Appendix A

Economic Analysis

INTRODUCTION

PURPOSE

Flood damages analyses were conducted to quantify single event and average annual flood damages under with and without-project conditions The without-project damages and costs are compared to the residual damages and costs expected to occur under with-project conditions (alternatives), the difference being the economic (monetary) benefit attributable to the alternatives. Future increases in flood damages resulting from additional development within the watershed, manifesting itself either 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.

STUDY AREA

Each stream that affects flooding in the city of Wharton is segmented into reaches based on hydraulic, economic, and physical characteristics within the city. The purpose of creating reaches is to simplify the assessment of existing and future conditions. Table A-1 displays the reach designations by stream stationing. A maps delineating all reaches is shown in Figure A-1. The majority of residential structures in the study area have concrete slab foundations. The terrain in most of Texas is flat, with relatively poor drainage.

Table A-1 Economic Reaches

River	Reach	Downstream Station	Upstream Station
Colorado	Below Bus 59	217669.00	342573.00
	Above BUS 59	342574.00	358435.00
Baughman Slough	Below Alabama	8609.00	13267.00
	Alabama to Bus 59	13267.01	19088.00
	Bus 59 to HWY 59	19088.10	26679.00
	Above HWY 59	26679.01	55815.00
Caney Creek	Crestmont	1000.00	9499.99
	South of HEB	9500.00	25940.99
	Wharton	34022.42	45000.00
	Outfall	45000.01	57000.00
	US 59 to 102	57000.01	67000.00
	Above US 59	67000.01	90000.00
Peach Creek	Below Alabama St	56373.00	57015.94
	Alabama to Bus 59	57016.00	64285.80
	Bus 59 to HWY 59	64285.81	66934.00
	West of HWY 59	66934.01	131455.00

This page intentionally left blank.

Insert Figure A-1

This page intentionally left blank

SOCIO-ECONOMIC OVERVIEW

Wharton County is bounded by Colorado County, Austin County, Fort Bend County, Brazoria County, Matagorda County, and Jackson County. It encompasses an area of 1,095 square miles. The city of Wharton, Texas, is located near the center of the county and is the county seat of Wharton County. The city of Wharton lies approximately 55 miles southwest of Houston, 142 southeast miles of Austin, 173 miles east of San Antonio, and 200 miles from Corpus Christi. It is bounded by U.S. Highway 59 to the west and the Colorado River to the south.

Wharton is home to the largest PVC film calendar plant in the United States. Located on U.S. 59 and the future Interstate 69, with direct access to Mexico, it also has an excellent medical center serving six counties. Wharton County is one of the largest rice producing counties in the United States, and it also leads in corn and grain sorghum. It has an airport located near the city.

Wharton County had a population of 41,331 in 2000, an increase of 3% over 1990. The 2003 population ranked 70th out of 254 counties in the state of Texas. In 2003 Wharton had a per capita personal income (PCPI) of $24,197. This PCPI ranked 95th in the state and was 83 percent of the state average, $29,074, and 77 percent of the national average, $31,472. The 2003 PCPI reflected an increase of 1.1 percent from 2002. The 2002-2003 state change was 1.2 percent and the national change was 2.2 percent. In 1993 the PCPI of Wharton was $16,616 and ranked 111th in the state. The 1993-2003 average annual growth rate of PCPI was 3.8 percent. (http://www.bea.doc.gov/bea/regional/bearfacts/)

In 2000, the county's population was approximately 53% Anglo, 31% Hispanic, and 15% African-American. 54.1% of Wharton County residents were between the ages of 20-64, 32.1% were under 20 years of age, and 14% were over 65. The population of the city of Wharton is approximately 10,000, with the city serving an area of approximately 19,000 residents.

The entire city of Wharton is situated within the 500-year floodplain, and the majority of it is within the 100-year floodplain of the Colorado River. The construction of Mansfield Dam (Lake Travis) in 1940 decreased the peak flows of the Colorado River through the city of Wharton, but it did not eliminate flooding.

STRUCTURAL AND VEHICULAR FLOOD DAMAGE COMPUTATION PROCEDURE

METHODOLOGY

The theoretical computation of flood damages is relatively straightforward. It is based on the depth of flooding for various flood events (exceedance probabilities), and a relationship between the depth of flooding and the estimated damages based on a percentage of the structure and content, or vehicle value. Damages to the various 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 exceedance probabilities. This is then repeated for the range of flood events in each damage category. The nomenclature used in this appendix to describe the relative risk reflects the actual probability, rather than the average recurrence interval, of flood events. For example, the commonly used term "100-year frequency flood", meaning that flood which stands a one percent chance of being equaled or exceeded in any given year, will hereafter be known as the "1 percent annual chance exceedance (ACE) flood."

HYDROLOGIC ENGINEERING CENTER- FLOOD DAMAGE ASSESSMENT (FDA) PROGRAM

The Hydrologic Engineering Center-Flood Damage Assessment (HEC-FDA) Program is used to compute flood damages under without- and with-project conditions. The program integrates hydrologic, hydraulic, and characteristics through application of a Monte Carlo simulation, and computes single event and expected annual damages while accounting for risk and uncertainty in the basic values. Damage susceptibility factors used by the program to estimate flood damages include 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.

Geographic Information System (GIS) technology was used extensively in the storing and manipulation of structure data used in conjunction with the HEC-FDA program. Aerial photographs of the study area were digitized using the state plane coordinate system to create a base map of the study area. The base map displays structure footprints, major physical features of the study area such as bodies of water, buildings, structures, roads, bridges, and other physical characteristics. Overlaid on the base map were "layers" of information including topographical contours and elevations, river cross-sections, and property parcel lines using a common coordinate system to assure the overlays were properly oriented. The use of this technology facilitated efforts to enter structure specific data into a spreadsheet format for inputting directly into the HEC-FDA program. This approach allowed for a more efficient storing and manipulation of large amounts of structure data (approximately 12,000 structures county wide) while adding a level of accuracy achieved by having the ability to visually verify the input data as well as corroborate the results generated by HEC-FDA.

Inputs to the model can be described in two major categories; an inventory of property and the hydrologic/hydraulic characteristics of the study area. Each of these inputs is described below.

RISK BASED ANALYSIS IN HEC-FDA

General

Even though every attempt is made to ensure accuracy, a degree of uncertainty is implicit in many areas of planning for water resource projects. The uncertainty arises due to error in the data being measured or errors inherent in the methods used to estimate the values of certain critical variables. The potential for error exists throughout the traditional analysis because each of the variables has been assigned a single point value rather than a range of values. In order to compensate for possible error, risk-based analysis can be applied to the planning and design of water resource projects. This approach, which quantifies the extent of systematic risk, provides the decision-maker with a broader range of information. Thus, a decision can be made that reflects the explicit tradeoff between risks and costs.

Overview of Risk-Based analysis

The Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) computer program was utilized to evaluate flood damages using risk-based analysis. A range of possible values, with a maximum and a minimum value, for each economic variable (first floor elevation, structure and content values, and depth-damage relationships) was entered into the HEC-FDA program to calculate the uncertainty or error surrounding the elevation- or stage-damage curves. The program also uses a representative number of years that stage records were available at a given stream gage to determine the hydrologic uncertainty surrounding the stage-frequency curves. The possible occurrences of each variable were derived through the use of Monte Carlo simulation, which used randomly selected numbers to simulate the values of the selected variables from within the established ranges and distributions. With each sample, or iteration, a

different value was selected. The number of iterations performed affects the simulation execution time and the quality and accuracy of the results.

The sum of all sampled values divided by the number of samples yields the expected value, or mean. This process is conducted simultaneously for each economic and hydrologic variable. When additional sampling does not trigger changes in the mean value, the sampling process stops. The resulting mean value and probability distributions formed a comprehensive picture of all possible outcomes.

INVENTORY OF PROPERTY

An inventory of property was conducted to determine the number and type of structures, structure and content values, and ground and first floor elevations (elevation where water enters the structure). Associated with the inventory is the identification of an applicable flood depth-percent damage relationship for each structure type. Lastly, the privately owned vehicles susceptible to flood were estimated. Each is described in detail in the following paragraphs.

NUMBER AND TYPES OF STRUCTURES

Structure types are defined as residential, residential outbuildings (garages, sheds, and other buildings near the main residence), commercial, industrial, public, and agricultural buildings (barns, sheds, and other agricultural use buildings). Residential structures are further broken down as single-family, or multi-family, and mobile units. These are further broken down by the number of stories, split level, and with- or without-basements.

The total number of structures in the study area was determined using aerial photography overlaid with flood plain delineations. A visual survey was conducted to verify the number and type of structures. All accessible structures in the study area flood plain were observed and structure types recorded. If the structures were not accessible, the types of structures were determined using the assumption that certain types of buildings fall within square footage ranges. Square footage figures were taken from the digitized aerial photographs. A summary of the square footage assumptions is presented in Table A-2.

Table A-2
Structure Type Based on Square Footage

Area (sq. ft.)	Type of Structure
Less than 300	Shed
300 to 600	Garage
600 to 900	Mobile Home
900 to 4000	Residential – Single Family
4000+	Commercial/Industrial/Public

During the visual survey, when structures were observed to be new or under construction (not on the aerial photographs or on the map), they were photographed and their data added. Some information about structure address, type of construction material (stone, brick, wood siding, etc), and size was collected when tax records were attached.

STRUCTURE VALUE

Structure values used in the analysis reflect the replacement cost less depreciation to the existing (pre-flood) structure. Replacement cost is the cost of physically replacing (reconstructing) the structure. Depreciation accounts for deterioration occurring prior to flooding, and variations in remaining useful life of the structure.

Residential, commercial, and industrial structure values were obtained from county appraisal districts. Property parcel maps were overlaid on the aerial photography resulting in each property having a corresponding identification number. This identification number allowed the parcel to be linked to the appraisal district data. In some instances, the appraisal district data listed a single structure value for property on which several structures were located requiring an apportionment of the total value to several structures. Structure values for public structures could not be obtained from the appraisal district. Owners of public structures (churches, schools, municipalities, etc.) were contacted directly to obtain structure values, which were based on the structures insured value. In instances where the appraisal district had no record of a particular structure, values were determined using the Marshall and Swift construction cost manual or the average square foot price of similar type structures.

CONTENT VALUES

Content values for one- and two-story, no basement, residential structures are correlated to the structure value and embedded within depth-percent damage relationships based on data collected at the national level. The value of residential outbuildings was determined by obtaining data from the appraisal districts for those that broke out values for multiple features on the same parcel. A square foot value was determined from this data and applied to each outbuilding. This methodology is sufficiently accurate, partially because there are basically no basements in Texas, with similar construction costs on residential structures, as well as outbuildings. Also, the area is sufficiently flat terrain, meaning the first floor elevations are likely to be very similar.

Commercial and industrial content values were obtained from the appraisal districts. Public content values were obtained directly from the entities involved. In the absence of commercial, industrial, and public contents value data from the appraisal district or directly from the owner, estimates of content values were based on the proportion of content value to structure value for similar structures in the study area with known structure and content values. These proportions were developed for specific structure types, sizes, business or activity, and applied to the structure value to estimate a specific content value for each structure.

Ground and First Floor Elevations

The elevation at which water first enters an opening (door, window, etc.) in the structure is typically referred to as the first floor elevation. This elevation can be obtained in two ways. The first is to conduct a structure specific survey to determine this elevation. The second is to measure, estimate, or assume ground elevation at the structures and either measure, estimate, or assume the vertical distance to the first floor (a first floor correction.)

First floor elevations were determined by estimating the ground elevation at each structure from topographic mapping. A visual estimate of the vertical distance to the first floor was then made. Prior to incorporating this technique for the Wharton study area, a pilot study was done as part of the overall Lower Colorado River Basin study in the city of Marble Falls (Burnet County) to determine the accuracy and efficiency of this method. More precise measurements of the first floor correction were performed by field survey within Marble Falls, and

compared with the first floor corrections estimated with a visual survey. The average error associated with the visual estimation of floor corrections is 6 inches. The conclusion reached was that the visual survey produced results sufficiently accurate for this investigation. Consequently, first floor corrections were estimated using this technique for the entire Lower Colorado River study area within the 1-percent ACE flood plain, and specifically for all of Wharton County.

During the pilot study, maximum and minimum ground elevations were determined for each structure, and compared to the estimated first floor correction. First floor corrections observed from the high side had few problems. However, in most cases where a floor correction was observed from the low side, the recorded figure was less than the difference between the maximum and minimum. In those cases, adding the recorded floor correction to the recorded side of the building gave an artificially low start to damages. The only reasonable method to correct this without a new survey was to make a few basic assumptions. They were:

- If the floor correction was taken at the low ground side, the low side ground elevation plus the recorded floor correction had to total at least as much as the maximum ground elevation. If this was not true, the floor correction needed adjusting. Further assumptions were based on types of structures and use. Assumptions made would give the lowest realistic floor correction for the type and use of each structure.
- All sheds and barns that did not have floor corrections higher than the maximum ground elevation were assumed to have zero floor corrections on the high side.
- Slab houses in central Texas have an average foundation thickness of approximately 6 inches above the ground. Six inches was added to all high side elevations unless there was already an estimate from the field that was in excess of or reasonably close to 6 inches.
- Detached garages were assumed to have similar support requirements as a single-family house.
- In reaches where the average recorded high side floor correction exceeded the minimum (for any type of structure), that average was used.
- Certain types of commercial buildings and most warehouses generally have some kind of a loading dock on the low side of the building. The back opening of a truck is at least 3 feet off the ground, so 3 feet was used as the floor correction on the low side for structures that could be identified as needing a loading dock.
- Mobile homes in the State of Texas are required by law to have a minimum of 30 inches of clearance on some side of the structure. It is unlikely that any other side sits directly on the ground, so mobile homes were given a minimum of three feet on the low side. It was also assumed that any low side measurement had to equal at least the maximum minus the minimum elevations plus 6 to eight inches to raise the structure off the ground on the maximum side.
- Averages were taken by reach for the remaining commercial buildings and public buildings and applied to the high side of structures where data was missing. If no data was available, figures from reaches with similar ground elevation features were applied.

Depth-Percent Damage Relationships

Depth-percent damage relationships relate the depth of flooding relative to the structure first floor, contents, and vehicle damages, as a percent of the estimated value. Depth-percent damage relationships can be based on specific data regarding the structure, contents, and expected damages; however, in most cases generalized relationships are used. For this

analysis, generalized curves for one and two-story (without basement) residential structures were developed by Institute for Water Resources from flood events that occurred in various parts of the United States. For the remaining structure types, the relationships used in this study are base generalized curves compiled by the U.S. Federal Emergency Management Agency, Flood Insurance Administration. Table A-3 displays the depth-percent damage relationship for the most prevalent structure type (single story residential – no basement) in the study area. This curve was used for both the main structure and applicable outbuildings if none existed for the specific type of structure.

Table A-3
Depth-Percent Damage Relationship for Residential Structure*

	Percent Damage			Percent Damage	
Stage	Structure	Contents[(1)]	Stage	Structure	Contents[(1)]
-2	0.0	0.0	9	70.5	37.2
-1	2.5	2.4	10	73.2	38.4
0	13.4	8.1	11	75.4	39.2
1	23.3	13.3	12	77.2	39.7
2	32.1	17.9	13	78.5	40.0
3	40.1	22.0	14	79.5	40.0
4	47.1	25.7	15	80.2	40.0
5	53.2	28.8	16	80.7	40.0
6	58.6	31.5	20	85.0	50.0
7	63.2	33.8	30	85.0	60.0
8	67.2	35.7	40	85.0	70.0

[(1)]As a percent of the structure value.
* IWR damage curves for single family without basement structures.

Privately Owned Vehicles

Damages for automobiles were therefore estimated based on the average number of vehicles per residence characteristic of the study area, and the probability of their being present at the time of a flood. An analysis was made of registered motor vehicles per occupied housing unit for counties within Metropolitan Statistical Areas (MSA) in Texas. The number of registered vehicles per occupied housing unit in MSA clusters around a mean value of 2.48. Given that not all registered motor vehicles are associated with private residences, and some housing units are unoccupied, an average of 2.0 vehicles per residence is assumed for this analysis. It is anticipated that 1.5 of these would be present during non-work hours (128 hours per week) and 0.5 present during work hours (40 hours per week). The expected number of vehicles present at any given time that a flood might occur would therefore be:

$$V = ((128/168)*1.5)+((40/168)^{*}0.5)$$

or 1.26 expected vehicles per residence. For simplicity and conservatism, it is assumed that one vehicle per residence would be present at the time of a flood. This vehicle is assumed to be at the same location, stream station and ground elevation as the structure with which it is associated. Damages start when flooding reaches one foot above the ground elevation.

A vehicle is usually the single most valuable item of personal property, and the most mobile. However, the majority of urban areas experience flooding with little or no warning time. Consequently, substantial vehicle damages are typically observed.

Field observations suggest a positive correlation between the value of a residential structure and the value of the associated vehicle. However, the relationship is not proportional,

since low-valued structures can be associated with vehicles worth as much as the structure itself. Likewise, the most affluent residence can be associated with a vehicle worth a tenth of the value of the structure. A plausible average value for a vehicle results by assuming the following relationship for detached single-family residences:

$$V = (0.15*S)+1000$$

where V is the vehicle value and S is the value of the residential structure. A residence, with a structure value in the range of $60,000 to $100,000, would have a vehicle worth $10,000 to $15,000. This is consonant with field observations and consideration of the average age of the private vehicle stock (five years), the corresponding depreciation (about fifty percent), and the average vehicle cost when new. An exception to this general formula results with mobile homes due to the lower structure. The assumed relationship for mobile homes is:

$$V = (0.2*S)+1000$$

The foregoing set of assumed relationships, although hypothetical is considered realistic and a sufficient basis for planning purposes. Table A-4 displays the depth-percent damage relationship applied to privately owned vehicles.

Table A-4
Depth-Percent Damage Relationship for Vehicles

Stage	Percent Damage
0[(1)]	20
1	50
2	80
3	100
5	100

[(1)]Zero stage relates to the elevation at which water first begins to effect the vehicle, and is assumed to be 1-foot above the ground elevation. The damage curve is the same one used in the New Orleans, Louisiana, Corps of Engineers.

STRUCTURAL & VEHICULAR FLOOD DAMAGE RESULTS

FLOOD PROFILES AND PROBABILITY OF FLOOD EVENTS

A full range of without-project water surface profiles were developed. They include the 50-, 20-, 10-, 4-, 2-, 1-, 0.4-, and 0.2 percent annual chance exceedance (ACE) flood events (or the 2-, 5-, 10-, 25-, 50- 100- 250-, and 500 year respectively.)

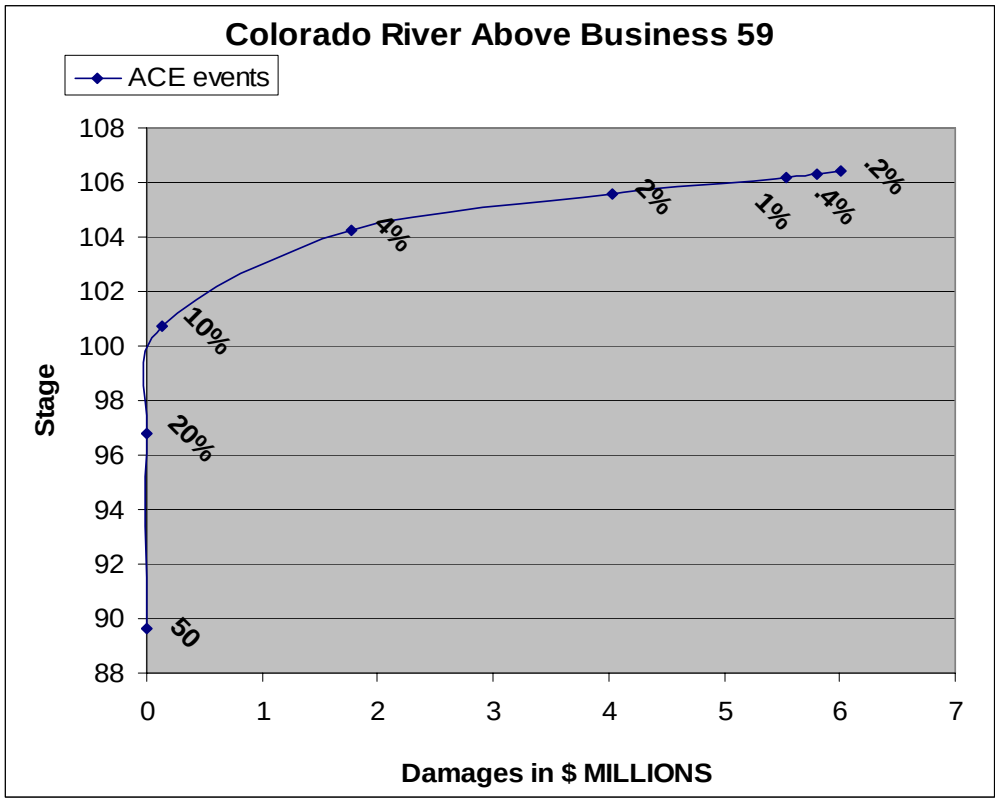
The profiles were used to delineate the flood limits, and determine the relationship of damageable properties to both elevation and frequency of flood occurrence. Satisfactory development of the hydraulics model is a multi-stage iterative process in which the reasonableness of the resulting economic effects assists in the refinement of the hydrology and hydraulics models. For example, if the initial results of the FDA analysis indicate frequent damage to many structures in a given reach, when there is no such history, then adjustments to the hydrology and/or hydraulics models may be in order.

Graphs of the stage damage functions for reaches on the Colorado River and Baughman Slough are presented in Figures A-2 through A-4. The Figures show the damage function for

each of six reaches as HEC-FDA aggregates the structural damage at a representative river station within each reach. This is called the index location station. This procedure allows the program to estimate expected damage values for each of the eight ACE events by depth and frequency event.

Figure A-2

Colorado River Reaches
Stage Damage Curves



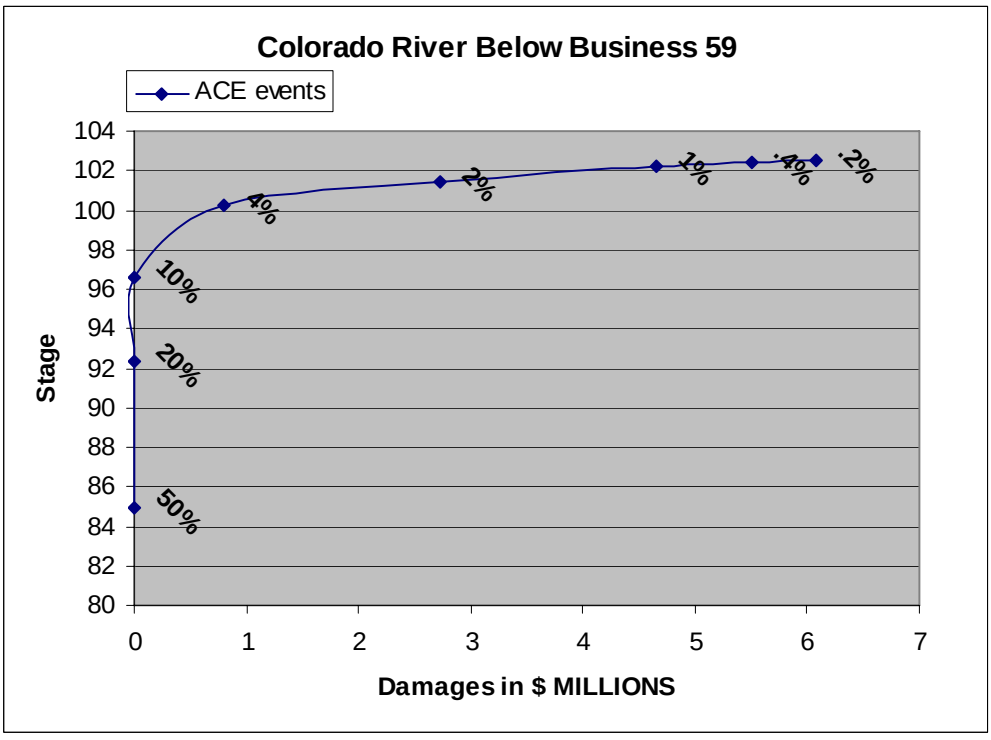
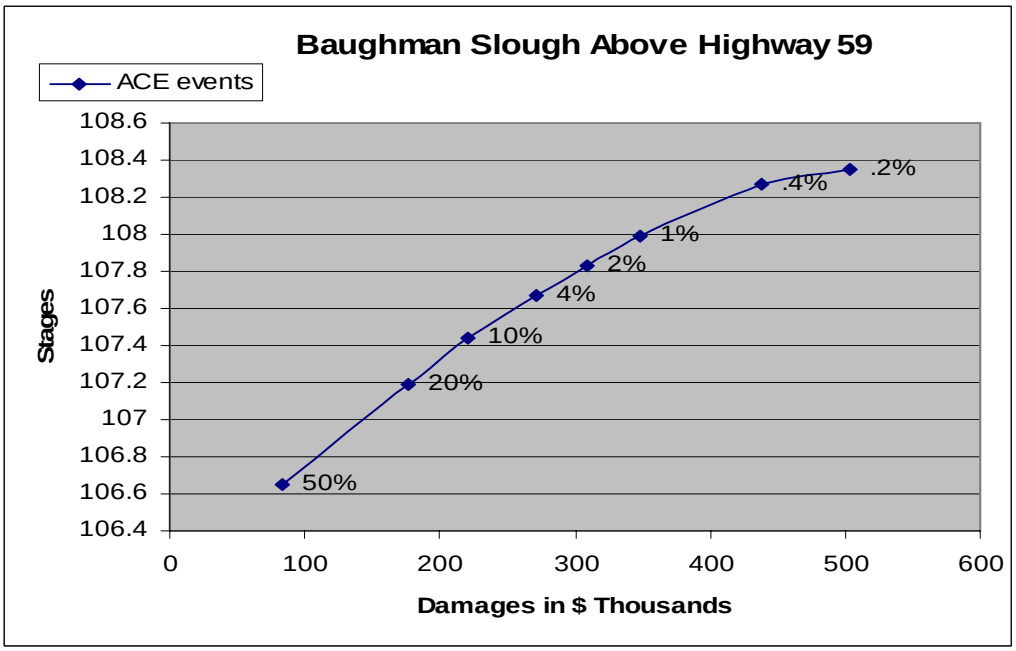


Figure A-3
Baughman Slough Reaches Above Business 59
Damage Curve



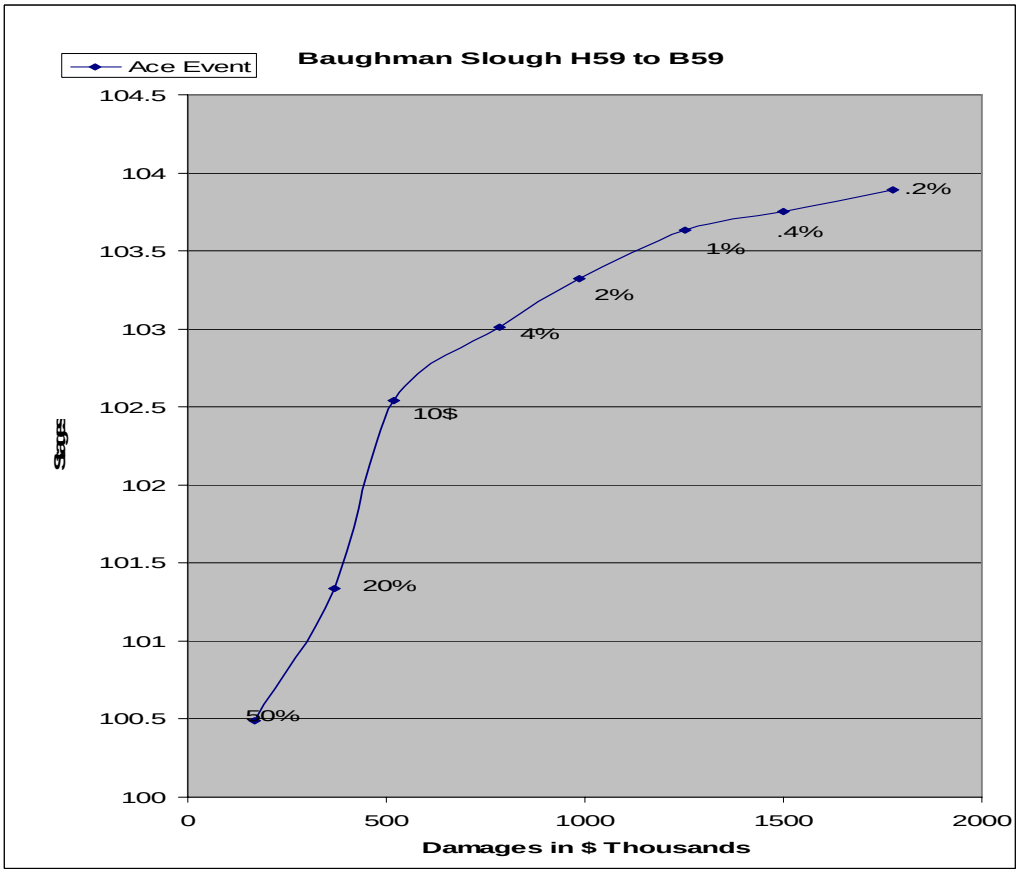
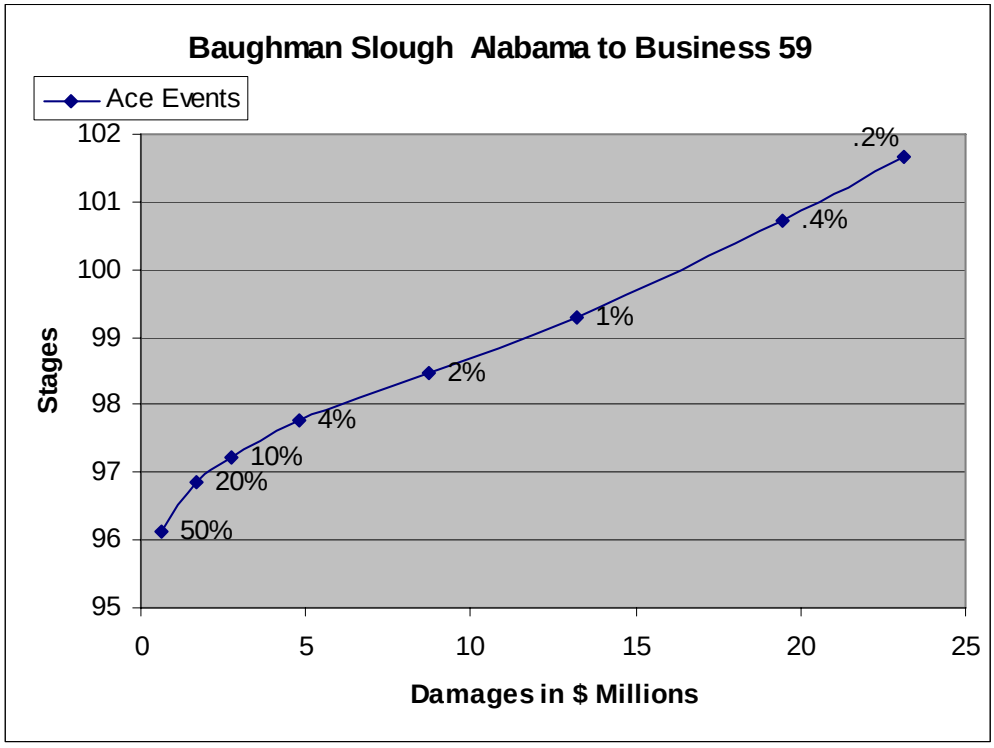
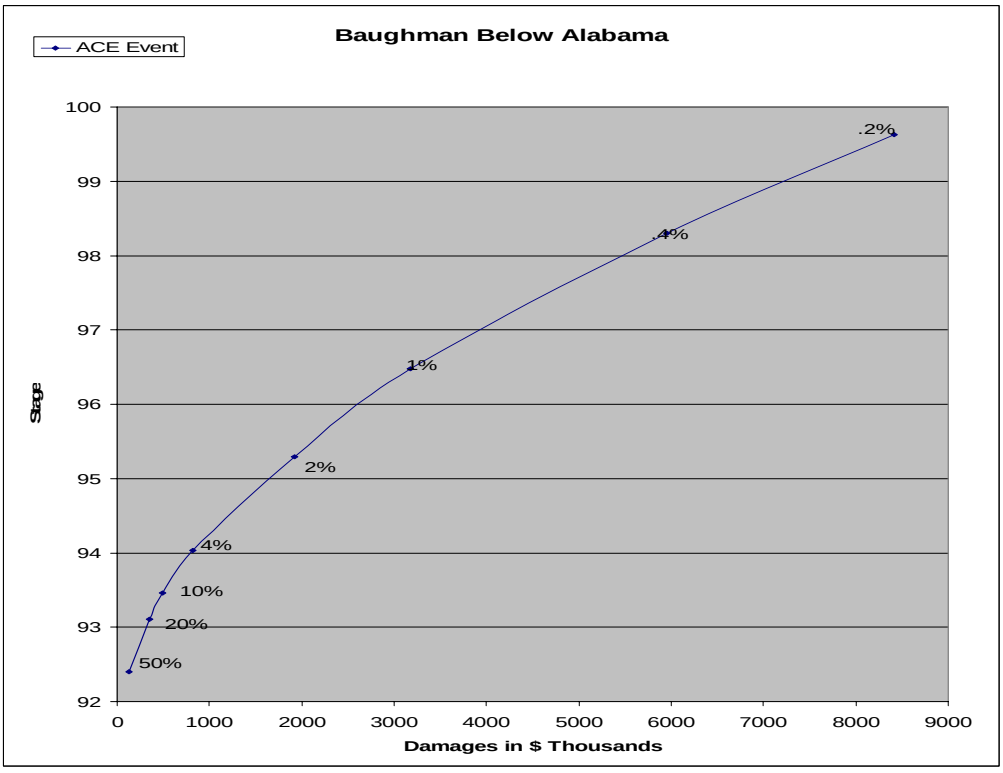


Figure A-4
Baughman Slough Reaches Below Business 59
Stage Damage Curve





VALUE OF FLOOD PLAIN INVESTMENT

There are 5,703 structures and their associated vehicles that are expected to receive damages within the 0.2% ACE. The total estimated value of these structures and their associated vehicles* is in the 0.2% ACE flood plain is $225,069,000. Tables A-5 A-D display a summary of value of the flood plain properties, not including vehicles, for 0.2% ACE flood plain.

* Actual number of vehicles have not been counted. Vehicle value is estimated per the previous discussion and is estimated to be $22,086,000.

Table A-5A

Number and Value of Structures by Stream and Reach
October 2004 Prices and Level of Development
(Values in $1,000s)

Stream/Reach	Structure Data		
Name	**Category**	**Value**	**Number**
Colorado			
Above Business 59	Commercial	$7,571	35
	Multi-family	$1,105	4
	Mobile Home	$687	100
	Public	$4,006	17
	Single Family Outbuilding	$666	208
	Single Family	$6,833	484
Reach Total		***$20,868***	***848***
Below Business 59	Commercial	$5,612	72
	Multi-family	$187	4
	Mobile Home Outbuilding	$6	1
	Mobile Home	$1,161	104
	Public	$1,012	17
	Single Family Outbuildings	$4,389	654
	Single Family	$21,116	691
Reach Total		***$33,484***	***1,543***
Stream Total		***$54,353***	***2,391***

Table A-5B

Number and Value of Structures by Stream and Reach
October 2004 Prices and Level of Development
(Values in $1,000s)

Stream/Reach Name	Structure Data		
	Category	**Value**	**Number**
Baughman Slough			
Above Highway 59	Commercial	$45	1
	Mobile Home	$34	5
	Single Family Outbuilding	$794	49
	Single Family	$1,793	57
Reach Total		***$2,666***	***112***
Alabama to Business 59	Commercial	$4,689	69
	MFR	$653	4
	Mobile Home	$842	78
	Public	$47,185	38
	Single Family Outbuilding	$1,527	365
	Single Family	$20,220	576
Reach Total		***$75,116***	***1,130***
Below Alabama	Commercial	$314	13
	Multi-family	$2,517	14
	Mobile Home	$157	15
	Public	$5,562	19
	Single Family Outbuilding	$2,701	220
	Single Family	$9,311	214
Reach Total		***$20,562***	***495***
Business 59 to Highway 59	Commercial	$528	11
	Mobile Home	$71	6
	Single Family Outbuilding	$640	71
	Single Family	$2,232	51
Reach Total		***$3,471***	***139***
Stream Total		***$101,815***	***1,876***

Table A-5 C

Number and Value of Structures by Stream and Reach
October 2004 Prices and Level of Development
(Values in $1,000s)

Stream/Reach	Structure Data		
Name	**Category**	**Value**	**Number**
Caney Creek			
Above US 59	Commercial	$1	1
	Single Family Outbuilding	$0	1
	Single Family	$33	1
Reach Total		***$35***	***3***
Crestmont	Commercial	$7	1
	Single Family Outbuilding	$31	33
	Single Family	$17,781	306
Reach Total		***$17,820***	***340***
Outfall	Commercial	$223	9
	Multi-family	$1,693	10
	Mobile Home	$472	47
	Single Family Outbuilding	$291	13
	Single Family	$1,532	44
Reach Total		***$4,211***	***123***
South of HEB	Commercial	$6	1
	Multi-family	$99	1
	Mobile Home	$44	4
	Public	$1	1
	Single Family Outbuilding	$62	40
	Single Family	$5,139	86
Reach Total		***$5,351***	***133***
Wharton	Commercial	$584	22
	Mobile Home	$104	4
	Public	$461	8
	Single Family Outbuilding	$368	41
	Single Family	$9,373	209
Reach Total		***$10,891***	***284***
Stream Total		***$38,307***	***883***

Table A-5 D

Number and Value of Structures by Stream and Reach
October 2004 Prices and Level of Development
(Values in $1,000s)

Stream/Reach Name	Structure Data Category	Value	Number
Peach Creek			
Alabama to Business 59	Commercial	$104	8
	Mobile Home	$12	1
	Single Family Outbuilding	$33	15
	Single Family	$333	9
Reach Total		***$482***	***33***
Below Alabama St	Single Family Outbuilding	$2	2
	Single Family	$148	2
Reach Total		***$151***	***4***
Business 59 to Highway 59	Commercial	$3	2
	Mobile Home	$7	1
	Public	$17	1
	Single Family Outbuilding	$91	6
	Single Family	$83	3
Reach Total		***$201***	***13***
West of Highway 59	Commercial	$644	3
	Mobile Home	$237	17
	Public	$62	3
	Single Family Outbuilding	$2,301	194
	Single Family	$4,429	120
Reach Total		***$7,673***	***337***
Stream Total		***$8,507***	***387***

STREAM STATIONING

Stream stationing is used to interface water surface elevations of various flood events to specific structures. For the Colorado River, an automated process utilizing GIS was used to attach river stationing directly to each structure. For the other streams within Wharton, a stream station was manually assigned to each structure.

SINGLE EVENT AND EXPECTED ANNUAL DAMAGES

The Flood Damage Analysis (FDA) computer program first computes stage-aggregated damages (single event damages) for each plan, year, reach, and damage category. Stage-aggregated damage functions are one the primary functions used to construct a damage-probability function.

The computation of expected annual damages utilizes only the stage-total aggregated damage function, and not the individual components such as structure damage. The expected annual damage is the mean damage obtained by integrating the damage-exceedance probability curve for the damage reach. The damage-exceedance probability function is obtained from the discharge-exceedance probability, stage-discharge, and damage-stage functions derived at a damage reach index location. The inclusion of uncertainty for these variables requires a numerical integration approach (Monte Carlo) be applied. Monte Carlo relies on an exceedance probability analysis of samples of the contributing random variables obtained from the generation of random numbers.

Uncertainty is the estimated amount or percentage by which an observed or calculated value may differ from the true value. The uncertainty distribution is a statistical relationship of possible outcomes that defines the dispersion or variance of errors about the median or “best estimate” of values along a function. Probability distributions are used to quantify errors when using uncertainty analysis. Within FDA, uncertainty for the inventory of property is defined for the first-floor elevation, structure value, and the content-to-structure value ratio.

In this analysis, the uncertainty (normal distribution – standard deviation) for first floor elevations on all structures was estimated to be 0.5-feet. This uncertainty was based on actual observations taken as discussed in the previous discussion of ground and first floor elevations, and is consistent with Corps’ guidance. For the residential structures using the Corps’ generalized depth-percent curves, uncertainty in structure values and the content-to-structure value ratio is not quantified as these uncertainties are already accounted for in the curves. For all other structure types, uncertainties for structure values and the content-to-structure value ratios, based on professional judgment and previous studies, are between 5- and 10%.

Tables A-6A through A-6D display a summary of the number of structures and amount of flood damages within each ACE flood plain (single event damages). Table A-7 displays a summary of the expected annual damages, by category and reach. A brief discussion of damages is discussed below.

Table A – 6A
Colorado River Single Event Damages
Structures and Contents
October 2004 Price and Development Levels - Values in 1000s

Stream/ Reach	Structure	50%		20%		10%		4%		2%		1%		0.40%		0.20%	
Colorado	Type	No.	Damage	No.	Damage	No.	Damage	No.	Damage	No.	Damage	No.	Damage	No.	Damage	No.	Damage
Above	Commercial	0	$0	0	$0	0	$0	4	$10	16	$660	22	$934	27	$1,075	27	$1,203
Business 59	Multiple Family	0	$0	0	$0	0	$0	0	$34	1	$178	2	$258	3	$304	4	$342
	Mobile Home	0	$0	0	$0	0	$0	15	$35	45	$89	56	$113	60	$124	62	$137
	Public	0	$0	0	$0	0	$0	5	$378	8	$434	10	$488	11	$515	11	$533
	Single-Family	0	$0	0	$0	6	$16	222	$683	381	$1,507	437	$1,822	467	$1,962	496	$2,096
	POVs	0	$0	0	$0	4	$3	165	$228	284	$574	326	$723	348	$796	370	$862
Total		**0**	**$0**	**0**	**$0**	**6**	**$19**	**246**	**$1,368**	**451**	**$3,442**	**527**	**$4,338**	**568**	**$4,776**	**600**	**$16,335**
Below	Commercial	0	$0	0	$0	0	$0	7	$2	16	$24	33	$55	49	$74	58	$106
Business 59	Mobile Home	0	$0	0	$0	0	$0	3	$5	9	$18	10	$24	12	$27	13	$29
	Public	0	$0	0	$0	0	$0	1	$2	3	$3	7	$20	8	$32	9	$45
	Single-Family	0	$0	0	$0	1	$6	210	$537	605	$1,992	709	$2,755	757	$3,168	830	$3,567
	POVs	0	$0	0	$0	0	$0	156	$108	451	$402	528	$556	564	$639	618	$719
Total		**0**	**$0**	**0**	**$0**	**1**	**$6**	**221**	**$654**	**633**	**$2,439**	**759**	**$3,410**	**826**	**$3,940**	**910**	**$4,466**
Colorado Structure Totals		**0**	**$0**	**0**	**$0**	**7**	**$25**	**467**	**$2,022**	**1084**	**$5,881**	**1286**	**$7,748**	**1394**	**$8,716**	**1510**	**$20,801**

Table A-6B

Single Event Damages – Baughman Slough

October 2004 Price and Development Levels - Values in 1000s

Stream/ Reach	Structure	50%		20%		10%		4%		2%		1%		0.40%		0.20%	
Baughman	Type	No.	Damage	No.	Damage	No.	Damage	No.	Damage	No.	Damage	No.	Damage	No.	Damage	No.	Damage
Above	Commercial	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$8	1	$10
Highway 59	Mobile Home	1	$1	1	$2	2	$2	2	$3	2	$3	2	$3	3	$3	3	$3
	Single -Family	27	$53	47	$100	50	$117	54	$130	58	$144	60	$158	63	$170	66	$183
	POVs	20	$11	43	$20	50	$24	54	$21	60	$29	61	$32	63	$35	65	$37
Total		**28**	**$65**	**48**	**$122**	**52**	**$143**	**56**	**$154**	**60**	**$176**	**62**	**$193**	**66**	**$216**	**70**	**$233**
Alabama to	Commercial	4	$0	6	$2	7	$13	10	$31	15	$128	36	$291	53	$390	68	$526
Business 59	Multi-Family	0	$0	0	$0	0	$0	0	$0	0	$0	2	$175	2	$258	2	$342
	Mobile Home	0	$0	1	$4	1	$6	2	$7	2	$15	27	$102	44	$194	76	$356
	Public	0	$0	2	$14	3	$40	3	$55	4	$179	29	$3,108	35	$5,069	38	$6,891
	Single-Family	72	$397	178	$945	217	$1,132	229	$1,258	357	$2,007	671	$5,346	833	$8,354	907	$11,650
	POVs	65	$79	66	$190	215	$228	221	$253	310	$404	589	$1,125	661	$1,761	$875	$2,470
Total		**76**	**$476**	**187**	**$1,155**	**228**	**$1,419**	**244**	**$1,604**	**378**	**$2,733**	**765**	**$10,147**	**967**	**$16,026**	**1091**	**$22,235**
Below	Commercial	0	$0	0	$0	0	$0	0	$0	1	$1	1	$5	3	$21	13	$51
Alabama	Multi-Family	0	$0	0	$0	0	$0	0	$0	0	$11	0	$0	0	$0	10	$557
	Mobile Home	0	$0	0	$0	0	$0	0	$0	0	$1	5	$17	11	$40	14	$89
	Public	0	$0	0	$0	0	$0	0	$0	1	$1	9	$4	17	$28	19	$595
	Single-Family	30	$85	52	$179	63	$247	83	$320	172	$886	300	$2,275	345	$3,853	403	$6,051
	POVs	22.5	$17	39	$36	47	$49	62	$64	129	$180	225	$458	258.8	$779	302.3	$1,339
Total		**30**	**$102**	**52**	**$215**	**63**	**$296**	**83**	**$384**	**174**	**$1,080**	**315**	**$2,759**	**376**	**$4,721**	**459**	**$8,682**
Business 59	Commercial	0	$0	3	$0	3	$0	5	$0	5	$3	7	$8	9	$13	11	$24
To Highway 59	Mobile Home	0	$0	0	$0	0	$0	0	$0	0	$0	2	$9	2	$13	6	$16
	Single -Family	39	$134	60	$239	75	$319	84	$423	93	$543	107	$747	108	$850	110	$950
	POVs	29.3	$27	45	$48	56	$64	63	$85	70	$109	80.25	$151	81	$173	82.5	$193
Total		**39**	**$161**	**63**	**$287**	**78**	**$383**	**89**	**$508**	**98**	**$655**	**116**	**$915**	**119**	**$1,049**	**127**	**$1,183**
Baughman Structure Totals		**173**	**$804**	**350**	**$1,779**	**421**	**$2,241**	**472**	**$2,649**	**710**	**$4,644**	**1258**	**$14,014**	**1528**	**$22,011**	**1747**	**$32,333**

Table A – 6C

Single Event Damages – Caney Creek October 2004 Price and Development Levels - Values in 1000s

Stream/ Reach	Structure	50%		20%		10%		4%		2%		1%		0.40%		0.20%	
Caney Creek	Type	No.	Damage	No.	Damage	No.	Damage	No.	Damage	No.	Damage	No.	Damage	No.	Damage	No.	Damage
Above	Commercial	0	$0	0	$0	0	$0	0	$0	1	$1	1	$1	1	$1	1	$1
Highway 59	Single -Family	0	$0	0	$0	0	$0	0	$0	2	$3	2	$5	2	$6	3	$7
	POVs	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0
Total		**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**3**	**$4**	**3**	**$6**	**3**	**$7**	**4**	**$8**
Outfall	Commercial	1	$1	8	$7	10	$16	10	$19	14	$29	14	$32	15	$34	17	$37
	Multi-Family	0	$0	1	$18	2	$83	3	$148	10	$395	10	$456	10	$491	10	$525
	Mobile Home	1	$9	10	$32	16	$54	18	$63	42	$106	45	$120	46	$127	46	$135
	Single -Family	3	$9	13	$73	25	$154	30	$167	39	$299	41	$344	42	$370	48	$394
	POVs	7	$6	43	$136	61	$239	66	$276	71	$425	74	$472	75	$494	76	$516
Total		**5**	**$25**	**32**	**$266**	**54**	**$537**	**62**	**$673**	**106**	**$1,254**	**111**	**$1,424**	**114**	**$1,516**	**122**	**$1,607**
South of HEB	Commercial	10	$2	11	$3	11	$3	11	$3	14	$11	14	$13	14	$13	14	$14
	Mobile Home	0	$0	0	$0	0	$0	0	$0	2	$4	2	$6	2	$6	2	$6
	Public	1	$1	1	$1	1	$1	1	$1	1	$1	1	$1	1	$1	1	$1
	Single-Family	14	$110	27	$181	42	$279	47	$312	78	$621	79	$654	80	$670	82	$687
	POVs	2	$8	3	$11	9	$18	10	$24	63	$221	70	$249	74	$276	79	$311
Total		**25**	**$121**	**39**	**$196**	**54**	**$301**	**59**	**$340**	**95**	**$858**	**96**	**$923**	**97**	**$966**	**99**	**$1,019**
Hwy 59 to 102	Single-Family	0	$0	0	$0	0	$0	2	$2	6	$6	6	$15	6	$20	7	$40
Total		**0**	**$0**	**0**	**$0**	**0**	**$0**	**2**	**$2**	**6**	**$6**	**6**	**$15**	**6**	**$20**	**7**	**$40**
Wharton	Commercial	1	$0	4	$5	8	$11	23	$17	27	$30	27	$31	27	$32	27	$121
	Public	0	$0	0	$0	3	$0	4	$0	5	$7	6	$10	6	$10	6	$11
	Single-Family	55	$643	82	$1,029	92	$1,287	98	$1,440	111	$1,888	113	$1,937	113	$1,942	113	$1,952
	POVs	16	$49	43	$161	51	$245	52	$288	56	$375	58	$392	59	$399	59	$406
Total		**56**	**$692**	**86**	**$1,195**	**103**	**$1,543**	**125**	**$1,745**	**143**	**$2,300**	**146**	**$2,370**	**146**	**$2,383**	**146**	**$2,490**
Crestmont	Commercial	0	$0	0	$0	0	$0	0	$0	1	$0	1	$0	1	$2	1	$4
	Single-Family	4	$268	19	$529	43	$933	50	$1,056	161	$2,251	171	$2,383	176	$2,515	185	$2,646
	POVs	3	$54		$106		$187		$211		$450		$477		$503		$529
Total		**4**	**$322**	**19**	**$635**	**43**	**$1,120**	**50**	**$1,267**	**162**	**$2,701**	**172**	**$2,860**	**177**	**$3,020**	**186**	**$3,179**
Caney Structure Totals		**60**	**$1,160**	**105**	**$2,292**	**146**	**$3,501**	**177**	**$4,027**	**311**	**$7,123**	**324**	**$7,598**	**329**	**$7,912**	**565**	**$8,343**

Table A – 6D

Single Event Damages – Peach Creek

October 2004 Price and Development Levels - Values in 1000s

Stream/ Reach	Structure	50%		20%		10%		4%		2%		1%		0.40%		0.20%	
Peach Creek	Type	No.	Damage	No.	Damage	No.	Damage	No.	Damage	No.	Damage	No.	Damage	No.	Damage	No.	Damage
Alabama	Commercial	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	8	$22	8	$41
To Highway 59	Mobile Home	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$2	1	$6
	Single-Family	0	$0	0	$0	0	$0		$0	1	$6	17	$82	24	$223	24	$296
	POVs	0	$0	0	$0	0	$0		$0	1	$1	13	$16	18	$45	18	$59
Total		0	$0	0	$0	0	$0	0	$0	1	$7	17	$98	33	$292	33	$402
Below Alabama St	Single-Family	0	$0	0	$0	0	$0	0	$0	0	$0	3	$24	4	$65	4	$89
	POVs	0	$0	0	$0	0	$0	0	$0	0	$0	2	$5	3	$13	3	$18
Total		0	$0	0	$0	0	$0	0	$0	0	$0	3	$29	4	$78	4	$107
Business 59	Commercial	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	2	$0	2	$0
To Highway 59	Mobile Home	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$2	1	$5
	Public	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$2	1	$2
	Single-Family	0	$0	0	$0	0	$0	0	$0	0	$0	2	$9	9	$70	9	$119
	POVs	0	$0	0	$0	0	$0	0	$0	0	$0	2	$2	7	$14	7	$24
Total		0	$0	0	$0	0	$0	0	$0	0	$0	2	$11	13	$88	13	$150
West of	Commercial	1	$9	1	$9	1	$10	1	$10	1	$10	1	$11	1	$12	3	$48
Highway 59	Mobile Home	1	$6	2	$13	2	$18	2	$27	3	$39	8	$68	10	$117	11	$148
	Public	0	$0	0	$0	0	$0	0	$0	0	$0	1	$2	2	$4	2	$5
	Single-Family	40	$164	72	$366	112	$659	143	$1,023	156	$1,399	213	$2,473	258	$3,404	293	$4,014
	POVs	30	$34	54	$76	84	$135	107	$210	117	$288	160	$508	193.5	$704	220	$832
Total		42	$213	75	$464	115	$822	146	$1,270	160	$1,736	223	$3,062	271	$4,241	309	$5,047
Peach Structure Totals		42	$213	75	$464	115	$822	146	$1,270	161	$1,743	245	$3,200	321	$4,699	359	$5,706

Table A- 7
Existing Conditions
Expected Annual Damages
October 2004 Price and Development Levels – Value in $1,000s

By Stream and Reach						
Peach Creek	Commercial	Multi-Family	Mobile Home	Public	Single-Family	Total
Below Alabama	0	0	0	0	1	1
Alabama to Business 59	1	0	0	0	9	10
Business 59 to Highway 59	0	0	0	0	1	1
West of Highway 59	7	0	10	0	372	389
EAD	8	0	10	0	383	401
Baughman Slough	Commercial	Multi-Family	Mobile Home	Public	Single-Family	Total
Below Alabama	0	10	1	3	254	268
Alabama to Business 59	43	9	9	186	1027	1274
Business 59 to Highway 59	2	0	1	0	224	227
Above Highway 59	2	0	1	0	93	96
EAD	47	18	12	189	1598	1864
Caney Creek	Commercial	Multi-Family	Mobile Home	Public	Single-Family	Total
South of HEB	5	0	1	0	195	201
Wharton	10	0	0	6	883	899
Outfall	8	34	22	0	120	184
Highway 59 to Business 59	0	0	0	0	3	3
Above Highway 59	1	0	0	0	1	2
Crestmont	0	0	0	0	609	609
EAD	24	34	23	6	1810	1899
Colorado River	Commercial	Multi-Family	Mobile Home	Public	Single-Family	Total
Below Business 59	4	0	2	2	133	141
Above Business 59	33	11	5	37	122	208
EAD	36	11	7	40	255	349

Discussion of Damages

Damages in the Colorado River reaches begin between the 20% and 10% ACE flood events. Significant damages take place by the 4% ACE flood event. The 0.2% ACE flood event affects 1510 structures, 806 vehicles, and results in approximately $9.8 million in damages. Expected annual damages are estimated at $349 thousand of which 73% are attributed to residential structures, contents, and vehicles.

Damages begin at the 50% ACE event in all the Baughman Slough reaches. The most serious damages are in the Alabama to Business 59 reach where 1,091 single-family structures and vehicles receive approximately $19.8 million in damages at the 0.2% ACE event. The 0.2% ACE flood for all reaches in Baughman Slough event affects 1747 structures and 885 vehicles,

and results in approximately $33.2 million in damages. Expected annual damages are estimated at $1,864,000, of which 85% are attributed to residential structures and contents, and vehicles.

Within the Caney Creek reaches, damages begin by the 50% ACE flood event. The 0.2% ACE event affects 566 structures, 300 vehicles, and results in approximately $ 8.3 million in damages. Expected annual damages are estimated at $1,899,000 of which 95% are attributed to residential structures, contents, and vehicles.

Within the Peach Creek reaches, damages begin by the 50% ACE event. Significant damages start between the 20% and 10% percent ACE flood events. The 0.2% ACE flood event affects 359 structures, vehicles, and results in approximately $5.5 million damages. Expected annual damages are estimated at $401,000 of which 95% is attributed to residential structures and contents, and vehicles.

Peach Creek is outside of the city limits; flooding along the creek does not affect damages in other reaches. Since no sponsor was available, further analysis was discontinues.

Probabilistic Methodology of Flood Events

A method used to determine frequency elevations in areas subject to both storm surge and riverine flooding in coastal areas was used for the City of Wharton. This methodology is based on total independence of the two events. The equation used to calculate the frequency of an event considering both local flooding and overflow flooding is:

$$T_{R\ Combined} = 1/(1-(1-1/T_{R\ Local})*(1-1/T_{R\ Overflow})), \text{ where}$$
$$T_{Rx} = \text{Return Period (years)}$$

In order to use this procedure, the local and overflow events must be totally independent. A historical analysis of Colorado River flows and local rainfall indicated that these two events are relatively independent in the Wharton area (A local flood in Wharton is not dependent on high flows along the Colorado River or vice versa.

The methodology was used to derive a composite discharge, which was converted to a composite elevation at each cross section for each frequency. These composite water surface profiles were imported into HEC-FDA in the traditional manner. The process of deriving composite water surface profiles had to be repeated for each alternative, depending on the effect of each specific alternative to the two types of sources. As an example of the probabilistic approach, suppose the 100-year Colorado River OVERFLOW at a selected point of interest produces a WSEL of 99'. Suppose a LOCAL water surface elevation of 99' is produced by a 50-year local event at that same location. By applying the above equation, a WSEL of 99' at the selected point corresponds to a 33.6-year frequency.

For the Colorado River water surface elevations, the probabilistic analysis was not needed. The probabilistic analysis was utilized for points of interest within the study area including: each of the Caney Creek storage areas and the upstream and downstream faces of all bridges along Baughman Slough and Peach Creek.

INVESTIGATED STRUCTURAL PLANS

Alternative plans were examined in a progressive manner starting with a base plan of 100-year levees on both Baughman Slough and the Colorado River. Preliminary screening of alternatives was conducted to identify feasible structural, and nonstructural alternatives. In all, 10 structural plans were analyzed using HEC-FDA. Because many of the components that make up each plan behave independently, these plans were, for formulation purposes, dissected into even

more plan combinations, as shown in Table A-8. Care was taken to insure that all combinations were correctly merged. Table A-8 provides the basis for all formulation presented in Chapter 4 of the main report, and from a formulation perspective is the single most important table in the report.

Table A – 8
Incremental Plan Analyses
Damages in Thousands.

Reach	Without	Plan 1 20% levee Colorado ONLY	Plan 2 1%+1ft Levee on Colorado ONLY	Plan 3 .2% yr levee on Colorado ONLY	Plan 4 1%+1 ft Levees only on Baughman Slough and Colorado	Plan 5 20% levee on Baughman Slough, Colorado Channel	Plan 6 Baughman Slough Levee Colorado 1%+1 ft levee Channel	Plan 7 Baughman Slough Levee Colorado .2%yr +1 levee Channel	Plan 8 Baughman Slough Levees, 75 ' and Channel Colorado Levee (Jones and Carter Design/Rating) Santa Fe Ditch at Crestmont	Plan 9 Baughman Slough Levees, 85 ' and Channel Colorado Levee,	Plan 10 2-60" pipes under Hughes and BS 1%+1ft levee Colorado 1%+1ft levee	Plan 11 3-60" pipes under Hughes and BS 1%+1ft levee Colorado 1%+1ft levee	Plan 12 3-60" pipes under Hughes 2-60" pipes under Richmond, BS and CR 1%+1ft levees	Plan 13 Hughes 3-60" pipes under Street Pipes 2-60" pipes Richmond Rd SF ditch (Jones and Carter Design/Rating)	Plan 14 Plan C plus 3-7'x5' Hughes Street Boxes 2-12'x4' Railroad connection Santa Fe Ditch (Jones and Carter Design/Rating)	Plan 15 Larger SF ditch and 3-7*5 boxes @Hughes and 12*14 RR	Plan 16 3-60" pipes under Hughes 3-60" pipes under Richmond, BS and CR 1%+1ft levees
Peach Creek																	
Below Alabama	1.41	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Alabama to Business 59	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	4.8	9.7
Business 59 to Highway 59	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
West of Highway 59	388.5	388.5	388.5	388.5	388.5	388.5	388.5	388.5	388.5	388.5	388.5	388.5	388.5	388.5	388.5	388.5	388.5
Total	401.1	401.1	401.1	401.1	401.1	401. 8	401.1	401.1	401.1	401.1	401.1	401.1	401.1	401.1	401.1	396.3	401.1
Baughman Slough																	
Below Alabama	267.4	264.6	266.9	185.1	266.9	266.9	145.4	145.4	145.4	142.3	145.4	145.4	145.4	145.4	145.3	145.7	145.4
Alabama to Business 59	1273.3	1114.2	918.4	825.6	473.9	351.4	177.1	177.1	177.1	177.0	177.1	177.1	177.1	177.1	177.1	176.5	177.1
Business 59 to Highway 59	227.6	228.5	177.5	165.6	205.6	205.6	208.4	209	208.4	208.4	208.4	208.4	208.4	208.4	208.4	208.4	208.4
Above Hwy 59	95.7	74	74.9	73.9	102.8	102.8	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0
Total	1864.1	1681.3	1437.9	1250.2	1049.3	926.8	629.1	629.1	629.1	625.9	629.1	629.1	629.1	629.1	629.0	628.7	629.1
Caney Creek																	
South of HEB	201	201	201	201	201	201	201	201	201	201	201	201	201	36.4	36.4	33.2	35
Wharton	899.3	878.1	868.6	868.5	893.4	893.4	893.4	893.4	893.4	893.4	893.4	893.4	269.4	269.3	448.9	434.3	193.3
Outfall	183.5	152.3	146.6	146.6	183.5	183.5	183.8	183.8	183.3	183.3	26.3	7.9	6.0	6.3	0.8	0.8	6.0
US59 to 102	2.8	1.8	1.5	1.5	0.8	0.8	0.8	0.8	0.8	0.8	1.0	0.88	0.8	0.8	0.8	0.8	0.8
Above US 59	1.4	0.8	0.6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.22	0.2	0.2	0.2	0.2	0.2
Crestmont	608.8	608.8	608.8	608.8	608.8	608.8	608.8	608.8	608.8	608.8	608.8	608.85	608.2	51.2	52.8	42.6	51.3
Total	1896.9	1843.02	1827.21	1826.76	1887.8	1887.8	1888.1	1888.1	1887.6	1887.6	1730.8	1712.24	1085.8	364.5	540.1	512.2	286.7
Colorado River																	
Above Business 59	140.2	87.8	17.2	0	17.2	68.2	17.2	0	17.2	17.2	17.2	17.25	17.2	17.2	17.2	17.2	17.2
Below Business 59	208.2	61.4	45.3	0	45.3	60.9	45.3	0	45.3	45.3	45.3	45.32	45.3	45.3	45.3	45.3	45.3
Total	348.4	149.2	62.5	0	62.5	129.2	62.5	0	62.5	62.5	62.5	62.57	62.5	62.5	62.5	62.5	62.5
Grand Total Damages	4109.6	3673.6	3327.7	3077	2999.7	2943.9	2579.8	2517.2	2579.3	2576.1	2422.5	2403.92	1777.5	1056.2	1231.7	1203.5	978.3
Benefits	**Without-no change**	**436**	**781.9**	**1032.6**	**1109.8**	**1165.7**	**1529.7**	**1592.3**	**1530.2**	**1533.4**	**1687.1**	**1705.68**	**2332.0**	**3053.4**	**2877.9**	**2906.0**	**3131.2**

As discussed in the main report, the levee alternatives evaluated for the Colorado River impact all other areas, and as such were logically selected as the first added elements to be evaluated. These were then combined with the independent alternatives on Baughman Slough and finally Caney Creek.

The 1%+1 ft levees were selected for evaluation in both Baughman Slough and the Colorado even though it they did not have the highest net benefits. The 0.2% plan had the highest benefits, but there was no high ground for a tie in of the levees where they ended. The result was that water went around the levees and induced flooding in these areas. With the levee alone, the 100-year water surface elevation in Baughman Slough exceeds the highest point on Junior College Boulevard for the levee to tie-in, and also causes some induced flooding downstream. These problems in the Below Alabama reach are addressed by plans 8 and 9. These two plans are varying channel sizes on Baughman Slough that alleviate existing and induced flooding problems on lower Baughman Slough, and lower the tailwater at the key tie-in area.

Last added are measures to reduce flooding caused by the altered capacity of Caney Creek, which is totally independent of the other streams. Varying the locations and number of pipes or box culverts facilitates alleviation of flooding from water trapped in the downtown area. The investigated plans and their features are detailed in Table A-9. Plans are listed in order of the features added. Maps showing the progression of the selected alternatives are included in the Chapter 4 of the main report.

Table A-9
Investigated Structural Plans

Plan 4 1% Levees **only** on Baughman and Colorado, No Channel on Baughman		**Plan 10** Plan C plus 2-60" pipes under Hughes to the Colorado
Plan 5 2% levees **only**, Colorado and Baughman Slough. No Baughman Channel		**Plan 13** Plan C plus 3-60" pipes under Hughes, 2-60" pipes down Richmond to the Colorado, Santa Fe ditch
Plan 8 1% Levees, 75 ‘ bottom width channel on Baughman Slough,		**Plan 15** Plan C plus 3-7'x5' Hughes Street Boxes. 2-12'x4' Railroad connection Santa Fe ditch
Plan 9 1% Levees, 85 ‘ bottom width channel on Baughman Slough,		**Plan 16** Plan C plus 3-60” pipes under Hughes, 3-60" pipes down Richmond to the Colorado, Santa Fe ditch

No plans were investigated for the Peach Creek reaches. The creek is outside of the city of Wharton. There was not a sponsor to pursue a project in these reaches.

COLORADO RIVER AND BAUGHMAN SLOUGH ALTERNATIVES

Flooding from the Colorado River spills both Caney Creek and Baughman Slough floodplains at some ACE event. If the Colorado River floods at the same time as either of these streams, flooding problems will be exacerbated. The Colorado River however, is independent of effects from the flooding on all other systems. It is the only totally independent source of flooding

within the city. Therefore, the first added component analyzed was a levee on the Colorado River. It must be clarified here that the adding on and sizing of alternatives are as interdependent as the probabilistic flooding. Since the Colorado River exacerbates flooding in other reaches, its alternatives will diminish those effects. To demonstrate the effect that the Colorado River has on other reaches, FDA runs were made using non-probabilistic water surface profiles for Caney Creek and Baughman Slough. EAD for the without project condition, NON probabilistic flows are presented in Table A-10. That is, damages in Baughman Slough and Caney Creek are broken out by causal flows for each reach.

Table A-10
EAD Without Project Conditions
EAD Broken down by Causal River and Reach
October 2004 Development and Price Levels – Values in 1000s

Colorado River		Peach Creek	
Below Business 59	$141	Below Alabama	$1
Above Business 59	$208	Alabama to Business 59	$10
Total	$349	Business 59 to Highway 59	$2
		West of Highway 59	$389
		Sub total	$401
		Colorado River Effects	
		None differentiated (no effect)	
Total Colorado River	$349	Total Peach Creek	$401
Caney Creek		Baughman Slough	
South of HEB	$201	Below Alabama	$268
Wharton	$868	Alabama to Business 59	$918
Outfall	$147	Business 59 to Highway 59	$210
59 to 102	$2	Above Highway 59	$75
Above Highway 59	$1	Sub total	$1471
Crestmont	$608		
Sub Total	$1827		
Colorado River effect		Colorado River effect	
South of HEB	$0	Below Alabama	$1
Wharton	$31	Alabama to Business 59	$355
Outfall	$36	Business 59 to Highway 59	$17
59 to 102	$1	West of Highway 59	$21
Above Highway 59	$0	Sub total	$394
Crestmont	$0		
Sub total	$58		
Total Caney Creek	$1895	Total Baughman Slough	$1865

A detailed analysis of single event damages and EAD for these reaches has been presented in Tables A-6 and A-7. Effects caused by the Colorado River alone were detailed in the Lower Colorado River Basin, Basin Wide Feasibility Study.

Three sections of levee were evaluated along the Colorado River. For design and estimating purposes, the levee was divided into five segments. Economic evaluation was,

however, performed utilizing only two reaches. Levee heights at the two index points were at elevation 106.93 and 113.19 Feet, respectively, for the 1% + 1ft ACE Colorado River levees (Plan A). Levee heights at the two index points were at elevation 106.75 and 102.8 feet, respectively, for the 2% ACE Colorado River levees (Plan B). The 0.2% levee was evaluated, but eliminated as a possibility due to lack of a location with sufficient ground elevation with which to join it. The 1%+1ft ACE levee was selected as the first added component.

The second selected component was chosen from an array of levee heights in the Alabama to Business 59 reach of Baughman Slough. The proposed Baughman Slough levee is a grass lined earthen structure on the right bank of Baughman Slough in the Alabama Road to Business 59 reach. Levees were evaluated for the 2%- and the 1% +1 ft ACE events in this reach. The heights of those levees are 97.4 and 97.9 feet respectively. Implementation of the 1% levee would reduce EAD in the reach from $1,273,000 to $473,900, or 63%, in this reach. The effectiveness of the 1% levee was restricted, due to the lack of a high tie-in point at the downstream end. The levee, however, has little or no effect on other reaches. The Ahldag subdivision is on the right bank of Baughman Slough in the Below Alabama reach. Drainage through this reach is currently not adequate to facilitate water trying to reach Baughman Slough. As a result, 246 homes and outbuildings are damaged when a 4%-ACE flood occurs under existing conditions. To alleviate the existing flooding and drainage problems, two water surface profiles were examined to simulate how adding different channel sizes would decrease the area's flooding problems. Profiles replicating channels of 75- and 85- foot bottom widths were produced and run through the HEC-FDA program.

The without project conditions and several combinations of channel plans were run through the HEC-FDA. Plan 8 was chosen to move forward as the second added component for flood reduction. Plan 8 incorporates the 75-foot bottom width channel into Plan 1the 1% levees on both Baughman Slough and the Colorado River. The channel causes damages to decrease in the Alabama to Business 59 by 23%. That brings total damages reduced in this reach to 86%. Damages in the Below Alabama reach are reduced by 47%, primarily to single-family houses. Table A-11 summarizes Plan 8 and the changes in expected annual damages for each reach affected by the project.

Table A-11
Cost and Benefits of Colorado River Levees
Various Heights by Frequency
Formulation Detail Level, 5.375%, 50 years. October 2004 Prices

Level	*First Cost*	*Annualized Cost*	*Annualized Benefits*	*B/C Ratio*	*Net Benefits*
2%	$4,052,000	$235,000	$436,000	1.9	$201,000
1%	$5,024,000	$291,000	$781,900	2.7	$490,900
0.20%	$6,316,000	$366,000	$1,032,610	2.8	$666,610

The 1%(plus 1 foot) was selected although is does not have the highest net benefits. This is because no higher levee can be constructed that has high ground to serve as a tie in at the end point. Prior to developing further analyses, the water surface profiles were refined to make HEC-FDA results more accurate. Iterations in refining the water surface profile were made as the components were added. Each addition changed the probabilities slightly. A final refinement was made using the probalistic methodology discussed previously, so that the sources

and levels of flooding from all sources was as accurate as possible. Structure and content values remain as originally recorded from the appraisal database.

Table A-12
Expected Annual Damages Comparison**
October 2004 Price and Development Levels - Values in 1000s

Baughman Slough*
Without Project and Plan 8

	Below Alabama				Alabama to Business 59			
	Without	Plan 8	Benefits	Change	Without	Plan 8	Benefits	Change
Commercial	$0	$0	$0		$43	$4	$39	
Multi-Family	$10	$7	$3		$9	$3	$6	
Mobile	$1	$1	$0		$9	$2	$7	
Public	$3	$2	$0		$186	$56	$130	
Vehicles	$21	$15	$7		$99	$23	$69	
Single-Family	$233	$120	$113		$934	$89	$845	
	$268	$145	$123	47%	$1,280	$177	$1,096	86%

Baughman Slough
Without Project and Plan 8

	Business 59 to Highway 59				Above Highway 59			
	Without	Plan 8	Benefits	Change	Without	Plan 8	Benefits	Change
Commercial	$2	$2.0	$0		$2	$2	$0	
Multi-Family	$0.0	$0.0	$0.0		$0	$0	$0	
Mobile Homes	$1	$1	$0		$1	$1	$0	
Public	$0.0	$0.0	$0.0		$0	$0	$0	
Vehicles	$19	$16	$3.0		$3	$4	-$1	
Single-Family	$205	$190	$15		$90	$91	-$1	
	$227	$209	$181	1%	$96	$98	-$3	-2%

Colorado River
Without Project and Plan 8

	Below Business 59				Above Business 59			
	Without	Plan 8	Benefits	Change	Without	Plan 8	Benefits	Change
Commercial	$4	$1	$3		$33	$10	$22	
Multi-Family	$0	$0	$0		$11	$3	$8	
Mobile Homes	$2	$0	$1		$5	$1	$4	
Public	$2	$1	$2		$37	$4	$33	
Vehicles	$17	$3	$14		$32	$8	$24	
Single-Family	$116	$12	$104		$89	$19	$71	
	$141	$17	$124	88%	$207	$45	$162	78%

*Slight differences may exist due to rounding

CANEY CREEK ALTERNATIVES

Caney Creek does not convey water on a constant basis. Most of the year it is a very shallow grass lined bed that runs through the city. Over the years it has been built over and broken into a series of storage areas further impeding any flow that could take water out of the downtown area in case of flooding. Damages in the Outfall Reach are heavy at the more frequent events. Some local drainage is in place to drain water some water from the upper areas of Caney Creek to the Colorado River. Due to rising waters on the Colorado River, a 4%-ACE flood on the river is high enough to prevent drainage of any creek water to the river. A number of alternatives were examined to observe their effects on the Creek and how they changed with different combinations.

Selected Plans in the Caney Creek Reaches

Plan 10

One of several combinations of alternatives examined to find the most cost effective solution for flooding in the Outfall reach was to replace an old 48" drainage pipe that runs under Hughes Street. The first added component was to replace the 48" pipe with 2-60" diameter reinforced concrete pipes.

Plan 13

The next added component was a combination of plans for the Outfall and Wharton and Crestmont reaches. The number of 60" pipes under Hughes is increased from 2 to 3. Increasing the number of pipes from Hughes alleviates 97% of flood damages in that reach.

While the pipes under Hughes Street alleviate nearly all of the flooding in the Outfall reach, they have no affect on the Wharton and Crestmont reaches. The Wharton storage area is located to the east of the Outfall storage area. There is currently an old, built up railroad right of way blocking water flow out of the Wharton reach. To divert flood waters in the Wharton reach, 2-60" pipes were modeled that extend 1,300 feet under Richmond Road ending at the Colorado River. Drainage from these pipes would reduce the EAD in the reach from the $893,000 to $269,000. Over all, the pipes at Richmond reduce EAD by in the Wharton reach by 70%.

The plan for the Crestmont reach is to build a grass lined earthen channel 11- to13-thousand feet long from Santa Fe and Alabama Roads to the C/
olorado River. This plan has been named the Santa Fe Ditch. The channel would carry floodwater away from the Crestmont and Below HEB reaches and direct it into the Colorado River. The upper portion of the channel would have an 8-foot wide bottom width with a side slope of 1 on 4. The remainder of the channel would also have an 8-foot wide bottom width, but with a 1 on 3 side slope. Without project EAD is estimated at $608,800. With project EAD is just over $51,000, or a reduction of 91% of damages.

A second, larger variation of the lower portion of the ditch was investigated, and reduced the damages by an additional $28,000. This, however, was not found to be incrementally justified.

Plan 15

The variation from plan F to plan G is in the Outfall reach. The 3-60" pipes would be replaced by 3-7' x 7' box culverts under Hughes Street. Flood profile were also modeled to simulate 2-12'x4' box culverts, near Sunset and Bolton Streets between the Wharton storage area and the Outfall reach. As previously mentioned, the old railroad bed currently cuts of drainage between Wharton and the Outfall reach. The box culverts create an outlet for floodwater in the Wharton reach. Floodwater flows under the railroad bed into the Outfall reach and eventually into the Colorado River. Expected annual damages in the Wharton reach without project are $899,000. This project would reduce the Wharton reach EAD to $449,000, for a total reduction of 50%. The third component of Plan G, the grass lined drainage ditch alternative at Crestmont, is unchanged.

Plan 16

The final plan evaluated is Plan H. This plan is identical to Plan F, except it increases the number of 60' pipes under Richmond Road to three. In summary, it incorporates the 1%-ACE levee in each of the two reaches on the Colorado River. There is also a 1%-ACE levee planned in the Alabama to Business 59 reach of Baughman Slough. The Below Alabama reach of Baughman Slough will be modified to include a 75' Bottom Width channel. Several alternatives will be constructed in the Caney Creek reaches. Three 60" pipes will replace the current 48" pipe under Hughes Street in the Outfall reach. In the Wharton reach, 3-60" pipes will be built under Richmond Road to the Colorado River. The last section of the plan is a grass-lined channel following the old Santa Fe Railroad ROW that will drain the Crestmont subdivision floodwaters. No action is taken to address Peach Creek. A detailed breakdown of benefits is shown in Table A-12.

Table A-13
Caney Creek Alternative - Plan 16
3-60" pipes at Hughes,
3-60" Pipes Down Richmond, Santa Fe Ditch

Caney Creek Economic Reaches

	South of HEB				Wharton			
	Without	Plan 16	Benefits	Change	Without	Plan 16	Benefits	Change
Commercial	$5	$3	$2		$10	$2	$8	
Multi-Family	$0	$0	$0		$0	$0	$0	
Mobile	$1	$0	$1		$0	$0	$0	
Public	$1	$0	$1		$6	$0	$0	
Vehicles	$11	$0	$11		$96	$12	$84	
Single-Family	$184	$31	$153		$787	$179	$608	
	$202	$34	$168	83%	$899	$193	$706	79%

	Outfall				US59 to 102			
	Without	Plan 16	Benefits	Change	Without	Plan 16	Benefits	Change
Commercial	$8	$0	$8		$0	$0	$0	
Multi-Family	$34	$0	$34		$0	$0	$0	
Mobile	$22	$0	$22		$0	$0	$0	
Public	$0	$0	$0		$0	$0	$0	
Vehicles	$65	$0	$65		$0	$0	$0	
Single-Family	$55	$0	$54		$3	$1	$2	
	$184	$0	$184	100%	$3	$1	$2	67%

	Above US59				Crestmont			
	Without	Plan 16	Benefits	Change	Without	Plan 16	Benefits	Change
Commercial	$1	$0	$1		$0	$0	$0	
Multi-Family	$0	$0	$0		$0	$0	$0	
Mobile	$0	$0	$0		$0	$0	$0	
Public	$0	$0	$0		$0	$0	$0	
Vehicles	$0	$0	$0		$13	$0	$13	
Single-Family	$1	$0	$0		$595	$53	$542	
	$2	$0	$2	100%	$608	$53	$555	91%

Table A-14
Selected Structural Plans 8 and 16
Calculations of EAD by River and Reach
October 2004 Price and Development Levels – Value in $1,000s

	Baughman Slough	Colorado River	Caney Creek
	Plan 8 1% Levees, 75 ' bottom width channel on Baughman Slough		Plan 16 3-60" pipes under Hughes, 3-60" pipes down Richmond to the Colorado, Santa Fe ditch
Damages Reduced	$1,235	$348	$1,610
Insurance Subsidy Reduction	$95	$231	$57
Total EAD Reduction	$1,330	$579	$1,667

These FEMA derived benefits were not used during plan formulation, but they will be reflected in the final analysis of the selected plan, if applicable.

NONSTRUCTURAL ANALYSIS

BENEFIT METHODOLOGY

As stated in ER 1105-2-100 page E-104, the total benefits of a nonstructural buyout are the total of

1) The annual benefit of the alternate use of the land.

2) The reduction in annual flood insurance subsidies.

3) The average annual public damages prevented (that is, damages to communications and public utilities facilities, and costs for flood fighting and public relief) based on actual FEMA claims.

4) The reduction in EAD that is brought about by the removal of structures.

Non Structural Benefits

Floodplain evacuation was considered as an option in the Colorado River reach, Above Business 59. There are 246 structures affected by water in the 4% ACE floodplain. Buyout plans were evaluated for residential structures within all floodplains up to the 4% ACE flood. Existing EAD at this level is $208,000. It was found that of the 246 structures, only 5 residential structures are in the flood zones below the 10% event. This means that the majority of the damages to residential structures are not in the most frequent events where the heaviest damages occur. A large part of the success of a nonstructural buyout depends on removing these frequently heavily damages structures from the floodplain. A full 4%ACE buyout would reduce EAD by only $94,000 out of $208,000 (see EAD table A-10)

The total value of the residential structures in this flood zone is $3.1-million. On average, these structures are valued at about $12,500 each. This figure includes all sheds garages etc. in the average. It does not address individual properties and values. The amount available to purchase these structures is based on the damages reduced, in this case, $94,500 of EAD. The total dollars available to determine the benefit cost ratio for this project is about $1.6-million, which makes the BCR approximately 0.5. Benefits from alternate use of the land were not calculated were deferred, pending serious consideration. FAI cost reductions would increase the benefits by another $36 thousand. Addition of these benefits would still not bring the BCR to unity.

This option was carried forward into the final array of alternatives, recognizing that alternative uses of the land would have to be developed in order for this plan to be economically justified. However, this plan does not fully address the citywide flooding problem found in Wharton.

Analysis of the Recommended Plan

2006 UPDATED VALUES AND ANALYSIS

Marshall and Swift was used to update the values used to calculate damages for the City of Wharton. A sample of structures was taken from the structure file database and input into Marshall and Swift based on appraisal district structure descriptions and field observation. In comparing the figures, it was found that increases in real estate values in the City of Wharton rose approximately 37 percent between 2004 and 2006. This increase was applied to the database with the following results for the Without Project and the Recommended Plan EAD. The results are shown in Table A-15.

Table A-15
EAD Without Project Conditions
EAD Broken down by Causal River and Reach
2006 Development and Price Levels – Values in 1000s

Colorado River		Peach Creek	
Below Business 59	$193	Below Alabama	$1
Above Business 59	$285	Alabama to Business 59	$14
Total	$478	Business 59 to Highway 59	$3
		West of Highway 59	$533
		Sub total	$551
		Colorado River Effects	
		None differentiated (no effect)	
Total Colorado River	$478	Total Peach Creek	$551

Caney Creek		Baughman Slough	
South of HEB	$275	Below Alabama	$367
Wharton	$1,189	Alabama to Business 59	$1,258
Outfall	$201	Business 59 to Highway 59	$285
59 to 102	$3	Above Highway 59	$103
Above Highway 59	$1	Sub total	$2,015
Crestmont	$833		
Sub Total	$2,503		
Colorado River effect		**Colorado River effect**	
South of HEB	$0	Below Alabama	$1
Wharton	$42	Alabama to Business 59	$486
Outfall	$49	Business 59 to Highway 59	$26
59 to 102	$1	A Highway 59	$29
Above Highway 59	$0	Sub total	$542
Crestmont	$0		
Sub total	$93		
Total Caney Creek	$2,594	Total Baughman Slough	$2,555

Baugham Slough and the Lower Colorado River Features

Table A-16 is the Table A-11 updated to 2006 figures. It summarizes Plan C and the changes in expected annual damages for each reach affected by the project. Plan C incorporates the 75-foot bottom width channel into Plan A, the 1% levees on both Baughman Slough and the Colorado River. The channel causes damages to decrease in the Alabama to Business 59 by 23%. That brings total damages reduced in this reach to 86%. Damages in the Below Alabama reach are reduced by 47%, primarily to single-family houses.

Table A-16
Expected Annual Damages Comparison*
2006 Price and Development Levels - Values in 1000s

Baughman Slough
Without Project and Plan 8

	Below Alabama				Alabama to Business 59			
	Without	Plan 8	Benefits	Change	Without	Plan 8	Benefits	Change
Commercial	$0	$0	$0		58	$5	$53	
Multi-Fam	$14	$11	$3		12	$4	$8	
Mobile	$2	$1	$1		12	$3	$9	
Public	$4	$3	$1		255	$77	$178	
Vehicles	$29	$21	$8		127	$32	$95	
Single-Family	$319	$164	$155		1280	$122	$1,158	
	$368	$200	$168	46%	$1,744	$243	$1,501	86%
	Business 59 to Highway 59				Above Highway 59			
	Without	Plan 8	Benefits	Change	Without	Plan 8	Benefits	Change
Commercial	$3	$3.0	$0		$3	$3	$0	
Multi-Fam	$0	$0	$0		$0	$0	$0	
Mob homes	$1	$1	$0		$1	$1	$0	
Public	$0	$0	$0		$0	$0	$0	
Vehicles	$26	$22	$4		$4	$4	$0	
Single-Family	$281	$260	$21		$124	$124	$0	
	$311	$286	$25	7%	$132	$132	$0	0%

Colorado River
Without Project and Plan 8

	Below Business 59				Above Business 59			
	Without	Plan 8	Benefits	Change	Without	Plan 8	Benefits	Change
Commercial	$5	$1	$4		$46	$14	$32	
Multi-Family	$0	$0	$0		$15	$4	$11	
Mob homes	$3	$0	$3		$7	$1	$6	
Public	$3	$1	$2		$51	$5	$45	
Vehicles	$23	$4	$19		$44	$11	$33	
Single-Family	$159	$16	$143		$122	$26	$96	
	$193	$23	$170	88%	$285	$61	$223	78%

Caney Creek

The final plan evaluated was Plan H. Table A-17 is the 2006 updated version of Table A-13. This plan is identical to Plan F, except it increases the number of pipes under Richmond Road to three. In summary, it incorporates the 1%-ACE levee in each of the two reaches on the Colorado River. There is also a 1%-ACE levee planned in the Alabama to Business 59 reach of Baughman Slough. The Below Alabama reach of Baughman Slough will be modified to include a 75' Bottom Width channel. Several alternatives will be constructed in the Caney Creek reaches. Three 60" pipes will replace the current 48" pipe under Hughes Street in the Outfall reach. In the

Wharton reach, 3-60" pipes will be built under Richmond Road to the Colorado River. The last section of the plan is a grass-lined channel following the old Santa Fe Railroad ROW that will drain the Crestmont subdivision floodwaters. No action is taken to address Peach Creek. A detailed breakdown of benefits is shown in Table A-12.

Table A-17
Caney Creek Recommended Plan 16
3-60" pipes at Hughes,
3-60" Pipes Down, Santa Fe ditch

Caney Creek

	South of HEB				Wharton			
	Without	Plan 16	Benefits	Change	Without	Plan 16	Benefits	Change
Commercial	$6	$4	$2		$14	$3	$11	
Multi-Family	$0	$0	$0		$0	$0	$0	
Mobile	$1	$0	$1		$0	$0	$0	
Public	$1	$0	$1		$8	$0	$8	
Vehicles	$15	$0	$15		$132	$16	$115	
Single-Family	$252	$42	$210		$1,078	$245	$833	
	$275	$46	$229	83%	$1,232	$264	$967	79%

	Outfall				US59 to 102			
	Without	Plan H	Benefits	Change	Without	Plan H	Benefits	Change
Commercial	11	$0	11		$0	$0	$0	
Multi-Family	47	$0	47		$0	$0	$0	
Mobile	30	$0	30		$0	$0	$0	
Public	0	$0	0		$0	$0	$0	
Vehicles	89	$0	89		$0	$0	$0	
Single-Family	75	$0	75		$4	$1	$2	
	252	$0	252	100%	$4	$1	$2	75%

	Above US59				Crestmont			
	Without	Plan H	Benefits	Change	Without	Plan H	Benefits	Change
Commercial	$1	$0	$0		$0	$0	$0	
Multi-Family	$0	$0	$0		$0	$0	$0	
Mobile	$0	$0	$0		$0	$0	$0	
Public	$0	$0	$0		$0	$0	$0	
Vehicles	$0	$0	$0		$18	$0	$18	
Single-Family	$1	$0	$0		$815	$73	$743	
	$2	$0	$2	100%	$833	$73	$555	91%

There is a slight increase in inundation effect in Matagorda County. Proposed modification to the Colorado River will raise the water surfaces downstream. Running these increases through the HEC-FDA program shows that the inundation increases the expected

annual damages from $270.1 thousand to $271.4 thousand, or an increase in $1.3 thousand dollars. This are annual induced damages of $1.3 thousand from the recommended plan on the Colorado River.

EQUIVALENT ANNUAL DAMAGES

Future conditions for the Wharton watershed were assumed to be the same as existing conditions. The assumptions implies that within the economic life of the project, runoff and flooding conditions will remain unchanged. With future conditions being equal to existing conditions, no equivalent damage calculations are required. Tabel A-18 shows the dollar value reduction by river for the selected project on each.

Table A-18
Selected Structural Plans 8 and 16
Calculations of EAD by River and Reach
2006 Price and Development Levels – Value in $1,000s

	Baughman Slough	Colorado River	Caney Creek
	Plan 8 1% Levees, 75 ' bottom width channel on Baughman Slough		Plan 16 3-60" pipes under Hughes, 3-60" pipes down Richmond to the Colorado, Santa Fe Ditch
Damages Reduced	$1,692	$477	$2,206
Insurance Subsidy Reduction	$130	$316	$78
Total EAD Reduction	$1,822	$793	$2,284

Net Benefits of the Recommended Plan

Table A-19
Wharton Comprehensive Flood Damage Reduction Plan
Cost and Benefits by Feature
(Formulation Detail Level, 5.375%, 50 years, October 2004 Prices)

Feature	*First Cost*	*Annualized Cost*	*Annualized Benefit*	*B/C Ratio*	*Net Benefits*
River Levees	$5,024,000	$291,000	$781,900	2.7	$490,900
Baughman Slough					
Levee	$1,197,000	$69,000	$388,600	5.6	$319,600
Channel	$4,188,000	$243,000	$420,200	1.7	$177,200
Caney Creek					
Hughes Street Drain	$1,039,000	$60,000	$175,400	2.9	$115,400
Richmond Drain	$1,931,000	$112,000	$700,100	6.3	$588,100
Santa Fe Ditch	$2,900,000	$168,000	$557,000	3.3	$389,000
Total Project	**$16,279,000**	**$943,000**	**$3,023,200**	**3.2**	**$2,080,200**

Risk and Uncertaintly Analysis for the Performance of the Recommended Plan

Risk and uncertainty are present throughout all the variables within HEC-FDA. By calculating the occurrence of the annual exceedence probability of the selected stage, the long-term probability of the occurrence of something greater than that stage can be estimated for other time periods. FDA specifically calculates risk for the 10-, 25-, and 50-year periods. Table A-20 displays the risk under with and without project conditions for a 50 year period under the recommended plan. That is, it shows the long term likelihood of a reach being flooded in a specific time period for any plan.

Table A-20

Risk and Uncertainty of the Wharton Recommended Plan

	Without Project			With Project		
	10 Year	25 Year	50 Year	10 Year	25 Year	50 Year
Caney Creek						
South Of HEB	100%	100%	0%	81%	99%	1%
Wharton	100%	100%	0%	97%	1%	1%
Outfall	99%	100%	0%	12%	28%	49%
Hwy 549 to 102	76%	97%	99%	56%	87%	98%
Above Hwy 59	43%	75%	94%	19%	41%	65%
Cretmont	100%	100%	100%	47%	79%	95%
Baughamn Slough						
Below Alabalma	1%	1%	1%	89%	99%	1%
Alabama to Business 59	1%	1%	1%	5%	12%	23%
Business 59 to Hwy 59	1%	1%	1%	1%	1%	1%
Above Hwy 59	1%	1%	1%	1%	1%	1%
Colorado River						
Below Business 59	42%	74%	93%	0%	1%	2%
Above Business 59	62%	91%	99%	0%	2%	4%

Flood Insurance Costs

It is assumed that all inhabitants of the flood plain pay annual premiums, for communities in the FEMA flood insurance program. As such, additional benefits accrue for each structure removed from the 1% ACE flood plain. Benefits are calculated using the following method:

Benefit Methodology:

As stated in ER 1105-2-100, and IWR Report 88-R-2, page IX-12, benefits for removing individual structures from the flood plain are limited to the sum of:

annualized residual value of the vacated land, *or* average annual recreation benefits for the land .

plus:

reduction in annual flood insurance subsidies:

agency cost:

plus:

agent fees (at 15 percent of the estimated premium), and other administrative costs (at $193 per policy

Table A-21
Annual Flood Insurance Cost Reduction
2006 Policy Costs Year
Benefits in Dollars

	Colorado and Baughman Slough	Caney Creek
Number of Structures Removed	2,186	373
Cost per Policy	$193	$193
Administrative Costs	$421,898	$71,989
Total Annual Cost Reduction	**$485,183**	**$82,787**

The total flood insurance reduction benefit by implementing the recommended plan is $567,970 annually.

FINANCIAL CAPABILITY ANALYSIS

A financial capability analysis of he City of Wharton was conducted in accordance with ER 1105-2-100 to ascertain the sponsor's financial condition and its ability to meet the cost sharing responsibilities for the proposed project. The assessment involved the calculation and analysis of nine key financial indicators. The selected indicators explain the difference in credit worthiness between communities with strong and weak credit ratings. Other relevant facts and data about the community which play a role in the analysis includes population, per capita income and property tax information. Table 5-15 provides a key of the financial indicator ratings. Table 5-16 shows the indicator values and rating for the City of Wharton. The indicators, calculated values and corresponding rating have been updated to reflect the sponsors' capability as of 2005, the most recent year where all data are available, and are summarized in Table 5-17.

The population for the City of Wharton between 2000 and 2005 exhibits a 0.29 percent annual rate of change. The population growth indicator's stability in the economic base is useful because the economic base typically rises and falls with changes in the population. In the case of the City of Wharton, the indicator is weak. Though it shows no decline in population, there is no significant growth that would expand the economic base.

The proportion of surplus/deficit expenditures to total expenditures is also a significant indicator of the community's strength. For Wharton, the ratio is 4.01% and is within average range.

The third indicator measures the efficiency of the city's tax collection system. Wharton has a collection rate of 97%, providing a near strong indicator of their ability to collect the funds to meet financial obligations.

Indicators' five through eight are used to assess the community's debt capacity. The current and future debt situation of the Wharton is very stable. Indicator five compares the amount of tax supported debt to the full market value of real property. A value that exceeds 5 percent shows a weakness, while values between three and 5 percent are considered average. The City of Wharton exhibits a strong value of 1.28 percent.

Personal income can be used as a yardstick to judge the city's ability to repay debt. Personal incomes are not reported at the city level, so data for Wharton County were used to estimate the per capita income of City of Wharton. In 2004, the personal income of Wharton County was $1,061,253,000. Looking at population and employment trends for the region, it is reasonable that the growth in income between 2004 and 2005 would be similar to the annual rate of change between 2000 and 2004. This would give an estimate personal income of $101,807,000. Using population data for the city of Wharton, the estimated personal income for 2004 would be $248,389,795.

Indicator six shows net debt representing about 1.62% of personal income for the City of Wharton, which shows a strong position indicating available area income to support additional debt.

Indicators' seven and eight represent the per capita direct and overall net debt. For Wharton, the direct net per capita is $301, which is within the better than average for most cities. Its overall net debt per capita is $428, also indicating a stable standing.

Finally, indicator nine compares the percentage of direct net debt due within five years to total outstanding direct net debt. Wharton has a strong indicator rating of 98%.

Overall, the City of Wharton has strong showings among the nine indicators, with the exception of population growth with a weak indicator, and an average bond rating of BBB+. The indicators suggest that the city could take on additional debt.

Table A-22
Financial Indicator Rating Key

Indicator	*Weak*	*Average*	*Strong*
1.Annual rate of change in population	<1%	1%	>1%
2. Current surplus/deficit as a percent of total current expenditures	<0%	0% to 5%	> 5%
3. Real property tax collection rate	<96%	96% to 98 %	>98%
4. Property tax revenue as a percent of full market value of real property	>4%	2% to 4%	<2%
5. Overall net debt as a percent of full market value of real property	>5%	3% to 5%	<3%
6. Overall net debt outstanding as a percent of personal income	>12%	4% to 12%	<4%
7. Direct net debt per capita	>$1,492	$663 to $1,492	<$663
8. Overall net debt per capita	>$1,989	$829 to $1,989	<$829
9. Percent direct net debt outstanding due within next 5 years	<10%	10% to 30%	>30%

Table A-23
Current Community Financial Indicator Values
For the City of Wharton

Indicator	*Value*	*Rating*
1. Annual rate of change in population.	0.29%	Weak
2. Current surplus/deficit as a percent of total current expenditures.	4.01	Average
3. Real property tax collection rate.	97%	Average
4. Property tax revenues as a percent of full market value of real property.	.56%	Strong
5. Overall net debt as a percent of full market value of real property	1.28%	Strong
6. Overall net debt outstanding as a percent of personal income	1.62%	Strong
7. Direct net debt per capita	$301	Strong
8. Overall net debt per capita	$428	Strong
9. Percent direct net debt outstanding due within next 5 years	98%	Strong

Table A-24
City of Wharton
Summary of Financial Capability

A. BOND RATINGS	***Rating***	***Date***	
General Obligation	BBB+	Oct 04	
Revenue Bond	NA	NA	
B. DEBT	***Outstanding***	***Projected***	***Total***
General Obligation Bonds	$6,685.000		$6,685,000
Revenue Bonds	$0		$0
Gross Direct Debt			
Direct Net Debt	$2,820,988	$0	$2,820,988
Overlapping Net Debt 1/	$1,190,955		$1,190,955
Overall Net Debt	$4,011,943		$4,011,943
Other Debt 2/	$527,901		$527,901
Estimated Future Debt	$2,500,000		$2,500,000
C. DEBT REPAYMENT SCHEDULE (principle only)			
	Outstanding	***Projected***	***Total***
Year 1	$495,000	$175,000	$670,000
Year 2	$545,000	$185,000	$730,000
Year 3	$580,000	$195,000	$775,000
Year 4	$610,000	$205,000	$815,000
Year 5	$645,000	$215,000	$860,000
D. DEBT LIMITS			
There is no legal debt limit for the City. Texas municipalities are not bound by any direct constitutional or statutory maximums as to the amount of obligation bonds which may be issued; however, all local bonds must be submitted to and approved by the State Attorney General. It is the established practice of the Attorney General not to approve a prospective bond issue if it will result in a tax levy for general bonded debt of over $1.00 for cities under 5,000 population, or $1.50 for cities over 5,000 population.			

[1] Overlapping net debt is the sponsor's share of taxes owed to other taxing bodies within the community, ie., a flood district.

[2] Other debt obligations include outstanding leases, unfunded pension liabilities, and notes with a maturity.

NON FEDERAL FINANCIAL PLANNING

The purpose of strategic financial planning is to optimize the use of capital over time in response to long term financial goals. The three principal elements involved include cost recovery alternatives, if needed; selection of the preferred financing alternative; and implementation of the cost recovery approach. Although financing decisions are ultimately the sponsors', the Corps of Engineers can assist in the decision making through the provision of timely information on costs, benefits and cost recovery opportunities. The sponsor is responsible for making arrangements to finance the project sufficiently in advance of construction to enable the project schedule to be met.

ABILITY-TO PAY ANALYSIS

Based on ER 1165-2-121 an ability-to-pay test should be applied to all flood control projects. The test determines the eligibility of the study area to qualify for a reduction in the amount to be cost shared by the Non-Federal interest. To qualify for a reduction the results of both the benefit and income portions of the twofold ability-to-pay test must fall within the specified guidelines.

The benefits' test determines the maximum reduction, called the "benefits based floor" (BBF), in the level of non-Federal cost sharing for any project. The factor is determined by dividing the project B/C ratio by four. If the factor (expressed as a percentage) is less than the standard level of cost sharing, the project may be eligible for a reduction in the non-Federal share to this BBF. The standard level cost share for a flood damage project is 25 percent. The recommended plan's B/C ratio of 1.4 was divided by four to yield a BBF of 35 percent.

The income test determines qualification for the reduction calculated in the benefit step. Qualification depends on a measure of the current economic resources of both the project area and the State in which the project is located.

In accordance with factors released in Economic Guidance 05-03, the income index factors for the state of Texas is 94.5 and for Wharton the index value is 77.16. The Eligibility Factor (EF) for a flood control project is calculated according to the following formula:

$EF = a - b_1 * (\text{State factor}) - b_2 * (\text{area factor})$

where:

$a = 18.1375$

$b_1 = 0.0790$

$b_2 = 0.1579$

Utilizing the above formula, an EF of -1.51 was calculated for Wharton. An EF less than zero indicates ineligibility for a reduction in construction cost sharing.

As stated previously, a BBF factor for the investigated plan was calculated at 35 percent. However, to qualify for a reduction, the BBF factor must be less than the standard level of cost sharing. According to ER-1165-2-121 paragraph 5a(2), the sponsor does not meet the criteria for a reduction in construction cost. This project does not meet either of the tests, therefore, the sponsors must pay the standard percentage of the total project cost.

Table A-25
Wharton Flood Damage Reduction Project
Cost Apportionment for the Recommended Plan
August 2006 Prices

Account	*Fed*	*Non-Fed*	*Total*
Lands and Damages		$4,116,000	$4,116,000
Relocations		$785,000	$785,000
Fish and Wildlife Mitigation	$1,010,000		$1,010,000
Channels and Canals	$1,354,000		$1,354,000
Levees and Floodwalls	$15,430,000		$15,430,000
Preconstruction, Engineering, Design	$1,093,000	$57,000	$1,150,000
Construction Management	$929,000		$929,000
Santa Fe Ditch (by City, Sec 104)		$2,900,000	$2,900,000
Subtotal	$19,816,000	$7,858,000	$27,674,000
5% Cash by Non-Fed Sponsor	-$1,384,000	$1,384,000	
Additional cash for 35% minimum	-$444,000	$444,000	
Total Cost Apportionment	**$17,988,000**	**$9,686,000**	**$27,674,000**
Cost Share Percentages	**65.0%**	**35.0%**	