US Army Corps
of Engineers ®

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AND
INTEGRATED ENVIRONMENTAL ASSESSMENT

OCTOBER 2005

U.S. ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT
on behalf of the
CITY OF GAINESVILLE, TEXAS

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EXECUTIVE SUMMARY

This report presents the results of the flood-damage reduction study conducted under the authority of Section 205 of the Flood Control Act of 1948, as amended, to identify water and related land resource problems and needs of Pecan Creek in Gainesville, Texas. This study was directed by the Fort Worth District, Corps of Engineers in partnership with the City of Gainesville.

The city of Gainesville experiences recurrent flooding from Pecan Creek within the city limits causing economic losses and a threat to health and safety. Flood damages begin with the 2-year flood event, with significant damages occurring prior to the 5-year event. The 10- and 100-year flood event result in damages of $1.4 million and $7.0 million, respectively. Annual flood damages are estimated at $783,300 (July 2005 price level).

An array of alternatives to reduce flood damages were evaluated. Detailed analyses were conducted on a non-structural solution (permanent evacuation of the flood plain) and channel modifications. The recommended (National Economic Development) plan consists of a grass-lined channel, approximately 7,859-feet in length. The modified channel has a bottom width of 30-feet with 1 vertical on 3.5 horizontal side slopes. The recommended plan also includes the removal of three residential structures, one commercial structure, and two sheds, as well as seven bridge replacements and utility relocations. Ecological mitigation entails acquisition and improvement to 22.05-acres of land.

The total project cost is estimated at $8,324,400 (October 2005 price level). Annual costs are estimated at $502,700. The project provides annual flood-damage reduction benefits of $676,300 and has a benefit-cost ratio and net benefits of 1.3 to 1.0 and $171,200, respectively. The recommended plan reduces 86-percent of the annual damages. Remaining annual damages with the project are estimated at $107,000.

The city of Gainesville is identified as the local sponsor for implementation of the recommended plan. Federal and non-Federal cost apportionments for the recommended plan are estimated at $4,162,200 each.

The recommended plan will cause no long-term adverse environmental impacts. A draft Finding of No Significant Impact (FONSI) was prepared. After the review period, the final FONSI will be signed. Distribution of this Detailed Project Report and Integrated Environmental Assessment, including the draft FONSI, was made available for public review. No significant comments or objections to the recommended plan were raised.

Questions regarding the recommended plan or the Detailed Project Report and Integrated Environmental Assessment should be directed to Mr. Eli Kangas, Chief, Plan Formulation Section, Fort Worth District Corps of Engineers, P.O. Box 17300, Fort Worth, Texas 76102, or (817) 886-1924 or eli.a.kangas@swf02.usace.army.mil

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INTRODUCTION

Study Authority. The U.S. Army Corps of Engineers, Fort Worth District, is conducting the Pecan Creek, Gainesville, Texas, Local Flood Damage Reduction Feasibility Study under the authority of Section 205 of the 1948 Flood Control Act, as amended. The City of Gainesville requested assistance for flood damage reduction from the Corps in a letter dated 28 February 2002.

Study Purpose and Scope. The objective of the study was to examine flood damage reduction along Pecan Creek in Gainesville, Texas, and recommend a flood damage reduction project for implementation if one could be found that is technically and economically feasible, environmentally acceptable, and supported by the city of Gainesville.

Study Participants. The Fort Worth District, U.S. Army Corps of Engineers, acting at the request and in coordination with the City of Gainesville, is conducting this feasibility study. The Project Delivery Team is comprised of various engineers, scientists, and other professionals from the Fort Worth District, as well as representatives from Gainesville. In addition, coordination with the U.S. Fish and Wildlife Service, Texas Parks and Wildlife Department, and the State Historical Preservation Office is ongoing.

Previous Studies and Reports. The following are studies and reports that have been conducted concerning or related to Pecan Creek in Gainesville, Texas.

Reconnaissance Report, Flood Protection, Pecan Creek – Gainesville, Texas. U.S. Army Corps of Engineers, Fort Worth District, April 1973.

Plan Formulation Fact Sheet, Pecan Creek, Gainesville, Texas. U.S. Army Corps of Engineers, Fort Worth District, December 1984

Detailed Project Report, Emergency Streambank Protection, Pecan Creek at Moss Street Bridge and Pecan Creek at Broadway Street Bridge. U.S. Army Corps of Engineers, Fort Worth District, April 1991.

Detailed Project Report, Pecan Creek, Gainesville, Texas. U.S. Army Corps of Engineers, Fort Worth, Texas, August 1986. This report recommended a grass-lined trapezoidal improved channel with a 65-foot bottom width along a 2.53-mile length of Pecan Creek and seven bridge replacements as an economically feasible project with a benefit-to-cost ratio of 1.7 to 1.0. The first cost of the plan, at April 1986 price levels, was estimated to be $6,933,000 with annual charges of $654,000. Average annual benefits of the selected plan were estimated to be $1,106,100, with net benefits of $452,100. At that time, the City was unable to obtain the level of funding required to continue with the project.

Flood Protection Planning Study, Gainesville, Texas. HDR Engineering, May 1999. This study was conducted for the City of Gainesville and Cooke County and included recommendations for flood protection along Pecan Creek. The study identified the segment of Pecan Creek from Highway 82 to Anthony Street as the principal flooding problem area in the creek watershed and recommended 65-foot bottom width channel improvements to a segment of Pecan Creek at a cost of $8,632,940.

Federal Emergency Management Agency Hazard Mitigation Grant. The city of Gainesville has acquired four structures to be demolished and removed from the flood plain under the Federal Emergency Management Agency's Hazard Mitigation Grant. The removal of these structures has been taken into account in the estimation of without-project damages.

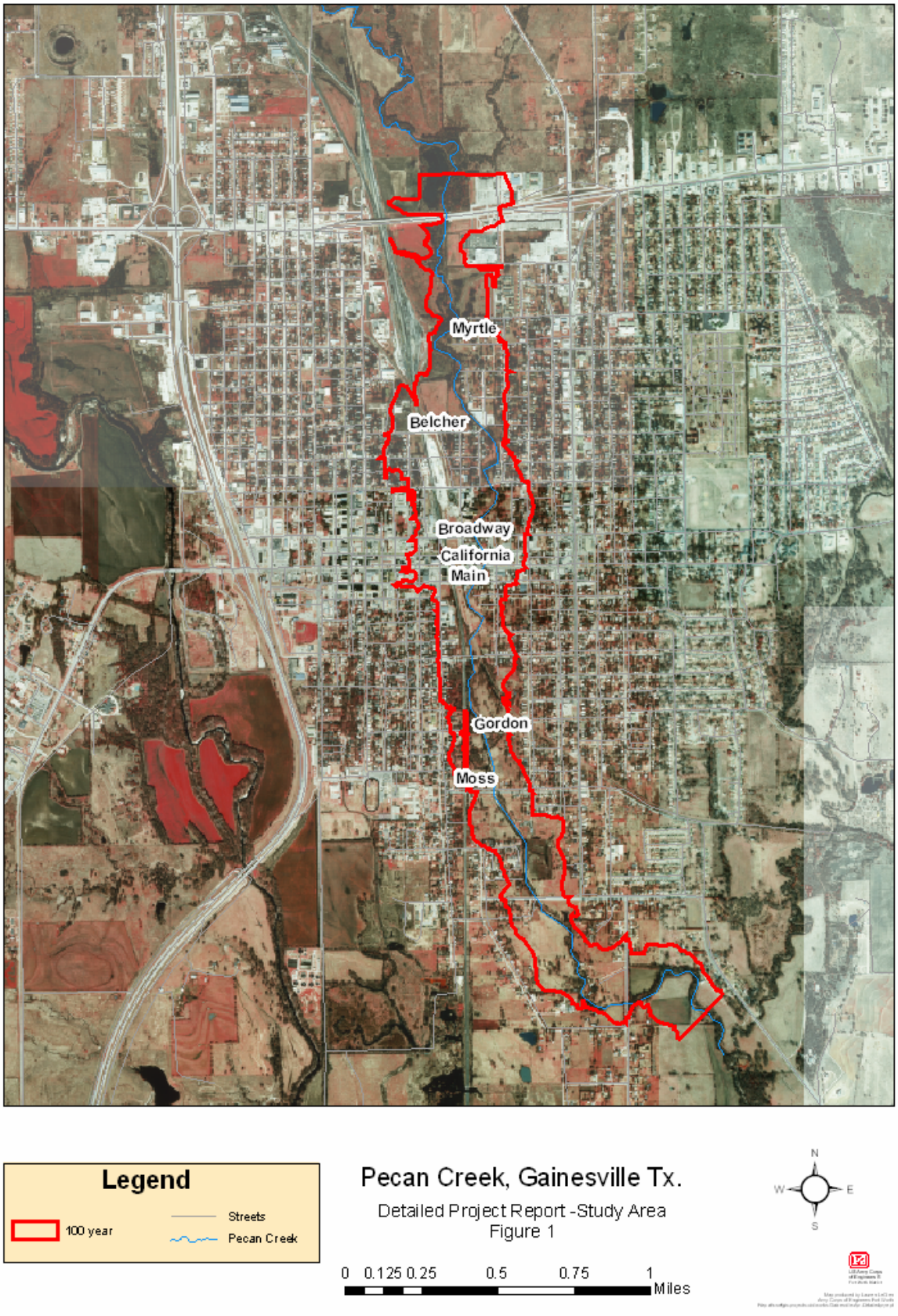
CHARACTERISTICS OF THE STUDY AREA

Study Area. Pecan Creek originates approximately 6 miles north of the city and flows south through the central portion of the city to its confluence with Wheeler Creek, Redmond Branch, and the Elm Fork of the Trinity River. Pecan Creek is located within the Trinity River (Elm Fork) Watershed specifically in the Lake Lewisville Sub-Watershed in north Central Texas and is located primarily in Denton and Cooke Counties. Pecan Creek rises three miles northwest of Gainesville in north central Cooke County and runs southeast for eight miles to its mouth on the Elm Fork of the Trinity River, three miles south of Gainesville. Gainesville is the county seat of Cooke County and is located approximately 60 miles north of the Dallas/Fort Worth metropolitan area and approximately 7 miles south of the Oklahoma state line. Figure 1 is a map of the study area. A larger version of the map is located in Appendix A.

Pecan Creek. The Pecan Creek watershed covers a drainage area of approximately 15.4 square miles at its confluence with Wheeler Creek. Land use within the watershed is predominantly rural. The drainage area of Pecan Creek within the study area is approximately 12.4 square miles. Downstream of Highway 82, the watershed narrows through Gainesville and is heavily urbanized with residential and commercial development. Within the study area, Pecan Creek has a length of about 8,000-feet.

The stream channel varies from wide and flat to narrow with steep banks downstream. Channel depth varies 2 to 4 feet. The creek has been modified in numerous places within the study area. Downstream of Garnett Street, Pecan Creek has been straightened. However, it has not been lined nor have the trees been removed from the bank. The channel is wider than in the reach near US Highway 82. Channel capacity is about 2,000 cubic feet per second, or approximately 25-percent of the 100-year peak runoff.

Vehicular bridges cross Pecan Creek at Summit, Belcher, Scott, Broadway, California, Main, Garnett, Moss, and Anthony Streets. A pedestrian bridge is located in Jaycee Park. Water, sanitary sewer, gas, electric, and telecommunication utilities also cross or are in proximity to the creek.


Myrtle
Belcher
Broadway
California
Main
Gordon
Moss
Legend
100 year
Streets
Pecan Creek
Pecan Creek, Gainesville Tx.
Detailed Project Report -Study Area
Figure 1
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Climate. The average annual precipitation is 36.9 inches per year. Heaviest precipitation tends to occur in spring, early summer, and during early fall. Average annual temperature for the area is 62.7° F with average low temperatures occurring in January (40.1° F) and average high temperatures occurring in July (83.4° F).

Regional Geology And Soils. The West Cross Timbers sub-region has a complex geologic history, resulting in a variety of soil types and terrain features. The terrain in most of this sub-region is very hilly, with sandstone and limestone escarpments, steep slopes, and irregular surface features. Exposed sandstone rocks and boulders dominate landscape features in many areas. The soils of this region can be sub-categorized using the Cross Timbers and Prairies Ecological Region sub-regions (East Cross Timbers, West Cross Timbers, and Fort Worth Prairie). Soils of the East Cross Timbers region are slightly acidic, sandy or sandy loam. Fort Worth Prairie exhibits thin soil over hard layers of resistant limestone. Underlying layers of limestone slope eastward with the exposed ends of younger layers forming escarpments or "cuestas" that produce the scenic topography typical for the area. The soils of Cooke County and the Pecan Creek watershed can be characterized by the Kiamitia clay that forms a narrow belt of fertile land along the crest of the escarpment bordering the Upper Cross Timbers Ecological Region. In Cooke County, the Denison marls, with their residual soils, form a strip of clay, which constitutes the major portion of the rock and soil of these marls.

Terrestrial Resources. Gainesville, Texas, lies within the ecological region referred to as the Cross Timbers and Prairies Ecological Region. This ecological region is made from several sub-regions (East Cross Timbers, West Cross Timbers, and Fort Worth Prairie), which together yield the vegetation typical of the Gainesville area. Soils in the East Cross Timbers region produce woodlands dominated by post oak, blackjack oak, cedar elm, hickory, osage orange, eastern red cedar, mesquite, bumelia, hawthorn, greenbriar, and a variety of other brush and grass species. Post oak-blackjack oak woodlands characterize much of the West Cross Timbers. Other associated woody species include shin oak, Spanish oak, live oak, Texas ash, mesquite, osage orange, Ashe juniper, eastern red cedar, cedar elm, skunkbush sumac, elbowbush, lotebush, tasajillo, rough-leafed dogwood, flame-leaf sumac, hawthorn, and hackberry.

The following are brief lists of the most common grasses, forbs, shrubs, and trees observed within the project area: – Canada wild rye (*Elymus canadensis*), johnsongrass (*Sorghum halepense*), Texas winter grass (*Stipa leucotricha*), rye grass (*Lolium multiflorum*), wheat grass, sedge grass (*carex* sp), switchgrass (*Panicum virgatum*), bermuda grass (*Cynodon dactylon*), poison ivy (*Toxicodendron radicans*), green briar (), ragweed (*Ambrosia artemisiifolia*), white aster (*Aster ericoides*), iva, milkweed (*Asclepias syriaca*), prairie primrose (), sunflower spp, rice cutgrass (*Leersia oryzoides*), curly dock (*Rumex crispus*), goldenrod (*Solidago* spp), hedge parsley (*Torilis arvensis*), dove weed (*Eremocarpus setigerus*), giant ragweed (*Ambrosia trifida*), wood-bine (*Parthenocissus quinquefolia*), sorrel (*Rumex acetosa*), honeysuckle (*Lonicera fragrantissima*), smartweed (*Polygonum* spp), common cocklebur (*Xanthium strumarium*), moonseed (*Menispermum canadense*), dayflower (*Commelina erecta*), trumpet creeper (*Campsis radicans*), Mexican hat (*Ratibida columnaris*), hackberry (*Celtis occidentalis*), American elm (*Ulmus americana*), green ash

(*Fraxinus pennsylvanica*), box elder (*Acer negundo*), pecan (*Carya illinoensis*), willow (Salicaceae), honey locust (*Gleditisia triacanthos*), red cedar (*Juniperus virginia*), persimmons (*Diospyros* sp), osage orange (*Maclura pomifera*), eastern cottonwood (*Populus deltoides*), sycamore (*Platanus occidentalis*), post oak (*Quercus stellata*), box elder (*Acer negundo*), coralberry (*Symphoricarpos orbiculatus*), hackberry (*Celtis occidentalis*), dogwood (*Cornus florida*), mesquite (*Prosopis pubescens*), honey locust (*Gleditisia triacanthos*), osage orange (*Maclura pomifera*), chinaberry (), mulberry, privit, Texas saphora, soap berry, Texas redbud

The wildlife populations within the undeveloped segments of the watershed represent a typical north central Texas wildlife community. The following are brief lists of the most common wildlife observed within Cooke County: Virginia opossum (*Didelphis virginiana*), southern short-tailed shrew (*Blarina carolinensis*), elliot's short-tailed shrew (*Blarina hylophaga*), least shrew (*Cryptotis parva*), eastern mole (*Scalopus aquaticus*), eastern cottontail (*Sylvilagus floridanus*), red fox (*Vulpes vulpes*), ringtail(*Bassariscus astutus*), common raccoon (*Procyon lotor*), striped skunks (*Mephitis mephitis*), smallmouth salamander (*Ambystoma texanum*), lesser siren (*Siren intermedia*), cricket frog (*Acris crepitans*), green toad (*Bufo debilis*), southern leopard frog (*Rana sphenocephala*), bullfrog (*Rana catesbeiana*), eastern mud turtle (*Kinosternon subrubrum*), eastern box turtle (*Terrapene carolina*), slider (*Trachemys scripta*), texas spotted whiptail (*Cnemidophorus gularis*), eastern collared lizard (*Crotaphytus collaris*), Texas spiny lizard (*Sceloporus olivaceus*), fence lizard (*Sceloporus undulatus*), corn snake (*Elaphe guttata*), common kingsnake (*Lampropeltis getula*), southern water snake (*Nerodia fasciata*), ground snake (*Sonora semiannulata*), yellow-billed cuckoo (*Coccyzus americanus*), wren, painted bunting (*Passerina ciris*), eastern meadowlark (*Sturnella magna*), bobwhite quail (*Colinus virginianus*), little blue heron (*Egretta caerulea*), American crow (*Corvus brachyrhynchos*), northern cardinal (*Cardinalis cardinalis*), blue jay (*Cyanocitta cristata*), downy woodpecker (*Picoides pubescens*), mourning dove (*Zenaida macroura*), northern mockingbird (*Mimus polyglottos*), American robin (*Turdus migratorius*), killdeer (*Charadrius vociferus*), grackle (*Quiscalus sp*), sparrow, and scissortail (USFWS 2003).

Aquatic Resources. Due to the ephemeral nature of Pecan Creek, there is not an abundant amount of surface water in the watershed. The stream channel varies from wide and flat to narrow with steep banks downstream. Channel depth varies 2 to 4 feet. The average depth at the time of the site visit was 2 feet. The creek has been channelized in numerous places within the project area. The northern reach (north of I-35 extending to downstream of US Highway 82) of the project area contains the most viable habitat (Figure 1). The substrate in this area of the creek is mostly small gravel and fine sediment. In addition this reach contains moderate to heavily forested creek banks that provide shade, habitat and contribute to feeding of aquatic organisms in the stream.

The middle reach of the study area is the most heavily disturbed due to past channelization, removal of vegetation on the stream banks and lining of the channel bottom and sides to facilitate storm runoff. Historical flagstone-lined sections as well as more modern concrete-lined sections are located in this reach. Water in this reach is often less than 2 inches in depth, and direct sunlight and the lack of physical structure precludes the development of aquatic biota within this reach.

Downstream of Garnett Street, Pecan Creek has been straightened. However , it has not been lined nor have the trees been removed from the bank. The channel is wider than in the reach near US Highway 82. In addition, the channel has deeper pools and zones of high siltation.

Field sampling was performed to evaluate the value of the Pecan Creek being considered for modification. Sampling was done within the upper and lower reaches. The channelized middle reach was not sampled due to the lack of visually observable fisheries and fisheries habitat. The results indicate the two reaches are of intermediate quality and that protection of those two reaches to the extent possible is warranted.

Threatened and Endangered Species. According to the U.S. Fish and Wildlife Service there are three Federally listed threatened, endangered, or candidate species that could occur in counties in the study area. Table 1 provides a listing of the species.

Table 1
Federally Listed Threatened and Endangered Species for Cooke County

Common Name	Scientific Name	Listing Status
Bald Eagle	*Haliaeetus leucocephalus*	Threatened, Proposed Delisting
Least Tern	*Sterna antillarum*	Endangered
Whooping Crane	*Grus Americana*	Endangered

Wetlands. An area that ponds water for significant periods is located on the right descending bank just upstream of Highway 82. It appears to have resulted from borrowing of material for construction of the elevated section of Highway 82 crossing Pecan Creek. It is important to protect this potential wetland area from unintended impacts from operation of any flood control project implemented downstream.

Air Quality. The Environmental Protection Agency uses six "criteria pollutants" as indicators of air quality, and has established for each of them a maximum concentration above which adverse effects on human health may occur. The six pollutants are Carbon Monoxide(CO), Nitrogen Dioxide (NO_2), Ozone (O_3), Lead (Pb), Particulates (PM 10 and PM 2.5), and Sulfur Dioxide ($S0_2$). These threshold concentrations are called National Ambient Air Quality Standards (NAAQS). Areas of the country where air pollution levels persistently exceed the NAAQS may be designated as nonattainment areas. Conversely, areas of the country that do not persistently exceed the NAAQS are designated as attainment areas. The study area is located within Cooke County, which is a designated attainment area.

Cultural Resources. The Area of Potential Effect is defined as the creek channel from US Highway 82 to Anthony Street (50 feet to each side of the centerline of the creek) and properties affected physically and visually. A number of sites may include culturally significant resources.

During the 1930s, the Civilian Conservation Corps completed a lining of the channel with flagstone. The flagstone channel is approximately 26 feet wide at the top, 14 feet wide at the bottom and 3.5 feet deep. The rock lining has been removed in several stretches and replaced

by concrete. An estimated 50 percent of the channel is original construction. The remaining original construction retains a high degree of integrity as evidenced by comparison with the 1948 photographs. As a true representative example as a depression-era public works project, the rock-lined channel is eligible for the National Register for Historic Places (NRHP) for its design and construction values and its association with the event of the Great Depression and its related large public works projects designed to provide work for unemployed Americans.

Georgia Davis Bass Park is located between California and Main Streets on the east bank of Pecan Creek. The park contains the site where forty suspected Unionists in Confederate Texas were hanged at Gainesville in October 1862. The park is unimproved with only a granite historical marker in the center of the space. The site is not included in the Texas Historic Sites Atlas database, which is probably an oversight. The site is eligible for its association with significant events in Texas history; although no material culture is extant that illustrates the site's significance.

The California Street Bridge built in 1935 is a primary crossing point for vehicular traffic in and out of downtown Gainesville. The structure is built of reinforced concrete. It retains a very high degree of integrity in both materials and workmanship. Only the original lampposts have been removed. While the concrete has spalled in several areas due to water penetration of the steel reinforcement, the bridge is structurally sound and viable for continued use. It is eligible for the NRHP on a local level for its construction values as a true representative example of early twentieth-century vehicular bridge.

The Whaley Mill & Grain Elevator (Texas Historic Sites Atlas # NRS79-0758) is located immediately adjacent to Pecan Creek on the west bank between Broadway and Scott streets, the structure is a 6-story brick commercial building and grain elevator. It has metal industrial type windows with recessed panels in spandrels, a rectangular plan, flat roof, and extended brick parapet with pediment projections rising from parapet. It is the tallest building in the city. It is eligible for the NRHP on a local level for its association with the economic growth of Gainesville.

Appendix E contains the complete cultural resources investigation.

Hazardous, Toxic, And Radiological Waste (HTRW). A records search for known HTRW sites was conducted for the study area, with specific emphasis on areas adjacent to the Pecan Creek channel. The records search identified one site adjacent to the channel that may have HTRW contamination. Bazflex Texas, Inc., located at 719 Smith Street. Bazflex Texas is a RCRA SQG (Small Quantity Generator) and borders the channel on the east. The records search identified additional potential HTRW sites. Appendix D contains the complete HTRW study.

Recreation. The park and open space within Gainesville is approximately 99.9 acres. The Gainesville inventory of park and open space system is composed of 45 acres of parks. The City of Gainesville has plans to add 56 acres of developed park land to the area. No regional parks exist in this area. The lack of trails and open space was addressed and recently demonstrated by the completion of a one mile walking/jogging trail. There are three major

creek corridors that run through Gainesville – Pecan Creek, Wheeler Creek and the Elm Fork – tributary of the Trinity River.

Socio-Economic Characteristics. The economy of Cooke County is driven by varied manufacturing, which makes up 23 percent of the workforce. Trade, Transportation, and Utilities make up 21 percent of the workforce, while local government makes up 16 percent of the workforce. Leisure and hospitality and professional and business services account for ten and eight percent of the workforce respectively. Industries important to the City of Gainesville include aircraft, steel fabrication, tourism, and agribusiness. Agricultural activities include beef, dairy operations, wheat, sorghum, corn, soybeans, and horses. The city is located on Interstate I-35 and is also serviced by US Highway 82. Other amenities include North Central Texas College and the Frank Buck Zoo. Tables 2, 3, and 4, display population data, per capita income, and unemployment rates.

Table 2
Population

	1990	2000	2004	2009-2010
Gainesville	14,256	15,538	16,250	17,184
Cooke County	30,777	36,363	38,126	41,619
Texas	16,986,510	20,851,820	22,293,020	23,286,510

Table 3
Per Capita Income

	1990	2000	2004
Gainesville	$10,527	$15,154	$16,521
Cooke County	$11,594	$17,889	$20,296
Texas	$17,446	$27,992	$30,281

Table 4
Unemployment Rates

	1990	2000	2004
Gainesville	5.7%	4.3%	4.4%
Cooke County	4.9%	4.6%	4.2%
Texas	6.3%	6.1%	5.5%

The population of Cooke County saw an increase of 21 percent from 1990 to 2004. This compares with a 31 percent increase in population for the State for the same period. Per capita income for Cooke County increased by 75 percent between 1990 and 2004. When adjusted for inflation, the increase in per capita income is 23 percent. By comparison, per capita income for the State between 1990 and 2000 increased 74 percent in nominal terms with a 22 percent increase when adjusted for inflation. Unemployment in Cooke County has fallen from 1.3 percentage points from 1990 to 2004 compared to a 0.8 decrease for the state of Texas. Table 5 shows the distribution of labor between industries in Gainesville.

Table 5
Gainesville Employment by Industry

	1990	2000	2004
Business/Professional	21.5%	24.1%	24.3%
Service	22.7%	16.8%	16.8%
Sales and Office	19.0%	23.6%	23.5%
Farming/Fishing/Forestry	2.9%	1.2%	1.2%
Construction	13.7%	12.1%	12.0%
Production/Transportation	20.2%	22.2%	22.2%

With the current growth rates in population and income a continuous increase in housing and the value of housing can be assumed. An increase in the benefits from flood damage reduction can be anticipated as a result of this trend.

PROBLEM IDENTIFICATION

Flooding History. Pecan Creek has flooded the city of Gainesville on numerous occasions. The October 1981 event was the most catastrophic flood recorded. Gainesville reached a total rainfall of 23.55 inches for the period of October 6-14, 1981 with 6.9 and 7.25 inches falling on October 12th and 13th respectively.

As a result of this widespread flooding, Cooke County was one of four counties in North Central Texas declared a national disaster area and received assistance under the Disaster Relief Act of 1970. The Corps conducted reconnaissance surveys of the flood-stricken area shortly after floodwater receded. Overall, 271 residential, commercial, and industrial structures throughout the city were found to have sustained damages from the storm. In addition, the Gainesville City Park, Frank Buck Zoo, and various public properties, streets, and bridges were inundated. No estimate on the losses to these public facilities is available.

Flood Damage Analyses. The purpose of the economic analyses was to identify the extent of the flood problem and, on a comparable basis, evaluate solutions to reduce monetary flood losses. Flood damages are estimated based on the exceedence probabilities (frequency) of flood events and a relationship between the depth of flooding and the estimated damages based on a percentage of the structure and content. The exceedence probability is expressed as an "annual chance exceedence." For example, a flood event with a 1-percent annual chance exceedence (ACE) means a flood of that magnitude has a 1-percent probability of being equaled or exceeded in any given year. Damages to the structures accumulated by frequency, produce a frequency-damage function. An integration process using this frequency-damage data calculates estimates of expected annual damages. This involves aggregating the multiplication of the mean damage between each pair of flood events by the difference in exceedence probabilities. This is then repeated for the range of flood events in each damage category. The Corps of Engineers, Hydrologic Engineering Center, Flood Damage Analysis computer program is employed in the estimation of flood damages.

The Flood Damage Analysis (FDA) computer program integrates hydrologic, hydraulic, and Flood plain characteristics through application of a Monte Carlo simulation, and computes single event and expected annual damages while accounting for uncertainty in the values of structures and contents. Hydrologic and hydraulic analyses developed water surface profiles for the 50-, 20-, 10-, 4-, 2-, 1-, 0.4-, and 0.2-percent annual chance exceedence (ACE) flood events. The profiles were used to delineate the flood plain limits and determined the relationship of damageable properties to both elevation and frequency of flood occurrence. Appendix C.1 contains the complete hydrologic and hydraulic analyses. Structure inventory data used by the program includes the number and type of structures, structure and content values, the elevation where the structure begins to sustain measurable damages, and a flood depth-damage relationship.

Flood Damage Reaches. The study area was separated into reaches for the flood damage analyses. The definition of the reaches is summarized in Table 6.

Table 6
Description of Reaches

Reach Name	Upstream Limit	Downstream Limit
Upper	U.S. Highway 82	Belcher Street
Middle	Belcher Street	Pecan Street
Lower	Pecan Street	Anthony Street

Value of Flood Plain Inventory. The 0.2% ACE contains 491 structures with a total structures and contents value of $32,498,800. Residential structures make up 55 percent of the structures and 51 percent of the structure and contents value. Commercial structures make up 15 percent of the structures and 27 percent of the structure and contents value. Public structures make up three percent of the structures and 22 percent of the structure and contents value. Other residential structures make up 27 percent of the structures but less than one percent of structure and contents value.

The upper reach has 72 structures; one commercial, 41 residential, and 30 other residential making up 15 percent of the structures and five percent of the structure and contents value in the 0.2% ACE. The average value for residential structures with contents is $36,900.

The middle reach has 294 structures in the 0.2% ACE, consisting of 63 commercial, 12 public, 151 residential structures, and 68 other residential structures. These make up 60 percent of the structures and 75 percent of the structures and contents value in the 0.2% ACE. Average value for residential structures and contents is $62,700. Commercial structures average $127,600 with contents and public structures with contents average $564,300 in value.

The lower reach has 125 structures; 10 commercial, two public, 80 residential, and 33 other residential making up 25 percent of the structures in the 0.2% ACE as well as 20 percent of the structure and contents value. Residential structures with contents average $68,300 with commercial structures with contents averaging $63,900.

Table 7 displays a summary of the number and value of flood plain properties. Table 8 displays a summary of the number and value of privately owned vehicles.

Table 7
Number and Value of Flood Plain Properties
(August 2003 price level; $000)

	50% ACE		20% ACE		10% ACE		4% ACE		2% ACE		1% ACE		0.4% ACE		0.2% ACE	
Upper	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value
Commercial	0	0.0	1	88.5	1	88.5	1	88.5	1	88.5	1	88.5	1	88.5	1	88.5
Residential	2	67.8	26	797.5	28	857.3	32	1097.7	33	1141.3	35	1224.8	39	1385.0	41	1511.3
Other	10	18.0	24	25.9	25	26.3	28	27.8	28	27.8	30	28.9	30	28.9	30	28.9
Total	12	85.8	51	911.8	54	972.1	61	1214.0	62	1257.6	66	1342.2	70	1502.4	72	1628.7

	50% ACE		20% ACE		10% ACE		4% ACE		2% ACE		1% ACE		0.4% ACE		0.2% ACE	
Middle	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value
Commercial	0	0.0	13	1014.0	28	1668.7	49	7236.7	54	7463.8	59	7782.0	63	8037.6	63	8037.6
Public	0	0.0	0	0.0	0	0.0	4	2752.9	5	2833.8	7	5377.0	11	6718.6	12	6771.8
Residential	0	0.0	53	2326.7	83	3577.8	101	4476.4	110	7126.1	126	7840.2	135	8357.0	151	9461.5
Other	0	0.0	39	120.3	47	124.9	58	150.2	60	152.7	65	195.7	67	197.0	68	197.5
Total	0	0.0	105	3461.0	158	5371.4	212	14616.2	228	17576.4	257	21194.8	276	23310.2	294	24468.4

	50% ACE		20% ACE		10% ACE		4% ACE		2% ACE		1% ACE		0.4% ACE		0.2% ACE	
Lower	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value
Commercial	0	0.0	1	9.1	1	9.1	2	56.1	3	56.6	10	638.8	10	638.8	10	638.8
Public	0	0.0	0	0.0	0	0.0	1	4.7	1	4.7	1	4.7	2	226.7	2	226.7
Residential	0	0.0	4	105.5	10	333.1	25	1306.3	36	2016.6	54	3483.2	72	4739.7	80	5465.7
Other	0	0.0	4	7.7	12	25.5	18	34.1	20	39.4	29	67.1	32	70.0	33	70.6
Total	0	0.0	9	122.3	23	367.7	46	1401.2	60	2117.3	94	4193.8	116	5675.1	125	6401.8
Grand Total	12	85.8	165	4495.1	235	6711.1	319	17231.4	350	20951.2	417	26730.8	462	30487.6	491	32498.8

Table 8
Number and Value of Privately Owned Vehicles

	50% ACE		20% ACE		10% ACE		4% ACE		2% ACE		1% ACE		0.4% ACE		0.2% ACE	
	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value
Upper	1	3.9	21	94.4	24	113.7	29	137.4	31	145.4	34	157.8	38	178.6	40	187.8
Middle	0	0.0	53	284.1	76	413.7	91	493.2	111	889.0	121	941.3	128	992.6	136	1053.0
Lower	0	0.0	2	3.7	16	52.3	22	93.3	29	199.7	49	299.8	62	452.1	75	589.2
Total	1	3.9	76	382.1	116	579.7	142	723.8	171	1234.2	204	1398.9	228	1623.2	251	1830.0

Single Occurrence Flood Event Damages. Damages begin at the 50% ACE (2-yr event) in the upper reach. At the 0.2% ACE (500-yr event) the study area experiences an estimated $7,900,700 in damages. The upper reach contributes four-percent to the damages, the middle reach contributes 86-percent, and the lower accounts reach for 11-percent of the damages.

Table 9 displays a summary of the number and value of single event flood plain damages. Table 10 displays a summary of the number and damage of privately owned vehicles

Table 9
Single Event Damages by ACE, Reach, and Damage Category
Structures and Contents
(August 2003 price level: $000)

	50% ACE		20% ACE		10% ACE		4% ACE		2% ACE		1% ACE		0.4% ACE		0.2% ACE	
Upper	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.
Commercial	0	0.0	1	7.8	1	9.0	1	10.2	1	10.6	1	11.4	1	12.4	1	13.3
Residential	2	8.5	26	81.9	28	110.1	32	151.2	33	171.3	35	206.1	39	241.6	41	273.2
Other	10	0.7	24	2.1	25	2.5	28	3.1	28	3.4	30	3.9	30	4.4	30	4.7
Total	12	9.2	51	91.8	54	121.6	61	164.5	62	185.3	66	221.4	70	258.3	72	291.2

	50% ACE		20% ACE		10% ACE		4% ACE		2% ACE		1% ACE		0.4% ACE		0.2% ACE	
Middle	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.
Commercial	0	0.0	13	187.6	28	483.2	49	2794.0	54	3270.8	59	3567.5	63	3864.4	63	3981.9
Public	0	0.0	0	0.0	0	0.0	4	252.3	4	393.5	7	501.6	11	833.6	12	1012.7
Residential	0	0.0	53	241.1	83	432.5	101	643.0	110	1061.4	126	1281.9	135	1533.2	151	1749.7
Other	0	0.0	39	8.3	47	11.3	58	14.6	60	17.3	65	22.0	67	24.9	68	27.6
Total	0	0.0	105	437.1	158	926.9	212	3703.9	228	4743.0	257	5372.9	276	6256.1	294	6772.0

	50% ACE		20% ACE		10% ACE		4% ACE		2% ACE		1% ACE		0.4% ACE		0.2% ACE	
Lower	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.
Commercial	0	0.0	1	0.7	1	1.0	2	2.4	3	7.4	10	47.0	10	62.6	10	76.4
Public	0	0.0	0	0.0	0	0.0	1	0.1	1	0.5	1	0.9	2	6.4	2	17.1
Residential	0	0.0	4	13.5	10	34.3	25	154.1	36	252.6	54	391.0	72	578.7	80	736.9
Other	0	0.0	4	0.2	12	0.8	18	2.1	20	3.1	29	4.5	32	6.0	33	7.1
Total	0	0.0	9	14.5	23	36.1	46	158.7	60	263.6	94	443.3	116	653.8	125	837.4
Grand Total	12	9.2	165	543.3	235	1084.6	319	4027.0	350	5191.9	417	6037.7	462	7168.1	491	7900.7

Table 10
Single Event Damages by ACE and Reach
Privately Owned Vehicles

	50% ACE		20% ACE		10% ACE		4% ACE		2% ACE		1% ACE		0.4% ACE		0.2% ACE	
	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.	No.	Dmg.
Upper	1	1.2	21	45.6	24	62.1	29	83.6	31	95.3	34	111.0	38	127.9	40	141.4
Middle	0	0.0	53	113.2	76	211.5	91	310.6	111	528.7	121	639.6	128	766.2	136	846.8
Lower	0	0.0	2	0.8	16	16.3	22	40.8	29	87.2	49	152.9	62	241.7	75	326.9
Total	1	1.2	76	159.5	116	289.8	142	435.0	171	711.2	204	903.6	228	1135.7	251	1315.1

Expected Annual Damages. The expected annual damages for the area total $673,870, at an August 2003 price level The upper reach accounts for nine percent of the EAD. The middle reach contributes 83 percent to EAD while the lower reach contributes the remaining seven percent. Table 11 summarizes the annual expected flood damages. Appendix F contains the complete Flood Damage Analysis study.

Table 11
Expected Annual Flood Damages
(August 2003 price level)

Reach	Structure and Contents			POV	Total
	Residential	Commercial	Public		
Upper	40.5	3.4	0.0	19.7	63.5
Middle	153.0	301.7	41.1	66.0	561.7
Lower	34.9	2.3	0.3	11.0	48.6
TOTAL	228.4	307.4	41.4	96.7	673.9

Totals may not sum due to rounding

Future Without Project Condition. The city of Gainesville is predicted to have an annual growth rate of approximately two percent over the study period. However, most of that growth is anticipated to occur to the east of the study area or within the area north and west of the recommended plan area. Within the Pecan Creek drainage basin it is anticipated that industrial growth would occur within the northern area of the City and that other conversions of existing farm and ranch land to residential properties would continue to occur. However, only minimal changes would likely occur under the without a project scenario within the the area adjacent to Pecan Creek. Existing floodplain regulations would reduce the amount of floodplain alterations for residential or business construction. However some clearing and other land use management could affect future habitat resource values. Tree and brush management would likely be limited to the less frequently flooded segments of the floodplain. Based upon observations of existing conditions, it is estimated that about ten percent of existing terrestrial habitat values associated with riparian woodlands would be lost during the project planning period.

Under the future without-project condition, flood damages will continue. Future increases in flood damages resulting from additional development within the watershed, manifesting as an increase in precipitation run-off and increased flood depths, and/or an increase in the number of damageable property, are not anticipated or accounted for in the analysis of flood damages.

PLAN FORMULATION

Plan formulation is the process of developing and evaluating alternatives that meet planning objectives and avoid planning constraints. This section details the process of stating the planning objectives and constraints, the initial screening of measures, the evaluation of alternatives, and the selection of the recommended plan.

Planning Objectives. Planning objectives are an expression of public and professional concerns about the use of water and related land resources resulting from the analysis of existing and future without project conditions in the study area. The planning objectives for the period of analysis between the years 2005 to 2055 are as follows:

- Reduce flood damages to structures and their contents as well as vehicles along Pecan Creek within the study area.
- Reduce the potential for loss of life associated with flooding.
- Reduce flood damages to public facilities such are roads, bridges, utilities, schools, churches, etc. along Pecan Creek within the study area.
- Reduce the public and private costs associated with flood fighting and recovery along Pecan Creek within the study area.
- Reduce the disruption and costs associated with the closure of highways and streets along Pecan Creek within the study area.
- Reduce business and commercial losses resulting from a loss of production and/or economic activity for establishments along Pecan Creek within the study area.
- Improve the overall health, safety and quality of life of the citizens of the City of Gainesville, the State of Texas, and the United States of America.
- It is the City's desire to provide the citizens of Gainesville the level of flood protection that is now considered a standard. This equates to complete protection from a 100-year storm event (1% ACE), as defined by the Federal Emergency Management Agency.
- Protect and restore riparian habitat and open space for public use, consistent with reduction of flood damages

Planning Constraints. In development of the flood damage reduction alternatives, the following constraints or limitations were identified to direct plan formulation efforts such that beneficial impacts would be maximized and adverse impacts would be minimized:

- Alternatives will be limited to the study area within the City of Gainesville along Pecan Creek.
- The formulation of alternatives that reduce flood damages and costs in one area should not result in measurable increases in the extent and magnitude of flooding in another area.
- The formulation of alternatives must avoid adverse impacts to significant ecological resources; and if avoidance is not feasible, then adverse impacts to ecological resources must be minimized. Unavoidable adverse impacts to ecological resources must be mitigated.
- The formulation of alternatives must avoid adverse impacts to significant cultural resources; and if avoidance is not feasible, then adverse impacts to cultural resources must be minimized. Unavoidable adverse impacts to cultural resources must be mitigated.
- The formulation of alternatives should avoid areas that are either known or suspected to be contaminated and/or contain hazardous, toxic, and radioactive waste.

- The formulation of alternatives should avoid adverse impacts to structures.
- The formulation of alternative should avoid adverse aesthetic and visual impacts.
- Total annual benefits must equal or exceed total annual costs for a plan to be implemented.
- The recommended plan must be generally acceptable to the public.
- The recommended plan must have a local non-Federal sponsor.
- Combined Federal expenditures on the planning, design, and implementation of the recommended plan shall not exceed $7.0 million, if possible. This is the current limit for projects authorized under Section 205 of the Flood Control Act of 1948, as amended.

Plan Formulation Rationale. Plans are formulated to meet planning objectives and avoid constraints. The following paragraphs discuss the technical, economic, environmental, and social criteria used to develop the formulated alternatives to meet the stated study objectives.

Technical Criteria. In order to develop a plan that would satisfy the primary objective of reducing flood damages and costs within the study area, the following technical criteria was adopted for use in developing, evaluating, and comparing alternative plans:

- The plan should be effective and efficient with regard to alleviating the specified problems and achieving the specified goals.
- The plan must be technically feasible using engineering methods and equipment available in the study region.
- Plans should be adequate to provide a project life of at least 50 years.
- Existing facilities should be utilized to the maximum extent possible.
- The plan is to be complete within itself and not require additional future improvements other than normal replacements, and operation and maintenance.
- The plan is to be formulated using engineering criteria taken from appropriate Corps of Engineers' engineering and design manuals and regulations related to flood damage reduction alternatives.

Economic Criteria. Economic feasibility of a plan is measured as a relationship of benefits-to-costs. Benefits are the monetary savings due to damages prevented, reduction in the cost of emergency services, and the reduced disruption of the local economy. These benefits are subsequently annualized to represent a yearly benefit applicable for the life of the project. The project costs, are also annualized so as to represent an annual project cost, applicable for the analysis period of the project. The annual benefits and the annual costs are then related in a benefits-costs ratio (BCR). To be economically feasible, a plan must have benefits which equal or exceed costs, i.e., a BCR equal to or greater than 1.0.

The National Economic Development (NED) objective is to increase the nation's output of goods and services and improve economic efficiency. For flood damage reduction projects, this objective relates to a plan's capability to prevent flood damages and costs (economic benefits). The amount that a project's economic benefits exceed the project cost (when both are expressed in annual terms) is defined as the net benefits of the plan. In the plan formulation process, the plan that meets the planning objectives and avoids the planning constraints, and yields the greatest net benefits, best meets the objective of NED. To meet the Federal guidelines for planning water resource projects, the following economic criteria were followed:

- All plans must be economically feasible, which dictates that the plan's flood reduction benefits must exceed the cost of the plan. Measures for mitigation, restoration, and protection of environmental resources must be justified based on a combination of tangible and intangible benefits.
- The alternative being selected as the recommended plan should reasonably maximize benefits over costs consistent with protecting the Nation's environment, while meeting the planning objectives and avoiding the planning constraints. Each separable unit or purpose of a given alternative must provide benefits at least equal to its costs.
- Alternatives will be evaluated using the current price level, a 50-year period of analysis, and the current Federal discount rate for water resource projects as determined by the U.S. Department of Treasury.
- Annualized costs include the cost of operation, maintenance, repair, replacement, and rehabilitation (OMRR&R).

Environmental And Social Criteria - Plans formulated under federal directives should be consistent with protecting the existing environment by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems in the recommended plan area. The following environmental and social criteria were considered:

- Protect against possible loss of life, property, and hazards to the health and safety of area residents, and preserve, maintain, or enhance community cohesion and desirable community and regional growth.
- Preserve and/or enhance social, cultural, educational, and aesthetic values as well as historical and cultural attributes of any sites within the project area.
- Promote the development of areas of natural beauty and human enjoyment and protect areas of valuable natural resources.

Screening Of Flood Damage Reduction Measures. A full range of structural and nonstructural flood damage reduction measures were considered. Structural measures consist of structures designed to control, divert, or exclude the flow of water from the flood prone

areas to the extent necessary to reduce damages to property, hazard to life or public health, and general economic losses. The structural measures considered most appropriate in dealing with the character of the flood problems encountered typically include small detention lakes, channel modifications, flood flow diversions, and levees.

Nonstructural measures, attempt to avoid flood damages by exclusion or removal of damageable properties from the flood prone areas. These measures do not affect the frequency or level of flooding within the floodplain; rather, they affect floodplain activities. The technique of controlled land use is particularly helpful in planning for future development, but is limited in highly developed areas.

Certain alternative solutions have been subjected to only preliminary investigations because of their evident economic infeasibility, social unacceptability, or increased adverse impacts on the environment. The more favorable alternative solutions have been subjected to more detailed studies to define their costs and benefits.

No Action. The "no action" alternative would not recommend any type of project, nonstructural or structural, be implemented. While the no-action measure does not require the expenditure of Federal funds, adoption of this alternative implies acceptance of the existing and future flood damages and other adverse impacts caused by continued potential flooding of the 491 structures within the 0.2 percent ACE (500 year) floodplain. Although flood insurance would partially compensate for flood damages, they would still be incurred at an estimated average rate of $674,000 annually. The costs for flood fighting and recovery costs, public damages, the potential loss of life, and the overall threat to health and safety would continue under the no action alternative. The no-action alternative does not meet the planning objectives and is eliminated from further consideration.

Floodplain Management. Effective floodplain management is dependent on the development of enforceable regulations that insure that uses of floodplain lands are compatible with the level of flood hazard. Several means of regulation are available to control future development, including zoning ordinances and building codes. Typical zoning ordinances would require installation of adequate drainage facilities, prohibit encroachment in floodway areas or require the placement of critical streets and utilities above a selected flood elevation. Building codes specify the criteria for the design and construction materials for both the repair and replacement of flood-damaged structures. The specifications can make requirements such as requiring water-tightness of exterior walls, valves on sewer lines, and placement of utilities at elevations high enough to reduce or eliminate flood damages.

The City of Gainesville participates in the National Flood Insurance Program, and has enacted restrictions on floodplain use. These measures do not reduce the damages to existing development and this alternative did not require further consideration. It should be noted that the City of Gainesville will be required to complete and implement a floodplain management plan within one year of the completion of any flood damage reduction plan recommended and implemented by the Corps of Engineers.

Flood Forecast and Warning. Flood forecasting and temporary evacuation involves the determination of imminent flooding, implementation of a plan to warn the public, and organization of assistance in the evacuation of persons and some personal property. The short warning time (or time of flood flow concentration) of Pecan Creek of less than one hour significantly reduces the reliability and would not represent a viable flood damage reduction measure, and therefore is not considered further in this study.

Flood Proofing. Flood proofing of residential and commercial structures can include providing watertight coverings for door and window openings, raising structures in place, constructing levees and floodwalls around individual buildings or groups of buildings, and waterproofing walls of structures. Flood proofing is more easily applied to new construction and more applicable where flooding is of short duration, low velocity, infrequent. Flood proofing techniques would require major modifications to existing structures. Additional shortcomings include not protecting public facilities such as roads, bridges, and utilities, and the continued threat of road closures and the isolation of residents trapped in their homes and businesses. While flood proofing would not likely result in any significant or permanent adverse impacts to ecological or cultural resources, it does not address fully the planning objectives or criteria previously discussed. Therefore, flood proofing is not considered further in this study.

Permanent Evacuation. Permanent evacuation involves the acquisition and demolition of frequently flooded structures from the floodplain, and the relocation of residents to flood free housing. The practicality of evacuation depends on several factors including, the frequency and severity of flooding, the willingness of residents to move out, the availability of flood-free housing, the value of the property, and the need for areas more suitable for floodplain use such as parks or nature areas. Previous studies have concluded that floodplain evacuation is a viable solution, particularly for frequent flood events, and will be analyzed further for Pecan Creek.

Diversion. Diversion of flows away from the damage centers is another measure for flood damage reduction. In order for diversion to be effective, there must be a suitable path for the diversion that avoids significant real estate acquisitions, relocations, and excavation costs. The diversion of Pecan Creek was considered. Based on the lack of availability of a suitable diversion site, and the anticipated high costs associated with relocations and construction costs, diversion was eliminated from further consideration.

Detention. Detention is a measure whereby floodwaters are temporarily stored, at a location upstream of the damageable properties, and then gradually released as downstream conditions permit. Detention may significantly reduce peak flood discharges immediately downstream thereby resulting in lower peak flood stages. Detention requires an impoundment site that is capable of providing sufficient storage. Detention sites were identified in the upstream portion of the basin. Initial analyses indicated the size of the required detention was relatively large. The real estate acquisition costs, as well as significant adverse environmental impacts and mitigation costs were anticipated to be prohibitively expensive. Therefore, detention was not considered further.

Levees and Floodwalls. Levee systems traditionally provide high levels of protection to flood prone areas but often require substantial amounts of real estate between the stream and the structures being protected. Concrete floodwalls are used in lieu of levees in situations where the acquisition of real estate for the levee or other topographic problems may be prohibitive. The feasibility of either of these measures is based on the cost and availability of real estate, the number of structures along the levee alignment, and the additional costs necessary to alleviate interior drainage problems to prevent induced damages in adjacent areas. Construction of individual levees or floodwalls around specific structures or small groups of structures is normally considered cost prohibitive unless the individual structure is very valuable, has cultural significance, or is prone to frequent flooding.

A levee alternative was considered. However, the proximity of structures and the lack of available space make a levee infeasible because of the high relocation cost associated with removal of the structures where the levees would be constructed. Floodwalls, which require less real estate acquisition, are historically much more expensive than any other alternative, either structural or nonstructural. Based on the value of the properties to be protected, and considering the length of the reach, the floodwall alternative would be prohibitively expensive. Therefore, levees and floodwalls were eliminated from further consideration.

Pecan Creek (Channel) and/or Bridge Modifications. This measure consists of modifying Pecan Creek by increasing the cross- sectional area of the stream channel and/or an existing structure (widening and/or deepening), straightening and realigning the stream channel, and/or reducing the friction losses of an existing channel through concrete lining. A channel modification design can vary significantly based on the topography of the stream channel and proximity of structures. Other factors to consider in the design of channel modifications include the existence of known or potentially significant ecological and cultural resources, as well as contaminated material.

Bridge modifications as a stand-alone measure were considered. Initial analyses indicated limited channel capacity will make bridge modifications alone as an ineffective means for reducing flood damages, and will not be considered further.

Based on the result of the study conducted by the U.S. Army Corps of Engineers, Fort Worth, Texas, completed in August 1986, channel and bridge modification warrant further investigation. The 1986 report recommended a grass-lined trapezoidal improved channel with a 65-foot bottom width along a 2.53-mile length of Pecan Creek and seven bridge replacements as an economically feasible project with a benefit-to-cost ratio of 1.7 to 1.0. The first cost of the plan was estimated to be $6,933,000 with annual charges of $654,000. Average annual benefits of the selected plan were estimated to be $1,106,100, with net benefits of $452,100. At that time, the City was unable to obtain the level of funding required to continue with the project.

Detailed Investigations of Alternatives. Measures receiving additional detailed analyses on potential project benefits and/or cost are permanent evacuation, detention, and channel and/or bridge modifications.

Permanent Evacuation. Benefits and costs were developed for permanent evacuation of the 50-, 20-, 10-, and 4-percent. Table 12 displays a summary of the single occurrence and average annual flood damages with permanent evacuation.

Table 12
With-Project Flood Damages
Permanent Evacuation
(August 2003 price level; $000)

ACE	Without-Project Expected Annual Damages	Number of Structures Removed	With-Project Expected Annual Damages	Annual Damages Reduced
50%	673.9	12	663.3	10.6
20%	673.9	165	428.3	245.6
10%	673.9	235	359.3	314.6
04%	673.9	319	346.2	327.7

Pecan Creek and/or Bridge Modifications. Initial analyses concluded that bridge modifications as a stand-alone measure would not significant reduce flood damages due to the limited channel capacity. Based on the location of the flood damage and hydraulic analyses, the initial channel modification investigation was located between from Broadway Street, extending 4,400-feet upstream to 600-feet upstream of Moss Street. A grass-lined channel with 1 vertical on 3.5 horizontal side slopes (1V:3.5H) with nominal bottom widths varying between 30- and 20-feet. A second grass-lined channel with 1V:3.5H side slopes had a nominal bottom widths varying between 65- and 50-feet. The third modification was a grass-lined channel with 1V:3.5H side slopes, and bottom width of 50-feet, except between Garnett and Moss Street where the channel was gabion-lined with 1V:1.5V side slopes with a bottom width of 45-feet. The fourth channel modification had an 80-foot bottom width for the grass-lined and 70-foot bottom width for the gabion-lined portion

Table 13 displays a summary of the average annual flood damages. Table 14 displays a summary of project first costs, project total investment cost, annual cost, annual benefits, benefit-cost ratio, and net benefits, and residual damages for the permanent evacuation, detention, and channel modification alternatives.

From Table 14, it can be seen that none of the permanent evacuation alternatives were economically justified. While the addition of recreation features can be added to non-structural projects and the benefits included as part of the overall project economic justification, the potential for including recreation features is limited. First, there are not a sufficient number of structures within he 50-percent ACE, nor are they located in an area where recreation features are appropriate. Secondly, the permanent evacuation of subsequently larger flood plains would have adverse impacts upon the central business district. Consequently, permanent evacuation will not be considered further in this analysis.

Table 13
With-Project Flood Damages
Channel Modifications
(August 2003 price level; $000)

Description	Without-Project Expected Annual Damages	With-Project Expected Annual Damages	Annual Damages Reduced
Grass-Lined Channel 30- / 20-ft bottom width	673.9	338.2	335.6
Grass-Lined Channel 65- / 50-ft bottom width	673.9	283.0	390.9
Grass- and Gabion-Lined Channel 50- / 45-ft bottom width	673.9	421.4	252.5
Grass- and Gabion -Lined Channel 80- / 70-ft bottom width	673.9	283.2	390.6

Channel modifications are an effective and efficient means of reducing flood damages. As can be seen from Table 14, the grass-lined channel provides the greatest net benefits. Lining the channel with gabion, while producing a greater reduction in flood damages, does so at a much higher cost. Therefore, the grass-lined channel is the preferred alternative and will receive additional analyses.

Channel modification alternatives are known to have potential to affect both aquatic and terrestrial resources that are of value to wildlife. Stream and riparian habitat is considered to have high importance for migratory and local wildlife and fisheries populations. To minimize impact to these important resources, plan formulation considerations were made to reduce the length of stream channel that would be modified. In particular the upstream limits were located to minimize upstream impacts to known high quality frequently flooded riparian forest. In addition, the channel modification was located to coincide with the reach of channel that had been previously modified. The fisheries in this previously modified area have been significantly reduced due to extreme shallow water over the hard bottom. With substrate unsuitable to sustain native fish and extreme temperature fluctuations adversely impacting fish that would attempt to temporarily use the existing channelized reach, it was determined that the habitat values were so low that further modification of this reach would cause substantially less impact than working in new reaches.

Optimization of Channel Modification Alternative. The identification of the grass-lined channel modification alternative as the most effective and efficient means for flood damage reduction, additional detailed investigation were completed to optimize net benefits, i.e., annual benefits in excess of annual costs. The optimization of the channel modification alternative was accomplished by increasing the length of the modification, shifting the modifications upstream, and identifying a uniform bottom width (instead of the varying bottom width between 30- and 20-feet) in order to capture more flood damage reduction

Table 14
Benefit – Cost Summary
All Alternatives
(August 2003 price level: $000; 5-7/8% @ 50-yr period of analysis)

	Permanent Evacuation (ACE floodplain)				Channel Modifications From Moss Street to Broadway Street [1]			
	50%	20%	10%	4%	Grass-Lined [2]	Grass-Lined [3]	Grass & Gabion [4]	Grass & Gabion [5]
Investment Cost:								
Estimated First Cost	228.7	8,317.5	11,353.6	25,400.4	5,025.8	6,679.6	8,380.9	11,679.0
Interest During Construction	1.6	366.5	500.3	1,119.3	146.2	244.1	369.3	603.3
Total Investment Cost	**230.3**	**8,684.0**	**11,853.9**	**26,519.7**	**5,172.0**	**6,923.7**	**8,750.2**	**12,282.4**
Annual Cost:								
Interest	13.5	510.2	696.4	1,558.0	303.9	406.8	514.1	721.6
Amortization	0.8	31.2	42.6	95.2	18.6	24.9	31.4	44.1
Operations and Maintenance	5.0	15.0	15.0	15.0	10.0	10.0	10.0	10.0
Total Annual Cost	**19.4**	**556.3**	**754.0**	**1,668.2**	**332.4**	**441.6**	**555.5**	**775.7**
Total Annual Benefits	**10.6**	**245.6**	**314.6**	**327.2**	**335.7**	**390.9**	**252.5**	**390.7**
Benefit Cost Ratio	**0.55**	**0.44**	**0.42**	**0.20**	**1.01**	**0.89**	**0.45**	**0.50**
Net Benefits	**(8.8)**	**(310.8)**	**(439.4)**	**(1,340.6)**	**11.9**	**(50.7)**	**(303.0)**	**(385.0)**
Residual Damages	**663.3**	**428.3**	**359.3**	**346.2**	**338.2**	**283.0**	**421.4**	**283.2**

Totals may not sum due to rounding

(1) Station 205+00 (600-feet upstream of Moss Street) to 248+00 (Broadway Street)
(2) Bottom widths varying between 30- and 20-feet with 1V:3.5H side slopes
(3) Bottom widths varying between 65- and 50-feet with 1V:3.5H side slopes
(4) Grass-lined portion has bottom width of 50-feet with 1V:3.5H side slopes**,** gabion lining between Garnett and Moss Streets with 45-foot bottom width and 1V:1.5H side slopes
(5) Grass-lined portion has bottom width of 80-feet with 1V:3.5H side slopes**,** gabion lining between Garnett and Moss Streets with 70-foot bottom width and 1V:1.5H side slopes.

benefits. For optimization purposes, the channel modification began at Olive Street and ended at Gordon Street, a distance of approximately 7,800-feet. Bottom widths of 30-, 50-, and 65-feet were analyzed with 1-vertical to 3.5-horizontal side slopes. All the channel configurations would require seven bridge replacements and the relocation of various water, gas, electric, telephone, and sewer lines. While steeper side-slopes were considered (1-vertical to 3-horizontal) as a means to reduce excavation and real estate costs, it was decided to maintain the 1-vertical to 3.5-horizontal (flatter) side slopes for ease of maintenance (steeper slopes present a hazard for mowing). Further, a bottom width of less than 30-feet would be narrower than the existing channel in many places resulting in an undesirable decrease in flood damage reduction.

The 30-foot bottom-width channel modification has an estimated first and annual of $7,295,700 and $481,400, respectively. With annual benefits (monetary flood damage reduction) of $583,800, the 30-foot bottom-width channel has a benefit-to-cost ratio of 1.21 to 1.0 and net benefits of $102,400. The 50-foot bottom-width channel modification has an estimated first and annual of $9,350,600 and $618,600, respectively. With annual benefits of $631,300, the 50-foot bottom-width channel has a benefit-to-cost ratio of 1.02 to 1.0. The 65-foot bottom-width channel modification alternative has an estimated first cost and annual of $12,471,900 and $815,900, respectively. With annual benefits of $645,000, the 65-foot bottom-width channel has a benefit-to-cost ration of 0.79 to 1.0.

The result of this optimization was a significant increase in flood damage reduction at a cost rate increase less than the increase in benefits. The optimized plan increased annual benefits by $248,100 and annual costs by $149,000, for an incremental benefit cost ratio and net benefits of 1.7 to 1 and $99,100, respectively. Table 15 provides a summary of the benefit-cost analysis for the channel sizes evaluated, and includes environmental mitigation. Appendix C.1, Hydrology and Hydraulics provides detailed description of optimization process.

Environmental Impact of Channel Modification Alternatives. Initial screening of the 30-, 50-, and 65-foot bottom width channels was conducted to determine impacts to fish and wildlife habitat and to determine environmental mitigation costs. Table 16 displays impacts and mitigation requirements for each channel width alternative. For the 30-foot, bottom-width channel a mitigation plan to offset impacts to 12.9-acres of riparian woodland having an annualized habitat value of 6.06 is required. The 50-foot bottom-width channel would require a mitigation plan to compensate for loss of 14.8-acres having an average annualized habitat value of 6.90. Similarly, a mitigation plan for the 65-foot bottom-width channel would need to compensate for loss of 16.3- acres of riparian woodland having an annualized value of 7.52 average annual habitat units.

Environmental Mitigation Area Screening. Four sites were initially investigated for their potential to meet these environmental mitigation requirements. One site was located adjacent to Kenesto Park in what appears to be an abandoned quarry site, where sand/gravel and or top soil were mined. A site investigation showed that the site currently reflects significant past surface disturbances including excavations, placement of overburden and subsequent disposal of construction and some residential wastes. Other areas are less disturbed, but most of the existing woodlands appeared to be relatively young in age. While this site has sufficient area to provide environmental mitigation, the costs to clean and grade the area appear to not be a cost

Table 15
Benefit-Cost Summary of Optimization Analysis
Channel Alternatives
(August 2003 price level; $000; 5.875% @ 50-yr period of analysis)

	Olive Street to Gordon Street		
	30-feet	50-feet	65-feet
Total Project Cost:			
Plans and Specifications [1]	535.0	697.5	944.5
Lands, Easements, Rights-of-Way, Relocations, and Disposal Areas	4,226.3	5,029.6	5,637.1
Construction [2]	2,106.3	3,065.6	5,134.6
Supervision and Administration [1]	428.0	558.0	755.6
Total Project Cost	**7,295.7**	**9,350.6**	**12,471.9**
Investment Cost:			
Estimated First Cost	7,295.7	9,350.6	12,471.9
Interest During Construction	266.6	412.0	455.8
Total Investment Cost	7,562.3	9,762.6	12,927.6
Annual Cost:			
Interest	444.3	573.6	759.5
Amortization	27.1	35.0	46.4
Operations and Maintenance	10.0	10.0	10.0
Total Annual Cost	**481.4**	**618.6**	**815.9**
Total Annual Benefits	**583.8**	**631.3**	**645.0**
Benefit Cost Ratio	**1.21**	**1.02**	**0.79**
Net Benefits	**102.4**	**12.7**	**(170.9)**
Residual Damages	**90.1**	**42.6**	**28.9**

Totals may not sum due to rounding

[1] Includes lands for environmental mitigation and amounts for bridge modifications, utility relocations, and storm water drain relocations.

[2] Includes mitigation feature.

Table 16
Summary of Vegetative Cover and Habitat Quality
Comparison of Without Project to Channel Modification Alternatives

	Frequently Flooded Riparian Forest			Riparian Forest			Grassland / Old Field			Disturbed / Urban			Riparian Forest Annualized Impacts
	ACs	HSI	HU	ACs	HSI	HU	ACs	HSI	HU	ACs	HSI	HU	
Without Project	38.6	0.55	21.23	176.5	0.41	72.36	84.3	0.27	22.8	207.6	na	na	na
Initial Screening													
30-ft Channel	6.9	0.55	3.80	6.0	0.41	2.57	0.9	0.27	0.25	0.0	na	na	-6.06
50-ft Channel	7.3	0.55	4.04	7.5	0.41	3.21	1.0	0.27	0.26	0.0	na	na	-6.90
65-ft Channel	7.7	0.55	4.22	8.6	0.41	3.68	1.1	0.27	0.28	0.0	na	na	-7.52
Refined Channel													
30-ft Channel													
Channel	5.34	0.55	2.94	4.54	0.41	1.86	0.55	0.27	0.15	6.6	na	na	
Right of Way	0.41	0.55	0.22	0.43	0.41	0.18	0.06	0.27	0.01	0.83	na	na	
Total	5.75	0.55	3.16	4.98	0.41	2.04	0.61	0.27	0.16	7.43	na	na	-4.96

effective solution. In addition, the site is located on a tributary to the Elm Fork and in general mitigation preference is to establish the mitigation as close to the site of the impacts as reasonable.

A second site was evaluated downstream of the Frank Buck Zoo, on the Elm Fork. This site is characterized by a mature stand of bottomland hardwoods. Habitat values were not measured by the general characteristics indicate that little management improvement is possible and it was determined that little threat to this tract exists therefore preservation credit could not realistically be attributed should the City acquire the tract. In addition, this site is even further away from the site of the impacts on Pecan than the Kenesto Park site.

A third site was proposed for consideration near the local airport, however, the distance from project impacts precluded further evaluation. The Federal Aviation Administration has also issued guidance on land uses that have the potential to attract hazardous wildlife on or near public-use airports. This guidance Advisory Circular 150/5200-33A would require a thorough evaluation by that agency to determine if the environmental mitigation would increase wildlife or bird strike risks to aircraft utilizing the airport.

The fourth site, containing riparian forest both upstream and downstream of US Highway 82 on Pecan Creek just above the recommended plan site was reviewed for its potential to mitigate riparian losses associated with each of the channel configurations. The evaluated site extends from the upper end of the proposed construction and lies on both the left and right over bank areas of Pecan Creek below US Highway 82 but is restricted to the left over bank above US Highway 82. Only lands within the 100-year floodplain were evaluated.

Acquisition of 33.43 acres with improvement of existing riparian forest would provide 7.11 average annual habitat units over the projected future without a project conditions. In addition four acres of grassland in the two sites could be managed to provide for improvements to the ecological system and provide management opportunities for recreational development should that be desired. This scheme would be sufficient to mitigate fully the impacts associated with either the 30- or 50-foot bottom-width channel alternatives.

Grassland habitat would be maintained by reduced mowing, approximately once per year during the non-breeding period of the year for birds, preferably during late summer, thus allowing a regrowth to 1 foot or more prior to winter. Minimum grass height should be 8 inches. Existing wooded areas in these two tracts, which currently total about 29.4 acres, would be improved by planting 5, 1-in diameter hard and soft mast producing native trees per acre.

Identification of the National Economic Development Plan. The National Economic Development (NED) plan maximizes net benefits, while protecting the Nation's environment. The NED plan must also address the criteria of effectiveness, efficiency, completeness, and acceptability. The NED plan is identified as the channel modification plan having a 30-foot bottom width. This alternative addresses the planning objectives and constraints. Further, this alternative has the greatest net benefits, and reduces 93-percent of the annual flood damages. It also results in the least impact to ecological resources of the feasible alternatives investigated. The 30-foot bottom-width channel modification provides for the most efficient use of resources,

and requires no other investment to obtain the identified flood-damage reduction output.

Selection of the Recommended Plan. The City of Gainesville has selected the NED plan as the recommended plan. Therefore, the NED plan will be recommended for implementation as a Corps of Engineers flood damage reduction project.

THE RECOMMENDED PLAN

The recommended plan is located in the city of Gainesville, Cooke County Texas. Gainesville is located approximately 30 miles north of Denton Texas. Pecan Creek flows roughly north to south transecting the downtown area. Pecan Creek is located within the Trinity River (Elm Fork) Watershed specifically in the Lake Lewisville Sub-Watershed in north Central Texas and is located primarily in Denton and Cooke Counties. Pecan Creek rises three miles northwest of Gainesville in north central Cooke County (at 33°41' N, 97°10' W) and runs southeast for eight miles to its mouth on the Elm Fork of the Trinity River, three miles south of Gainesville (at 33°35' N, 97°07' W). It traverses variable terrain, surfaced by shallow, stony, clay loams that support juniper, oak, and grasses. Historically the Pecan Creek area has been used as range and crop land.

Description of the Recommended Plan. The recommended plan consists of a grass-lined trapezoidal channel, beginning approximately 400-feet below Olive Street and ending just 360-feet downstream of Gordon Street. There is a 200-foot rock riprap transition at the upstream project limit. The project has an aggregate length of 7,860-feet, has a 30-foot bottom width, and 1 vertical on 3.5 horizontal side slopes. Total excavation amounts are approximately 124,280 cubic yards or soil and rock and 1,425 cubic yards of concrete rubble (not including the demolished bridges.)

The recommended plan will also include the relocation of approximately 720-feet of water lines, 1,490-feet of sanitary sewer lines, 900-feet of gas lines, 1,000-feet of telephone lines, and 1,000-feet of electric lines. In addition, seven existing bridges will be replaced replacement - Garnett, Main, Broadway, California, Scott and Belcher Streets, and a foot-bridge. Three residential structures, one commercial structure, and two sheds will be removed to accommodate construction. The residential structures are located at 733 Gossett, 718 Main, and 700 block of Pecan. The commercial structure is located at 731 California. The sheds are located on the 200 block of Schopmeyer. Finally, the city of Gainesville will complete the removal of all structures acquired under the Federal Emergency Management Agency Hazard Mitigation Grant Program. This cost is not included as part of the recommended plan. Figure 2 displays an aerial view of the recommended plan. A larger version of the map is contained in Appendix A.

Appendix C contains the complete engineering appendix including hydrology and hydraulics (Appendix C.1), geotechnical engineering (C.2), civil engineering (C.3), structural engineering (C.4), and cost engineering (C.5).

Real Estate Acquisition. In addition to the structures, approximately 73.38-acres of lands will be acquired in fee or as a temporary or permanent easement. The 73.38-acres is comprised of the

following: 25.26-acres for channel modification and permanent maintenance easement, 24.07-acres temporary easement for disposal of spoil material, 2.0-acres for temporary construction (access and staging area) easement, and 22.05-acres for ecological mitigation.

The disposal area is on city owned lands located about 10-miles southeast of the middle of the project area. This disposal area will accept all excavated material includes trees, brush, concrete rubble, soil, rock, and miscellaneous trash and debris.

Environmental Mitigation. Following an analysis of the three channel modification alternatives, additional review was conducted of the 30-foot bottom width channel to reflect additional information available from the plan formulation design of that channel. Assumptions used for the fate of the potential mitigation lands if mitigation were not implemented were as follows. Less frequently flooded riparian forest lands would decrease in acreage by ten percent over the 50-year planning period, however, the acreages remaining would retain their existing value over that period. There would be no loss in frequently flooded riparian forest acreages or habitat values over the planning period. The riparian areas lost were assumed to be converted to grasslands that would have the same habitat values as existing conditions.

Assumptions used to evaluate the improved conditions subsequent to active mitigation strategy implementation were as follows. Riparian forest habitat values would be improved to an HSI of 0.95 by the end of the 50 year planning period. These habitat value increases would occur as a result of removing non-native shrubs and non-native trees that are in the mitigation area. In addition, native trees and shrubs would be replanted within the area where the non-natives would be removed. Grassland conversions to riparian forest would increase by 0.1 HSI per acre every ten years cumulatively providing 0.5 HSI per acre by year 50 of the planning period.

Since the smaller channel plan with less environmental impacts was selected as the most likely candidate plan, a revision in the mitigation plan formulation developed was also pursued. A corridor along Pecan Creek upstream of the project to the southern right-of-way of US Highway 82 was investigated. Four corridor widths varying from 300 feet (150 feet on each side of the center line of the channel) to 500 feet (250 feet on each side of the center line of the channel) were analyzed for existing vegetation and habitat conditions and were assessed for their potential to provide compensatory mitigation for the losses attributable to the 30 foot bottom width channel. It was determined that the 300 foot wide corridor with the channel at its center would include 20.70 acres of existing riparian forest lands and 1.35 acres of grassland. Table 17 shows habitat gains as measured by average annual habitat units in comparison to the without a project future conditions for the 300 foot wide mitigation corridor.

Based upon this assessment the 300-foot wide corridor would provide 4.95 AAHU for riparian forest habitat over the without a project future. As shown in Table 17, the 30-foot wide channel project would impact 4.96 AAHU of riparian forest habitat, which falls well within the margin of error for these mitigation computations. Conversion of the grassland to riparian forest would provide an additional 0.30 AAHU of riparian forest habitat value, however, since there are some impacts to grasslands with the project it would be appropriate to preserve the grasslands within


Myrtle
Belcher
Broadway
California
Main
Gordon
Moss
FM 902
Legend
Mitigation Area
Creek
100 Year With Project
100year
City Disposal Site
Streets
Pecan Creek, Gainesville, Texas
Detailed Project Report
Figure 2
Recommended Plan
0 0.1 0.2 0.4 0.6 0.8 1
Miles
N
W
E
S

Table 17
Compensatory Ecosystem Mitigation Habitat Quality Gains Attributable to 300 Foot Wide Corridor (22.05 acres) Between Pecan Creek and US 82

	AAHU	AAHU Gain
Future Without Mitigation	10.27	0.00
Future With Acquisition and Preservation Only	10.38	0.11
Future With Grassland Conversion	0.30	0.30
Future With Active Forest Management	15.22	4.95

the mitigation corridor as native grasslands. In summary, the 300-foot total width corridor totaling 22.05-acres would provide adequate mitigation for the recommended plan proposed construction of the 30-foot bottom width channel.

The final channel alignment will minimize impacts on residential and commercial property, utility relocations, and ecological resources. Compacted fill from the channel excavation will be utilized to shape the channel in certain areas with the natural meanders to remain open in order to carry low flows and preserve the environmental quality within the creek-banks. The natural rock will be utilized for the channel bottom.

Preliminary Pollution Prevention Plan. Temporary stabilization activities would occur for all unpaved, graded and disturbed portions of the site when construction activities cease for 21 days or more and there is no requirement for the establishment of permanent turf. Temporary stabilization may include structural and nonstructural measures. A nonstructural method for temporary stabilization would be to till the soil to a depth of four inches, spread native vegetation at a rate of about 4000 pounds per acre, and anchor the mulch into place using a mulch-anchoring machine. Structural storm water controls would be used during temporary stabilization to prevent soil erosion where construction produces the potential for significant erosion damage, particularly where there is significant slope and at the boundaries of the project's unpaved and disturbed land. Some of the typical temporary structural stormwater controls that could be used to minimize sediment runoff include silt fences, staked hay bales, diversion dikes, excavated sediment traps, pipe slope drains, rock berm or check dams, log check dams, rock check dam, and sand bag berms. The following are the specific conditions under which each measure could be utilized:

Silt Fence. Silt fences shall be used for drainage areas of one acre or less with velocities of 0.5 feet per second (fps) or less. The silt fences would not be constructed in tributaries or swales that lead into Pecan Creek. The silt fences would be used primarily for perimeter control of overland flow to prevent sheet and rill erosion. Sediment would be removed from the silt fence when it accumulates to one-third the height of the fence. The silt fences would be securely fastened to each support post or to the backing, which is in turn attached to a fence post.

Staked Hay Bales. Staked hay bales would be used for drainage areas of one acre or less with velocities of 0.5 fps. The bales would not be used in tributaries or swales that lead into Pecan Creek. The hay bales would be used primarily for perimeter control of overland flow to prevent sheet and rill erosion. The hay bales would be used where the effectiveness is required for less than three months, or the bales would be replaced every three months. Hay bales would

be placed end to end with no caps between the bales. The accumulated sediment would be removed and disposed when it reaches a depth of six-inches.

Diversion Dikes. Diversion dikes would be used to divert storm flows of one-foot in depth or less, from Pecan Creek. The side slopes of the diversion dikes would be 3:1 or flatter and the minimum width of the embankment at the crown would be two-feet. Dike height would be a minimum of one foot greater than the flow depth for the 10-year event. Diversion dikes would be placed parallel to existing contours for perimeter control by diverting run-on water away from the disturbed area.

Excavated Sediment Trap. An excavated sediment trap would be used in small drainage areas around Pecan Creek of less than one acre, where overflow capacity is needed and in areas of heavy flow. The drainage area would be fairly flat with slopes of 5% or less. Washed gravel (3-5 inches in diameter) would be used to a depth of at least one foot. The recommended volume of sediment trap is 35 cubic yard per acre disturbed. Sediment would be removed from the trap when it accumulates to half the height of the filler stone. Weep holes would be filled with grout prior to backfilling of storage.

Pipe Slope Drain. A pipe slope drain would be recommended for drainage areas around Pecan Creek up to 10-acres. The pipe inlet and outlet would be stabilized. A flared end section would be used at the entrance of the pipe and soil around the pipe fully compacted. The outlet would enter into a 12-inch thick bed of riprap. Diversion dike height on the drain would be a minimum of one foot greater than the flow depth for the 10-year event.

Rock Berm or Check Dam. Check dams would be installed in steeply sloped swales or in swales sloping into Pecan Creek where adequate vegetation cannot be established (not streams). Open graded rock, four to eight inches in diameter would be used in the check dams. The dams would be secured with a woven wire sheathing having maximum 1 inch opening and minimum wire diameter of 20 gauge. Check dams would be spaced so that the toe of the upstream dam is at the same elevation as the top of the downstream dam. Debris and sediment would be removed from behind the dam when it accumulates to one-third of the height of the berm.

Log Check Dam. Log check dams would be installed in steeply sloped swales, or in swales sloping into Pecan Creek where adequate vegetation cannot be established (not streams). The logs used would be from 6 to 8 inches in diameter. Log check dams would be spaced so that the toe of the upstream dam is at the same elevation as the top of the downstream dam. Debris and sediment would be removed from behind the dam when it reaches a height of one-half the original dam height.

Rock Check Dam. Rock check dams would be installed around Pecan Creek in drainage areas of two acres or less. Rock check dams would be constructed with 5- to 15-inch diameter stone. The maximum height of the rock check dam would be no greater than three feet and the center of the dam would be six inches lower than the outer edges. For added stability, the dam would be keyed into the surrounding soil approximately six inches deep. Filter cloth may be added under the stone to provide a stable foundation and facilitate removal of the dam. Rock check dams would be spaced so that the toe of the upstream dam is at the same elevation as the

top of the downstream dam. Debris and sediment would be removed from behind the dam when it reaches a height of one half the original dam height.

Sand Bag Berm. Sand bag berms would be used around Pecan Creek, when the contributing drainage area is greater than five acres. The sand bags would be constructed from polyethylene, polyamide or cotton burlap woven fabric, have a minimum weight of four ounces per square yard, a mullen burst strength exceeding 300 pounds per square inch and ultraviolet stability exceeding 70 percent. Sand bags would be 24- to 30-inches in length, 16- to 18-inches in width and 6- to 8 -nches in thickness. The sand bags would be filled with coarse grade sand, free from deterous material, and shall pass through a No 10 sieve. The minimum weight of the bag would no less than 40 lbs.

The construction contractor would be able to select from these temporary measures for sediment control according to the appropriate existing conditions. The final selection of controls would have to be approved by a Corps of Engineers Contracting Officer. Many of the storm water controls are temporary and would be removed after final site stabilization is completed. Some of the temporary storm water measures; however, would remain in place as permanent measures to control erosion, create additional wildlife habitat, and improve water quality.

Permanent site stabilization would occur when construction activities permanently cease. Several of the measures previously described for temporary stabilization would be applicable for permanent stabilization. Of the methods previously described for temporary stabilization, those measures that utilize natural materials such as the log and rock check dams would remain in place permanently. The log and rock check dams would provide permanent stabilization in areas where there is high erosion potential. The stabilization and reduction of soil erosion that would occur in the bank areas where these measures have been installed would eventually allow riparian vegetation to become established, create additional wildlife habitat and provide water quality benefits by filtering runoff water that flows into Pecan Creek during storm events. In addition to the permanent stabilization measures previously identified, turfing work would be done from 1 April to 1 June. Live sod would be placed on all disturbed and unpaved areas. If available living sod containing native vegetation would be used. The areas to be sodded would be excavated to a sufficient depth so that the top of the sod when set in place would be about ½ inch below the surrounding soil at the outer edges of the solid sodded area. Sod would be immediately pressed firmly into contact with the sod bed by hand tamping. Screened soil of good quality would be used to fill all cracks. Sod would be watered and fertilized at an approved rate and for a duration necessary to ensure permanent survival. The native sod would serve habitat for the native wildlife species by providing food, cover, and nesting material. The sod would act as a filter to improve the water quality and runoff water during storm events.

Betterments. The city of Gainesville is interested in project betterments. These betterments will address Gainesville's need to address the community's desire for greater aesthetic quality. The park concept makes the most of the visual interest without maximizing the number of elements and plant materials found within the recommended channel. The concept will also minimally affect conveyance of the new channel design. An overall design approach was taken with the park, giving recommendations for added elements and plant materials within the park and its visual extents not just the project boundary. The betterments include retaining walls,

retaining wall plantings, vegetation, ponds, a pilot channel, and small wetlands. Each is described in more detail below.

Retaining Wall Plantings. The retaining wall plantings are a visual focus to the park concepts. Major view sheds and focal points were used to determine their location and were used to maximize their effectiveness as a tool for beautification of the proposed channel. A retaining wall planting consists of a small flagstone retaining wall and the associated vegetation. The retaining walls are 3-feet in height with a flagstone construction that reflects the style and color of the flagstone currently found in the existing channel. The vegetation associated with the retaining walls consists of a small grouping of two to three large evergreen trees, two to three ornamental trees, several medium to large shrubs, and several overhanging shrubs/vines.

Ribbon of Grasses. The ribbon of grasses is an effective and creative way to maximize visual interest within the channel while also linking the retaining wall plantings to one another. The park now has a unique and formal trail of flowing vegetation that will be recognized the entire length of the park, thus connecting the extents of the park limits. Medium size grasses will be used to create the ribbon with an occasional tree.

Ponds. Small ponds will be created upstream of bridge structures. Weir structures constructed under bridges will create ponds one to three feet in depth without the weir itself being easily seen. The ponds will rise and fall with local runoff and add interest to the channel.

Pilot Channel. A defined pilot channel, constructed of flagstone resembling the current channel walls, creates a visual change for the viewer, becomes an architectural feature, and reminds the viewer of the old flagstone channel wall. The pilot channel will also better transfer runoff to the pooling areas.

Wetlands. Formal wetland areas have been created to maximize the capture runoff from outfalls and drainage pipes. The small flagstone structures, one to two feet in height, pool water for aquatic vegetation and become an intended visual element to the channel, not an area that seems to wet to be maintained properly. The majority of the betterments lie within the recommended project footprint, and will be designed during the plans and specifications phase. Appendix A contains a rendition of the conceptual betterment plan. All design and construction costs are the responsibility of Gainesville. The estimated betterment costs are $1,100,000.

Total Project Cost and Benefit-Cost Summary. The total project cost is comprised of all expenditures for lands, easements, rights-of-way, relocations, and disposal areas, plans and specifications construction, supervision and administration including contingencies. The detailed cost estimate is located in Appendix C.5. Table 18 displays a summary of the total project cost. Table 19 displays the final benefit- cost summary. Costs were estimated at a July 2005 price level. Without-project flood damages, with-project flood damages and flood damages prevented were also updated to a July 2005 price level using current depreciated structure values for an accurate comparison with project costs.

The recommended plan results in a minor but measurable increase in water surface profiles between the end of the project and Anthony Street. The increase is due to the loss of valley

Table 18
Estimated Implementation Cost
Recommended Plan
(October 2005 price level; rounded)

Item	Estimated Cost
Total Project Cost:	
Plans and Specifications [1]	$ 1,008,400
Lands and Payments [2]	$ 1,769,900
Bridge Replacements	$ 2,176,700
Utility Relocations	$ 216,200
Total Lands, Replacements, Relocations	$ 4,162,800
Channel Construction [3]	$ 2,649,000
Supervision and Administration [4]	$ 504,200
Total Project Cost	**$ 8,324,400**

[1] Includes $478,600 for bridge replacements / utility relocations design, a non-Federal responsibility.
[2] Includes lands for construction and maintenance, environmental mitigation, and disposal area.
[2] Includes mitigation feature.
[2] Includes $239,300 for bridge replacements / utility relocations supervision and administration, a non-Federal responsibility.

Table 19
Benefit-Cost Ratio Summary
Recommended Plan
(October 2005 price level; 5.125-percent)

Annual Without Project Flood Damages	$ 783,300
Annual Residual Damages	$ 107,000
Annual Flood Damage Reduction Benefit	$ 676,300
Annual Disbenefit	$ (2,400)
Total Annual Flood Damage Reduction Benefit	$ 673,900
Total Implementation First Cost [1]	$ 8,219,400
Interest During Construction	$ 424,800
Total Investment Cost	$ 8,644,200
Interest	$ 443,300
Amortization	$ 39,700
Annual Cost	$ 482,700
OMRR&R	$ 20,000
Total Annual Cost	$ 502,700
Benefit Cost Ratio	1.3 to 1.0
Net Benefits	$ 171,200

[1] Does not include $105,000 in relocation assistance.

storage within the recommended plan area, i.e., floods that once overflowed the creek banks are now contained within the modified channel. Increased flood depths range from 0.1- to 0.2-feet for the 50% ACE to 0.2- to 0.3-feet for the 4% ACE, and begin to decline to 0.1-feet for the 1%

ACE and no increased flood depths at the 0.2% ACE. The increased flood depths may affect a total 37 residential structures within the Pecan Creek Mobile Home Park (29), and along McCubbin (3), South Taylor (3), and Moss Streets (2). Under without-project conditions, annual flood damages are estimated at $14,800 (approximately $400 per structure) and with the recommended plan annual flood damages are estimated to be $17,200 (approximately $465 per structure), an increase of $2,400 (or $65 per structure). While the increase in flood depths and flood damages is measurable by the hydraulic and flood damage estimating computer models, actual impacts, if any, will be essentially undistinguishable from flood events that may occur under without-project conditions. Mitigation of the increased flood depths are not warranted nor required. The increased in flood damages will be included as a "disbenefit" in the final benefit-cost ration summary.

Project Cost Sharing. Gainesville is required to share in the project cost. This includes a cash payment equal to five-percent of the total project cost. Gainesville is also responsible for the acquisition of all lands, easements, and rights-of-way, and the implementation of all utility relocations and bridge replacements including engineering, design, supervision, and administration. The sum of the five-percent cash payment and the expenditures on land acquisition, utility relocations, and bridge replacements must equal a minimum of 35-percent of the total project cost or an additional cash payment will be required to meet the 35-percent minimum. In the event the sum of the five-percent cash payment and the city's expenditures on land acquisition, utility relocations, and bridge modifications exceeds 50-percent of the total project, the Government may reimburse the city so their maximum expenditure equals 50-percent of the total project cost. Gainesville is also responsible for operating and maintaining the project after construction. Table 20 summarizes the cost sharing requirements.

Table 20
Estimated Cost Sharing
Recommended Plan
(October 2005 price level)

Item	Estimated Cost	
Total Project Cost	$ 8,324,400	
Federal Cost Share	$ 4,162,200	(50%)
Non-Federal Cost Share:		
5% Cash Payment	$ 416,200	
Lands, Easements, Rights-of-Way Relocations and Disposal Areas:	$ 4,880,700	
Subtotal Non-Federal	$ 5,296,900	(63%)
Reimbursement by Federal Gov't	$ 1,134,700	
Total Non-Federal Share:	$ 4,162,200	(50%)

Flood Damage Reduction Impacts. The recommended plan will reduce annual flood damages by $676,300 or 86-percent of the total without project flood damages. A summary of single-event without- and with-project flood damages is shown in Table 21.

Table 21
Summary of Without- And With-Project Flood Damages
And Water Surface Elevations
Recommended Plan
($000; October 2005 price level)

	50% ACE		20% ACE		10% ACE		1% ACE		0.2% ACE	
	Structures	Damages	Structures	Damages	Structures	Damages	Structures	Damages	Structures	Damages
Without Project	12	10.4	165	604.6	235	1,203.4	417	6,637.9	491	8,713.8
Recommended Plan	0	0.0	6	14.0	20	35.6	212	1,022.7	326	5,108.3
Reduction in Water Surface Elevation [(1)]	-5.2-feet		-5.7-feet		-7.1-feet		-2.5-feet		-2.2-feet	

[(1)]As measured near California Street.

ENVIRONMENTAL EFFECTS OF RECOMMENDED PLAN

Any of the structural alternatives evaluated which would alter Pecan Creek channel would have negative impacts to the stream habitat and the aquatic environment. Generally, the more extensive the alterations to the channel, the more adverse the environmental impacts would be. On the other hand, any of the non-structural alternatives which would remove intrusive structures and reduce the amount of human induced stresses to the existing natural resources would have positive impacts on the environment. Since all channel plans would impact the same reach of stream the impacts to aquatic habitat would be similar regardless of the ultimate bottom width of the channel. As a result of project planning, the recommended plan is substantially smaller than had been recommended in previous studies. The 30-foot bottom width channel recommended would cause fewer impacts to important riparian forest and would not impact wetlands.

The recommended plan including channel construction, removal of three residential structures, and one commercial building, two sheds, and replacement of seven existing bridges would require that approximately 73.38-acres of lands will be acquired in fee or as a temporary or permanent easement. The 73.38 acres is comprised of the following: 25.26 acres for channel modification and permanent maintenance easement, 24.07-acres temporary easement for disposal of spoil material, 2.0-acres for temporary construction (access and staging area) easement, and 22.05-acres for ecological mitigation.

The identified disposal area is within an existing city landfill located about 10-miles southeast of the middle of the project area.

Land Use. The project if implemented would reduce flood damages on parts of the floodplain within the project area. Within existing urbanized areas of the project, it is likely that intensification of building upkeep, repair and new construction would occur, however, the main changes to land use would be on those lands that would be required for project implementation. Land use on the areas proposed for channel construction would remain as floodplain, however approximately 9.88 acres of riparian forest would be removed and 0.55 acres of grasslands and 6.6 acres of existing urbanized area would be affected by construction. An existing 22.05 acres of existing floodplain vegetation would be incorporated into the plan and would remain as floodplain vegetation, but it would be put in public ownership and managed for environmental mitigation.

Air Quality. Cooke County is in compliance with air quality requirements. Implementation of the recommended plan entails construction that would temporarily increase localized air quality changes. Machinery working in the air could temporarily increase fugitive dust levels, however, there would be no long term significant adverse impacts to air quality from implementation of this plan.

Vegetation. The project construction would adversely effect approximately 9.88 acres of existing riparian forest, and 0.55 acres of riparian grassland, however the environmental mitigation plan would include public acquisition, improvement and long term management of an existing riparian area containing 20.70 acres of forest and 1.35 acres of grassland.

Safeguards to reduce soil erosion would be implemented as need during the construction of the recreational features and during the demolition and removal of structures in the buyout area. The disturbed soils along the construction sites and in the buyout areas would be stabilized during and following construction.

No significant adverse impacts to soils would occur from implementation of the plan and overall, the project would provide for preservation of riparian bottomland forest upstream of the project area.

Wildlife Resources. The upper reaches of the Pecan Creek watershed is within a rural area in which the predominant use is for agricultural activities ranging from crop and hay raising to livestock growing. Some business and residential growth was noted in the study area during the study period. The primary study area and the area that would be most effected by the project is a the more urbanized area within the city of Gainesville, and most of the wildlife species found there are typical of those expected to be found in urbanized areas. The exception to this general statement is that wildlife resources associated with the existing riparian forest is more characteristic of the more rural areas upstream and downstream of the project. Studies were conducted by the Corps of Engineers and the U.S. Fish and Wildlife Service to evaluate the quality of wildlife habitat that would be affected by the project. The methodology utilized evaluates physical structure of habitat components and relates those elements to functional aspects for wildlife.

It was determined that the project would adversely effect approximately 9.88 acres of existing riparian forest, and 0.55 acres of riparian grassland by converting these areas to channel that would be maintained and manicured to more closely resemble low quality urban habitat. Based upon analysis conducted the channelization and other aspects of the construction of the project would result in the loss of 4.96 average annual habitat units of wildlife habitat associated with riparian forest. Riparian and bottomland hardwoods within this ecoregion are important resources requiring compensatory mitigation. Both the US Fish and Wildlife Service and the Corps of Engineers have a mitigation goal of no net loss of functional value of riparian forests. A compensatory mitigation plan was developed that provides an estimated 4.95 average annual habitat units of riparian forest habitat gain and 0.30 average annual habitat units of native grassland habitat.

No significant adverse impacts to wildlife resources would occur from implementation of the plan provided the environmental mitigation plan is implemented.

Aquatic Resources. Construction of the channel project would impact approximately 3,355 linear feet of extremely low quality stream habitat associated with the existing channel reach that is lined with concrete and flagstone. Evaluation of this reach by biologists of the Corps of Engineers and the US Fish and Wildlife Service indicated that during low flows no usable habitat is available for fish or most other aquatic organisms. Construction of the remaining channel would impact 4,505 linear feet of moderate quality aquatic habitats along 2,280 linear feet of channel that has previously been realigned and 2,225 feet of channel that has been only minimally disturbed by past activities associated with the urban environment. It is anticipated that after completion of the project that similar aquatic habitat would be redeveloped within the

2,280 linear feet of previously realigned channel and that the aquatic habitat in the upstream 2,280 linear feet of channel would be similar to that in the downstream reach. Within the middle reach that is currently lined with concrete and flagstone, the modified channel would provide slightly improved aquatic habitat over time.

Construction of transition zones at the upper and lower reaches of the new channel would provide for stream channel stabilization. The terrestrial mitigation plan identified also would include acquisition of the stream channel between the upper end of the project and US Highway 82. By protecting this reach, it is believed that any temporary or long term impacts of the intermitted stream would be completely compensated. In addition, betterments to the project have been proposed that would include addition of features within the channelized reach that while designed to improve aesthetics of the project would also provide some additional minimal aquatic and terrestrial habitat improvements. The features include plantings of overhanging shrubs, medium height grasses, inclusion of formal wetlands and other features would act to slightly improve aquatic habitat within the channelized reach.

Erosion control and sediment reduction plans would be incorporated into the project construction plans. There would be no impacts to the aquatic habitat from the demolition and removal of the buyout structures.

In conclusion no significant adverse impacts to aquatic resources are anticipated to occur from implementation of the recommended plan.

Impacts to Cultural Resources. The recommended plan is not expected to adversely impact any significant cultural resources. Despite best efforts to locate and evaluate all the cultural resources within the project area of potential effect, unanticipated subsurface deposits are possible at any ground-breaking undertaking. If previously unknown cultural materials are exposed by construction activities related to the undertaking, work will stop in the immediate vicinity, the resource will be protected, and the THC will be notified within 24 hours of discovery. If, in consultation with the THC, it is determined that the resource is significant, and cannot be avoided by construction, then a mitigation plan will be prepared in consultation with the THC and implemented before construction is allowed to continue in that vicinity.

If unmarked human burials are discovered during construction, work will stop in the immediate vicinity, the remains will be protected, and the local law enforcement agency and THC will be notified as soon as possible. The location of the unmarked human burial or burials will be documented and the provisions of the Native American Graves Protection and Repatriation Act will be implemented.

Impacts to HTRW. The recommended plan is not expected to be impacted by any hazardous, toxic, or radioactive wastes, or contaminants. Prior to the next phase of this project, it is recommended that the environmental database search be updated to address more recent environmental conditions that could impact the project areas.

If the soils within the channel adjacent to the former Bazflex Texas, Inc. property are to be disturbed or excavated, it is recommended that soil samples be collected to identify potential

contaminants that could have been released to the soils in the channel and to characterize the soils for disposal. In addition, because the study area is in an urban area, soil removed for disposal should be tested to make sure potential contaminants are not released to the disposal site. At the disposal site, care should be taken to stay a safe distance away from the oil well and storage tanks to avoid a release of petroleum hydrocarbons to the environment. Otherwise, the property is suitable from an environmental standpoint for excavated material disposal.

Water Quality. There would be no significant long term adverse impacts to the water quality of Pecan Creek from implementation of the plan. Temporary impacts would occur during construction of the channel, however, following completion of construction including final stabilization of the channel, water quality below the project would return to conditions similar to existing conditions. The channel runs approximately north to south and the water is exposed to the sun only during the mid day period. The project would also reduce the length of stream where the water is extremely shallow, and therefore overall, the effects of day time heating are anticipated to be minimized. It is not anticipated that temperatures or dissolved oxygen would be affected adversely by the project when completed. The project would not generate additional nutrients or contaminants that would adversely impact the water quality.

Noise. Sound levels within the Pecan Creek study area are typical of those found in small urban neighborhoods. Noise levels in the area would be expected to increase for a short time while demolition and construction activities are ongoing as a result of the added noise of heavy equipment and workers in the area. However, following construction, the noise levels should return to levels currently occurring in the area. Maintenance of a riparian south of US Highway 82 as would be implemented by the environmental mitigation plan should serve to continue to buffer the sounds of traffic and general noise of that major arterial highway from the downstream neighborhoods.

There would be short-term negative impacts during the construction and demolition phase. There would be no significant adverse impacts to the noise levels in the recommended plan area along Pecan Creek from implementation of the plan, except on a temporary basis, and the plan would positively impact noise levels in the long-term due to buffering from tree growth associated with the environmental mitigation area.

Light. The project is within an urban area and lighting already permeates most of the project area. No new lighting is proposed based upon implementation of the recommended plan. Existing lighting may impact larger areas as some streamside vegetation would be removed permanently as a result of the project. In addition, most of the project area has already been channelized and therefore it is not anticipated that this lighting spread would be substantial. Therefore, it is anticipated that there would be no significant adverse impacts caused by lighting attributable to the recommended plan.

Traffic Patterns. Short-term impacts to traffic patterns would likely occur as a result of bridge replacement. Additional trucking to remove materials from bridge demolition and surplus materials from the channel project could also result in localized interruptions in traffic flows. Traffic would have to be rerouted at times as the bridges are replaced, however cross traffic access would not be completely eliminated at any time.

As indicated, during the demolition of the structures and construction of the various project features, there might be some temporary traffic inconveniences as trucks and equipment move along adjacent streets, but no more than short-term inconveniences not constituting a significant impact.

Hydrology and Hydraulics. The recommend plan would reduce flood elevations associated with flooding in areas adjacent to the channelized reach; however the project has been designed to reduce negative impacts to riparian resources upstream of the project by reducing draw down of frequent flood elevation upstream of the project and restricts increase in water surface elevations downstream of the project. In addition, the upper end of the channel project includes a transition zone that would stabilize the channel above the project, by preventing head cutting. This effort would protect stream aquatic and terrestrial habitat upstream of the project including the area recommended to serve as compensatory environmental mitigation and the wetlands identified upstream of US Highway 82. Therefore the project would provide significant beneficial reduction in flood elevations adjacent to the project but would not have significant environmental impacts either upstream or downstream of the project.

Cumulative Impacts. The assessment of cumulative impacts is addressed in NEPA by its reference to interrelations of all components of the natural environment. The Council on Environmental Quality defined cumulative impacts as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency Federal or non-Federal) or person undertakes such actions. The term "reasonably foreseeable" implies that the project may only have a general public knowledge or acceptance at a point in time and that detail of design and project specific impacts are yet to be developed or disclosed by the project proponent. This cumulative impacts analysis considered the existing conditions to be a result of the past and present projects that have occurred in the study area and serves as a baseline to address impacts of the reasonably foreseeable projects.

The significant resources identified within the study area were those resources dependent on the Pecan Creek and its provision of water. Those resources include the resource values associated with the riparian forest, aquatic habitat associated with Pecan Creek and wetlands. Types of activities that might adversely impact these resources are broad in nature but primarily include road construction, bridge replacement, and encroachment by urban development, changes in farming activities that would minimize riparian corridors or induce additional sediments or chemicals. Beneficial impacts to these resources could result from environmental cleanups, environmental stewardship programs, environmental mitigation and or restoration.

Potential for cumulative impacts associated with the recommended plan is low and the significance of cumulative impacts is also low. This cumulative impacts analysis uses the level of information available at the time this environmental assessment was prepared to describe these other projects and their respective potential impacts on the environment.

Searches identified few potential reasonably foreseeable projects in the area that would have identifiable cumulative impacts to the study area. No studies or reasonably foreseeable projects were identified by Texas Department of Transportation that would cumulatively impact riparian

resources within the Pecan Creek watershed. No other proposed construction by others were identified that would cause cumulative adverse impacts.

Beneficial cumulative impacts are expected to occur as a result of ongoing remediation of a petroleum contaminated site located with Pecan Creek basin upstream of I-35. This cleanup should provide localized improvements to water quality and direct beneficial cumulative impacts to aquatic and riparian habitats.

RESULTS OF AGENCY COORDINATION

Biologists of the US Fish and Wildlife Service participated in HEP analysis and vegetation cover surveys and stream condition analysis of the Pecan Creek watershed. They also served as team member whose recommendations of objectives appropriate to the proposed site and existing resources were the basis for the habitat impact assessment and mitigation measures proposed in the recommended plan. A letter documenting USFWS appraisal of the recommended plan is included in Appendix G. The feasibility report and integrated environmental assessment (EA) were distributed for review and comment to the following additional agencies during the public notice 30-day comment period: Environmental Protection Agency (Region 6), Texas Parks and Wildlife Department, Texas Commission on Environmental Quality, and the Texas Historical Commission.

STATUS OF ENVIRONMENTAL COMPLIANCE

Section 404 - Clean Water Act. The recommended plan has been reviewed in accordance with Section 404 of the Clean Water Act. Since the recommended plan would impact waters of the United States, a Section 404 (b)(1) analysis was conducted. Following procedures of a joint agency agreement between the U.S. Army Corps of Engineers and the State of Texas, the project including effects of the project on the physical chemical and biological characteristics of the project area have been solicited during public review of this document. Water quality certification by the State of Texas will be required prior to commencement of construction on aspects of the project impacting waters of the United States. Appendix H contains the Section 404 analysis.

Executive Order 11988 - Flood Plain Management. In addition to Section 404, Executive Order 11988, Floodplain Management, was considered during the development of the recommended plan. There are no practical alternatives to achieve the project purposes of flood damage reduction without placing fill within the floodplain. Material removed from the project area requiring disposal would be placed in approved landfills for the types of materials involved. The proposed fill actions within the channel would result in adverse environmental impacts however an environmental mitigation plan has been developed and recommended for implementation that would compensate for losses in floodplain functional values. Further, floodplain fill associated with the project would not directly or indirectly induce additional development in the floodplain and would therefore be in compliance with Executive Order 11988.

Executive Order 11990 - Protection of Wetlands. In addition to Section 404 and Executive Order 11988, Executive Order 11990, Protection of Wetlands was considered during the development of the recommended plan. The recommended plan would neither adversely impact or result in any loss of wetland areas so the project is in compliance with Executive Order 11990.

Threatened and Endangered Species. The recommended plan has been reviewed by the U.S. Fish and Wildlife Service. As proposed, the project is not likely to adversely affect threatened or endangered species.

Environmental Justice. Census blocks intersecting the study area were examined to ascertain compliance with Executive Order 12898, "*Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations*" to assess potential impacts to minority and low income populations. Of the eleven census blocks, none had significant (50 percent or more) minority compositions. In assessing the existence of low-income populations for the study area, median household incomes for all eleven census blocks were compared with a poverty level threshold of $14,776 (2004 level for a household size of three considering the average number of persons per household for Cooke County is 2.6). None of the census blocks in the study area had median household incomes below this level, therefore, it is determined that minority and low income residents are not disproportionately impacted by the recommended plan.

IMPLEMENTATION OF THE RECOMMENDED PLAN

Project Implementation Schedule. Table 22 displays a summary of the estimated project implementation schedule.

Table 22
Project Implementation Schedule

Item	Date
Initiate Plans and Specifications	January 2006
Execute PCA	January 2007
Acquire Real Estate	January 2008
Advertise Contract	February 2008
Award Contract	April 2008
Issue Notice to Proceed	May 2008
Complete Construction	May 2010
Project Closeout	September 2010

Plans and Specifications. During the plans and specifications portion of project implementation, the final design is completed and project construction drawings, project construction specifications, estimation of final quantities, and the government cost estimate are finalized. These documents (with the exception of the government cost estimate) are made available to contractors interested in bidding on the construction of the project. All cultural resource investigations and mitigation requirements will be finalized prior to the final project design. The cost of the plans and specifications is initially Federally financed. The non-Federal portion of these costs is repaid prior to project construction. It is during the plans and

specifications that the city of Gainesville will execute the Project Cooperation Agreement and acquire all necessary lands, easements, and rights-of-way required for project construction, operation, and maintenance.

Real Estate Acquisition. The recommended plan will require approximately 73.38-acres of land including 51.33 for project construction, operation and maintenance, and 22.05-acres for ecological mitigation. An estimated 53 tracts of land will be acquired. In addition three residential structures, one commercial structure, and two sheds will be acquired and removed from the project area. Relocation assistance will be provided to the affected property owners. The city of Gainesville is responsible for acquiring all privately, as well as local government or public, owned lands, easements, rights-of-way, relocations, and disposal areas required for project construction, operation, and maintenance. Following the execution of the Project Cooperation Agreement, Gainesville will be provided a right-of-way map delineating the real estate to be acquired, and will coordinate the real estate acquisition with the Fort Worth District. Gainesville will provide the Fort Worth District a right-of-entry. All lands must be acquired prior to the advertisement and award of any construction contract. Appendix I is the Real Estate Plan.

Bridge Replacements and Utility Relocations. The city of Gainesville will be responsible for all engineering, design, construction, supervision and administration of all bridge replacements and utility relocations. The city may engage any design and or construction firm it chooses. In doing so, the firms must coordinate closely with the Fort Worth District on the design of these features and the timing of construction. The District will approve all designs and schedules. In the alternative, the city may choose to have the Fort Worth District complete the design and construction of these features, paying the District 100-percent of the design and construction cost. This cost is applied to the 35-percent minimum cost share.

Contract Award Activity. Following the acquisition of real estate and the completion of the plans and specifications, a construction contract will be solicited (12-days) and advertised (30-days). The contract will be awarded to the lowest responsive bidder and the notice to proceed will be issued once the contractor provides all necessary work plans. Construction may be initiated within 30-45 days from the bid opening .

Construction. After the notice to proceed is issued, the contractor will mobilize and start project construction. The Fort Worth District will manage the project construction. The total construction period is estimated to take 24-months.

Operations and Maintenance. The city of Gainesville is responsible for operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) of the completed project. The Fort Worth District will provide an operations and maintenance manual after construction is complete, and prior to turning the project over to the non-Federal for OMRR&R. Typical OMRR&R will include periodic mowing of the grass-lined channel , the removal of sediment and debris from the channel, and the replacement of the rock riprap at the upstream transition of the project. The estimate annual OMRR&R cost is $20,000.

Project Cooperation Agreement and Items of Non-Federal Responsibility. Prior to commencement of construction, the non-Federal sponsor must enter into a binding agreement with the Government to provide its required cooperation, the Project Cooperation Agreement (PCA). The PCA is an agreement setting forth the obligations of each party. Local interests must agree to meet the requirements for non-Federal responsibilities, as summarized below and in future legal documents. Appendix J is a draft model PCA.

a. Provide a minimum of 35-percent of the project costs allocated to flood damage reduction as further specified below:

(1) Provide a cash payment equal to 5-percent of the total project cost.

(2) Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas (LERRD's) , and perform or assure the performance of all relocations determined by the Government to be necessary for the construction, operation, and maintenance of the flood-damage reduction project.

(3) Provide additional funds needed to meet the 35% minimum non-federal share of the total project cost.

(4) In the event the sum of the 5% cash and the value of the LERRD's exceeds 50-percent of the total project cost, the non-Federal sponsor is entitled to a reimbursement so that the maximum total contribution is equal to 50-percent of the total project cost.

(5) Provide 100% of all design and construction costs associated with project betterments

b. For so long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the completed project, or functional portion of the project, including mitigation features, at no cost to the Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and any specific directions prescribed by the Federal Government.

c. Give the Government a right to enter, at reasonable times and in a reasonable manner, upon property which the local sponsor owns or controls for access to the project for the purpose of inspecting, completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

d. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

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

f. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence is required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20.

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

h. Assume, as between the Federal Government and the Non-Federal sponsor complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Government determines necessary for the construction, operation, or maintenance of the project.

i. Agree, as between the Federal Government and the Non-Federal Sponsor, that the Non-Federal Sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project and otherwise perform its obligations in a manner that will not cause liability to arise under CERCLA.

j. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) which might interfere with the proper functioning of the project, hinder operation and maintenance, or reduce the benefits of the project.

k. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public law 91-646, as amended by title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR part 24, in acquiring lands, easements, and rights-of-way, and performing relocations for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

l. Comply with all applicable Federal and State laws and regulations, including Section 601 of the Civil Rights Act of 1964, Public Law 88-352, and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army".

m. Do not use funds from other Federal programs, including any non-Federal contribution required as a matching share, to meet the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that the expenditure of such funds for such purpose is authorized.

Financial Plan and Capability Assessment. Total financial obligation of the non-Federal sponsor during project implementation is estimated at $4,162,200 (after a reimbursement by the Federal Government of $1,134,700), or an initial outlay of $5,296,900. The annual non-Federal obligation for operation, maintenance, repair, rehabilitation, and replacement is estimated at $20,000. Table 23 displays their financial obligation by fiscal year (starting October 1, 2006).

Table 23
Estimated Schedule of Federal and Non-Federal Expenditures

	Non-Federal [1]				
	Cash	Acquisition	Relocations	Total Non-Federal	Total Federal
FY 2006	$ 0	$ 0	$ 0	$ 0	$ 400,000
FY 2007	$ 0	$ 1,327,000	$ 2,333,000	$ 3,660,000	$ 100,000
FY 2008	$ 416,200	$ 442,900	$ 777,800	$ 1,636,900	$ 113,600
FY 2009	$ 0	$ 0	$ 0	$ 0	$ 1,500,000
FY 2010	$ 0	$ 0	$ 0	$ 0	$ 2,048,600 [2]
TOTAL	$ 416,200	$ 1,769,900	$ 3,110,800	$ 5,296,900	$ 4,162,200

[1] Does not include the $1,134,700 reimbursement occurring after project construction is complete.
[2] Includes $1,134,700 reimbursement

Statement of Financial Capability ands Financing Plan. The statement of financial capability is based on information provided by the city of Gainesville, and is a description of its capability to meet its financial obligations for the recommended plan. The city of Gainesville passed a bond election in 2002 in the amount of $5.1-million. The purpose of the bonds was specifically for Pecan Creek flood damage reduction. The funds will remain available until the project is completed. Gainesville will provide the funds in the manner described in the Project Cooperation Agreement.

A**ssessment of Financial Capability**. The city of Gainesville has sufficient funds to meet the cost-sharing requirements during project implementation. It is reasonable to expect that Gainesville will make the required expenditures and provide the required funds in a timely manner.

VIEWS OF THE LOCAL SPONSOR

The city of Gainesville supports the recommended plan, and intends to participate in its implementation. A letter of intent stating their support and intention to participate in project implementation is expected to be received following the public review period.

PUBLIC INVOLVEMENT

The draft Detailed Project Report and Integrated Environmental Assessment was released for public review in August 2005. The review period ended In September 2005. During this time, a public meeting was held Gainesville, Texas. The purpose of the public meetings was to seek public to comment and ask questions on the recommended plan. About xx citizens attended the meetings. [SUMMARIZE PUBLIC REVIEW / INVOLVEMENT AFTER PUBLIC REVIEW PERIOD OVER].

TECHNICAL, POLICY, AND LEGAL REVIEW. All technical analyses and other studies have received an independent technical including hydrology, hydraulics, flood damage estimates, civil-, structural, geotechnical-, and cost-engineering, cultural and hazardous waste studies, environmental assessment and mitigation plan, and the gross appraisal and real estate plan. A policy review was conducted by the District's plan formulation specialist, the Chief of Planning Branch, and the Chief of Planning, Environmental, and Regulatory Division. The District's Office of Counsel has reviewed the report for legal sufficiency. A signed Certificate of Technical, Policy, and Legal Sufficiency is located in Appendix K.

CONCLUSIONS

The following conclusions are based on the study findings conducted in connection with this feasibility level report:

- The city of Gainesville experiences recurrent flooding from Pecan Creek within the city limits causing economic losses and a threat to health and safety. Flood damages begin with the 2-year flood event, with significant damages occurring prior to the 5-year event. The 10- and 100-year flood event result in damages of $1.4 million and $7.0 million, respectively. Annual flood damages are estimated at $783,300.

- The recommended (National Economic Development) plan consists of a grass-lined channel, approximately 7,860-feet in length. The modified channel has a bottom width of 30-feet with 1 vertical on 3.5 horizontal side slopes. The recommended plan also identifies seven bridge relocations, as well as utility relocations. Ecological mitigation is the acquisition and improvement to 22.05-acres of land.

- The total project cost is estimated at $8,324,400. Annual costs are estimated at $502,700. The project provides annual flood-damage reduction benefits of $673,900 and has a benefit-cost ratio and net benefits of 1.3 to 1.0 and $171,200, respectively. The recommended plan reduces 86-percent of the annual damages. Annual damages with the project are estimated at $107,000.

- The city of Gainesville is identified as the local sponsor for implementation of the recommended plan. Federal and non-Federal cost apportionments for the recommended plan are estimated at $4,162,200 each.

- The recommended plan will cause no long-term adverse environmental impacts. A draft Finding of No Significant Impact (FONSI) was prepared. After the review period, the

final FONSI will be signed. Distribution of this Detailed Project Report and Integrated Environmental Assessment, including the draft FONSI, was made available for public review. [SUMMARIZE PUBLIC COMMENTS AND DATE FONSI SIGNED, IF WARRANTED].

- The recommended plan is supported by the city of Gainesville.

The decision to invest in the Pecan Creek, Gainesville, Texas, local flood damage reduction plan is warranted because:

- Fulfills Corps flood damage reduction mission
- Is in accordance with the Corps Civil Works Strategic Plan
- In is accordance with the Corps Environmental Operating Principles
- Is in compliance with Corps policy
- Is technically sound
- Gainesville is prepared to implement the recommended plan immediately having secured all required funding for implementation

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RECOMMENDATION

I propose the flood damage reduction identified as the recommended plan in the Pecan Creek, Gainesville, Texas, Detailed Project Report and Integrated Environmental Assessment proceed with implementation in accordance with the cost sharing provisions set forth in this report.

This recommendation is made with the provision that prior to project implementation, the non-Federal sponsor shall enter into a binding agreement with the Secretary of the Army to perform the items of local cooperation, as specified in this document.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent 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 an opportunity to comment further.

_____
John R. Minahan
Colonel, Corps of Engineers
District Engineer

Date_____

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Pecan Ceek, Gainesville, Texas
Detailed Project Report and Integrated Environmental Assessment
Finding of No Significant Impact

Pecan Creek originates approximately 6 miles north of the Gainesville, Texas and flows south through the central portion of the city to its confluence with Wheeler Creek, Redmond Branch, and the Elm Fork of the Trinity River. Gainesville is the county seat of Cooke County located 60 miles north of the Dallas/Fort Worth metropolitan area. Land use within the watershed is predominantly rural. The drainage area of Pecan Creek within the study area is approximately 12.4 square miles. At the request of the city of Gainesville, the U.S. Army Corps of Engineers, Fort Worth District initiated a feasibility study to evaluate potential solutions to flooding problems, under the authority of Section 205 of the Flood Control Act of 1948, as amended.

Structural and nonstructural alternatives were evaluated including flood plain regulation, flood forecasting and warning, flood proofing, flood plain management, permanent evacuation, detention, levees, bridge replacements, and channels modifications. Channel modifications were the only alternative that proved economically, technically, and socially feasible. Various channel widths and configurations were evaluated in detail.

The recommended plan consists of a grass-lined trapezoidal channel, beginning approximately 400-feet below Olive Street and ending just 360-feet downstream of Gordon Street. There is a 200-foot rock riprap transition at the upstream project limit. The recommended plan has an aggregate length of 7,860-feet, has a 30-foot bottom width, and 1 vertical on 3.5 horizontal side slopes. Total excavation is estimated at 124,280 cubic yards of soil and rock and 1,425 cubic yards of concrete rubble. Approximately 720-feet of water lines, 1,490-feet of sanitary sewer lines, 900-feet of gas lines, 1,000-feet of telephone lines, and 1,000-feet of electric lines will be relocated. In addition, seven existing bridges will be replace, and three residential structures, one commercial structure, and two sheds will be removed to accommodate construction. In addition to the structures, approximately 73.38-acres of lands will be acquired in fee or as a temporary or permanent easement. The disposal area is within an existing city landfill located 7.5--miles southeast of the middle of the project area. The recommended plan will reduces expected annual flood damages by 86-percent.

The recommended plan provides beneficial impacts to the human environment by providing flood damage protection. The recommended plan will adversely impact 9.98-acres of riparian forest, 0.55 acres of riparian grassland, 3,355-linear feet of low quality aquatic habitat, and 4,505 linear feet of moderate quality aquatic habitat. The environmental mitigation plan identifies 20.7-acres of restored riparian forest and the preservation of 1.35-acres of riparian grassland. There are no impacts to known or suspected cultural resources.

The possible consequences of the recommended plan have been considered in accordance with Sections 404 and 401 of the Clean Water Act. The recommended plan would be specified as complying with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects to the aquatic ecosystem and to implement and abide by the mitigation plan in this document. The recommended plan is in compliance with Section 401 of the Clean Water Act.

Based upon the Environmental Assessment and results of coordination, I have concluded that the proposed action would not have a significant adverse effect on the human or natural environment. Consequently, construction of the recommended plan would not constitute a major Federal action of sufficient magnitude to warrant the preparation of an Environmental Impact Statement.

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John R. Minahan
Colonel, Corps of Engineers
District Engineer

Date_____

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