

APPENDIX A- ECONOMICS FLOOD DAMAGES ANALYSES

INTRODUCTION

PURPOSE

Analyses were conducted to quantify single event and average annual flood damages and costs under with- and without-project conditions within the study area. 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.

STUDY AND DAMAGE AREA

The study area is defined as the entire Onion Creek watershed, which encompasses approximately 343 square miles, and is located primarily in southern Travis and northern Hays Counties, with a minor portion of the upper portion of the basin extending into eastern Blanco County. The analysis of the flood damage was limited to six specific areas of interest along Onion Creek and Williamson Creek (a left-bank tributary of Onion Creek.) The damage areas of interest along Onion Creek lie between the confluence with the Colorado River and extends upstream to the Hays County line. The area was further subdivided into 5 reaches within either Austin city limits or unincorporated sections of Travis County immediately bordering Austin.

The damage areas of interest along Williamson Creek begin at the confluence with Onion Creek (near South Congress Avenue) and extend upstream to near Westgate Boulevard. This area was further subdivided into 4 reaches. These reaches were given titles for identification purposes, which are shown in Table A-1. Figures 2 and 3 within the main report display the study and damage areas.

**Table A-1
Reach Descriptions**

<i>Onion Creek</i>		
<i>Reach Name</i>	<i>Downstream Limit</i>	<i>Upstream Limit</i>
Timber Creek	Colorado River	U.S. Highway 183
Onion Creek Forest - OCFYB	U.S Highway 183	William Cannon Drive
Bluff Springs Road - Perkins Valley	William Cannon Drive	Slaughter Lane
Onion Creek Subdivision	Slaughter Lane	Interstate Highway 35
Bear-Onion Confluence	Interstate Highway 35	Hays County Line
<i>Williamson Creek</i>		
<i>Reach Name</i>	<i>Downstream Limit</i>	<i>Upstream Limit</i>
Heartwood	South Congress Avenue	Jeffburn Cove
Radam - Salem Walk	Jeffburn Cove	Manchaca Road
Broken Bow - Buckskin Pass	Manchaca Road	Jones Road
Westgate Boulevard – Bayton Loop	Jones Road	Westgate Boulevard
Sunset Valley	Westgate Boulevard	Reese Rd

POPULATION, UNEMPLOYMENT, AND PER CAPITA INCOME

As can be seen in Table A-2, from 1990 to 2000, population increased by 46-, 41-, and 23-percent for Austin, Travis County, and Texas, respectively, and is anticipated to increase by 56- and 16%, respectively by the year 2010 where figures are available

Table A-2
Population

	<u>1990</u>	<u>2000</u>	<u>2010</u>
Austin	465,600	680,000	800,000
Travis County	576,400	812,300	1,065,624
Texas	16,986,000	20,851,800	24,178,507

The city of Austin and Travis County are centers for manufacturing, trade, distribution, and finance. The principal manufacturing activities include electronics and industrial machinery. Other major employers are schools, utilities, and various government services. The county unemployment rate for the March of 2002 was estimated at 5.4 percent, compared to the state unemployment rate of 5.6 percent. The unemployment rate is reflected in the area's personal income. Personal income is considered the most comprehensive measure of economic activity available since it maintains a close and generally constant relationship with the gross national product.

Between 1990 and 2000, per capita income (Table A-3) has increased by 71-, 79-, and 61-percent respectively. These factors are indicative of the development and growth that has incurred, and is expected to continue, in Austin and Travis County.

Table A-3
Per Capita Income

	<u>1990</u>	<u>2000</u>	<u>2004</u>
Austin	\$18,553	\$31,794	\$32,497
Travis County	\$19,628	\$35,095	\$35,492
Texas	\$17,446	\$28,035	\$29,039

STUDY PHASES

There are 3 phases to this study. Phase I is the existing conditions as they were in 2001. The data was analyzed to determine which sections would be carried forward into the feasibility stage, or phase II. In phase II, those reaches that were carried forward were updated to reflect 2004 dollar values. Various alternatives were refined and reanalyzed to complete the plan formulation section of this phase and determine the selected plan. In the final phase, the economic analysis of the recommend plan, the market values of the structures was again updated to reflect 2006 structure values and expected annual damages. All costs and benefits of the project were then calculated in 2006 dollar values.

PHASE I PRELIMINARY SCREENING OF ALTERNATIVES WITHOUT PROJECT FLOOD DAMAGES

METHODOLOGY

The theoretical computation of flood damages is relatively simple. It is based on the depth of flooding for various flood events (exceedence probabilities), and the 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. The expected annual damage (EAD) is the mean damage obtained by integrating the damage exceedence probability curve for the damage reach. This is then repeated for the range of flood events in each damage category. In this phase, damage and benefits calculations are limited only to structures. Other categories will be calculated starting in phase II.

HYDROLOGIC ENGINEERING CENTER-FLOOD DAMAGE ASSESSMENT (FDA) PROGRAM

The Hydrologic Engineering Center-Flood Damage Assessment (FDA) Program is used to compute flood damages under without- and with-project conditions. The 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 basic values. Damage susceptibility factors used by the program to estimate flood damages include the number and type of structures, structures 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 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 major physical features of the study area such as bodies of water, building, structures, roads, bridges, and other physical characteristics. Overlain on the base map were "layers" of information including topographical contours and elevations, river cross-sections, and property parcel lines. These layers are added using a common co-ordinate system to assure the overlays were properly orientated. The use of this technology enabled structure specific data to be entered into a spreadsheet format for inputting directly into the FDA program. This approach allowed for a more efficient storing and manipulation of large amounts of (structure) data 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 FDA.

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

INVENTORY OF FLOOD PLAIN PROPERTY

An inventory of flood plain 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

The number and type of structures are two important parameters in estimating potential flood damages. The number of structures in the study area includes detached garages, sheds, barns, and other similar buildings. Structure types are defined as residential, commercial, industrial, and public. Residential structures are further separated as either single- or multi-family, or mobile home. Single- and multi-family structures are separated further by the number of stories, split level, and with-or without-basements.

The city of Austin provided data regarding the number and types of structures using aerial photography, property parcel lines, and GIS technology. The number of structures, as well as some structure types, could be determined from the aerial photographs, in most instances. By adding Travis County Appraisal District property parcel lines to the base map, the corresponding parcel numbers were used the appraisal District database that provided additional information on the type of foundation construction and structure type. Based on this data, it was determined that all residential structures were without basements (slab or pier and beam foundations). Further, it was assumed that all single-family residential structures were one-story, and all multi-family residential structures were two-story. Windshield surveys were conducted to corroborate these assumptions, and to collect missing data on structure types.

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 the structure damaged or destroyed by a flood. Depreciation accounts for deterioration occurring prior to flooding, and variations in remaining useful life of the structure.

The City of Austin provided the structure value data on residential, commercial, and industrial structure based on information they collected from the Travis County Appraisal District. Given, structure values for public structures are not included in appraisal district data, values for these types of structures were obtained directly from the entity. All structure value data provided was reviewed, and considered representative of the depreciated replacement value net of the value of associated lands. In mid 2004, the city of Austin provided 2003 sales in Travis County. The data was provided with structure and land values segregated. This data was used in phase 2 to update structure values in conjunction with Marshall and Swift calculations.

CONTENT VALUE

Content values for residential structures were not specifically collected. Content values for one- and two-story, no basement, and residential structures are correlated to the structure value and embedded within depth-percent damage relationships based on data collected at the national level. Content value was assigned by FDA as 100% of the value of the structure. Content value data on commercial and industrial structures were provided by the city of Austin initially obtained through the Travis County Appraisal District records. Content value data for public structures were obtained directly from the entity involved.

FIRST FLOOR ELEVATIONS

The elevation at which water first enters an opening in the structure is typically referred to as the first floor elevation (or zero damage elevation). This elevation can be obtained in two ways. The first is to conduct a structure specific survey to determine this elevation (either a sample or the entire study area). The second is to determine the ground elevation at the

structure, and estimate the vertical distance to the first floor (first floor correction). This vertical distance or floor correction is the depth of the base of the structure above ground level. It also is the mechanism that provides the horizontal surface which corrects for non level terrain.

Again, using GIS capability, the ground elevation at each structure was estimated, and a first floor correction added. This correction was based on typical first floor corrections developed in previous studies and based on the structure construction and type. For single- and multi-family residential structures, this correction was assumed to be 0.5-feet; 3-feet for mobile homes. For commercial structures, this correction was assumed to be between 1.5- and 5-feet. For vehicles, the "finished floor" is defined as the bottom of the engine block and is assumed 1.5 feet above the ground. These first floor corrections were field checked using a windshield survey. Floor corrections in the Timber Creek study area were determined from actual survey results.

DEPTH-PERCENT DAMAGE RELATIONSHIPS

Depth-percent damage relationships (curves) relate the depth of flooding relative to the structure first floor to flood damages as a percent of the estimated structure value. Single-family residential depth-percent damages were calculated from relationships developed and provided by IWR in 2001. The remaining damages curves were represent data provided by the U.S. Federal Emergency Management Agency, Flood Insurance Administration. They are results of an analysis of historical data collected from major flood events across the United States. These curves assume that contents for all residential structures are equal to the value of the structure. The curves reflect the results of an analysis of historical data collected from major flood events across the United States, and have been supplemented based on the findings of subsequent economic field surveys of flood plain properties in Fort Worth District, considering such factors as the design of the structure and nature of the structure contents. These curves were further modified in 1996 for compatibility with the HEC-FDA program. Single-family residential and vehicles damage curves are included in tables A-52 and A-53 as the end of this appendix.

PRIVATELY OWNED VEHICLES

Damages for privately owned vehicles (POV's) were 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, using data from the U.S. Census and the Texas State Department of Highways and Public Transportation. 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

$$((128/168)*1.5) + ((40/168)*0.5)$$

or 1.26 expected vehicles per residence. The exact number would vary depending on the assumptions made, but for further simplicity, and conservatism, it is assumed that one vehicle per residence, which 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.

Calculation of the expected number of vehicles present in the flood plain at the time of a flood is irrelevant to the amount of warning time flood plain residents receive since a flood affects all vehicles present. A vehicle is usually the single most valuable item of personal property, and the most mobile. However, the majority of urban flood plains experience flooding with little or no warning time, because of either a steep flood hydrograph, a lack of a warning system, or both. Consequently, substantial vehicle damages are typically observed. In any case, the effects of increased flood warning time would take the expected number of flood plain vehicles as its baseline.

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. The typical residence, with a structure value in the range of \$40,000 to \$60,000, would have a vehicle worth \$7,000 to \$10,000. 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 (about \$15,000 to \$25,000). An exception to this general formula results with mobile homes due to the lower structure value relative to the economic status of the residents, (which is the basic determinant of the value of their personal property, including vehicles). The assumed relationship for mobile homes is

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

While all of these values are assumed rather than empirical, varying them does not greatly affect the resulting assumed average vehicle value or the vehicular flood damages that result from using them. The foregoing set of assumed relationships, although hypothetical is considered realistic and a sufficient basis for planning purposes.

HYDROLOGY AND HYDRAULIC ENGINEERING

The Onion Creek model developed for this analysis is based on the Onion Creek backwater models developed for the 1997 Travis County Flood Insurance Study (FIS). The Onion Creek FIS models were based on the Onion Creek backwater models developed by the U.S Army Corps of Engineers, Galveston District for the 1972 Onion Creek Flood Plain Information Report. The Onion Creek 1997 FIS backwater models were developed in HEC-2 water surface profiles, September 1982 version, computer program format. Seven distinct backwater models were developed for Onion Creek. These backwater models were combined and converted to HEC-RAS River Analysis System, version 3.0.1 format. HEC-RAS is software that computes one-dimensional steady and unsteady low hydraulics calculations. The HEC-RAS software was developed at the Hydrologic Engineering Center, a division of the Institute of Water Resources of the U.S Army Corps of Engineers. A complete discussion of the hydrologic and hydraulic engineering is located in Hydrology and Hydraulics Appendix.

As previously discussed, expected annual damage is the mean damage obtained by integrating the damage-exceedance probability curve for the damage reach. The damage-exceedance probability curve results from the discharge-exceedance probability, stage-discharge and stage-damage functions derived at each reach index location. The following sections describe the end products of the hydrologic and hydraulic analyses required for executing the FDA program and estimating flood damages.

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 flood, respectively.) The classic nomenclature describing the relative risk of flooding has been revised to reflect 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 period will hereafter be described as the "1 percent annual chance exceedance (ACE) flood."

The profiles were used to delineate the flood plain (and damage) limits, and determined the relationship of damageable properties to both elevation and frequency of flood occurrence. Satisfactory development of the hydraulic model is a multi-stage iterative process in which the reasonableness of the resulting economic effects assists in the refinement of the hydraulic models.

FLOOD PROFILE STATIONING

Flood profile stationing occurs as specific creek "cross-sections" and connects water surface elevations of various flood events to specific structures. This provides a depth of flooding relative to the first floor. The city of Austin assigned the stationing (connecting cross sections to individual structures) using maps provided by the Fort Worth District. In some instances, profiles were interpolated for areas that lacked sufficient cross-sections.

VALUE OF FLOOD PLAIN INVENTORY

Data was collected on over 10,000 structures in the potential damage areas along Onion Creek and Williamson Creek. Within all reaches on Onion Creek, there are 1,412 structures within the 0.2% ACE flood plain, with a total investment value in excess of \$138,392,000 including vehicles, based on December 2001 price levels and development. Residential structures and contents account for 88-percent of the investment value (1,407 structures); commercial and industrial structures account for 2-percent of the total investment value (5 structures); and privately owned vehicles accounted for 10-percent of the total investment value.

Within the Timber Creek reach along Onion Creek, there are 144 structures within the 0.2% ACE flood plain, having a total investment value of approximately \$4,566,000, including vehicles. There are 135 mobile homes with an average structure value of \$22,600; 8 single-family residential structures with an average value of \$49,000, and one commercial (warehouse) structure.

Within the Onion Creek Forest - OCFYB reach along Onion Creek, there are 853 structures within the 0.2% ACE flood plain, having a total investment value of approximately \$56,000,000 including vehicles. There are 130 mobile homes with an average structure value of \$23,000; 666 single-family residential structures with an average value of \$66,000, and 57 multi-family residential structures with an average value of \$79,000.

Within the Bluff Springs Road - Perkins Valley reach along Onion Creek, there are 81 structures within the 0.2% ACE flood plain, having a total investment value of approximately \$7,204,000, including vehicles. There are 5 mobile homes with an average structure value of \$18,000; 69 single-family residential structures with an average value of \$73,800, 4 multi-family residential structures with an average value of \$35,750, 2 commercial structures with an average value of \$156,000, and one industrial structure with a structure value of \$312,000.

Within the Onion Creek Subdivision reach along Onion Creek, there are 305 structures within the 0.2% ACE flood plain, having a total investment value of approximately \$66,304,000, including vehicles. There are 242 single-family residential structures with an average structure value of \$182,000, 61 multi-family residential structures with an average value of \$147,000, and 2 commercial structures (associated with the golf course).

Within the Bear - Onion Confluence reach along Onion Creek, there are 29 single-family residential structures within the 0.2% ACE flood plain, having a total investment value of approximately \$4,300,000, including vehicles, with an average structure value of \$131,000.

Table A-4 displays a summary of the number of structures, and the value of the structures and contents within the 0.2-percent ACE flood plain for the Onion Creek reaches:

Table A-4
Depreciated Replacement Value: Structures and Contents
Onion Creek
(\$000; December 2001 price level)

<i>Reach</i>	Damage Category	Number	Structure Value	Content Value	Total Value
<i>Timber Creek</i>	Single-Family	8	392	0	392
	Mobile Homes	135	3,060	0	3,060
	Industrial	1	106	186	292
TOTAL		144	3,558	186	3,744
<i>Onion Creek Forest/ OCFYB</i>	Single-Family	666	40,526	0	40,526
	Mobile Homes	130	2,980	0	2,980
	Multi-Family	57	4,103	0	4,103
TOTAL		853	47,609	0	47,609
<i>Bluff Springs Road/ Perkins Valley</i>	Single-Family	69	5,095	0	5,095
	Mobile Homes	5	90	0	90
	Multi-Family	4	143	0	143
	Industrial	1	33	58	91
	Commercial	2	312	398	710
TOTAL		81	5,673	456	6,129
<i>Onion Creek Subdivision</i>	Single-Family	242	43,981	0	43,981
	Multi-Family	61	8,996	0	8,996
	Commercial	2	3,702	926	4,628
TOTAL		305	56,679	926	57,605
<i>Bear Onion Confluence</i>	Single-Family	29	3,809	0	3,809
TOTAL		29	3,809	0	3,809
<i>TOTAL ALL REACHES</i>	Single-Family	1,014	93,803	0	93,803
	Mobile Homes	270	6,130	0	6,130
	Multi-Family	122	13,242	0	13,242
	Industrial	2	139	244	383
	Commercial	4	4,014	1,324	5,338
GRAND TOTAL		1,412	117,328	1,568	118,896

Table A-5 displays the number and value of privately owned vehicles within the 0.2-percent ACE flood plain for the Onion Creek reaches:

Table A-5						
Onion Creek- Number and Value of Privately Owned Vehicles						
(\$000; December 2001 price level)						
	<u>Timber</u> <u>Creek</u>	<u>Onion Cr Forest/</u> <u>OCFYB</u>	<u>Bluff Springs Rd/</u> <u>Perkins Valley</u>	<u>Onion Cr</u> <u>Subdivision</u>	<u>Bear Onion</u> <u>Confluence</u>	<u>TOTAL</u>
Number	143	853	78	303	29	1,406
Value	822	8,348	1,075	8,699	552	19,496

Table A-6 displays the number and value of structures within the .2% ACE in the Williamson Creek reaches:

On Williamson Creek, there are 439 structures within the 0.2% ACE flood plain, with a total investment value in excess of \$53,400,000, including vehicles, based on December 2001 price levels and development. Residential structures and contents account for 91-percent of the investment value (430 structures); commercial structures account for 1-percent of the total investment value (1 structure); and privately owned vehicles accounted for 8-percent of the total investment value.

Within the Heartwood reach along Williamson Creek, there are 133 structures within the 0.2% ACE flood plain, having a total investment value of approximately \$12,780,000 including vehicles. There are 132 single-family residential structures with an average value of \$82,600, and one multi-family structure.

Within the Radam - Salem Walk reach along Williamson Creek, there are 109 single-family structures within the 0.2% ACE flood plain, having a total investment value of approximately \$12,525,000 including vehicles. The average value of these structures is approximately \$99,000.

Within the Broken Bow - Buckskin Pass reach along Williamson Creek, there are 71 structures within the 0.2% ACE flood plain, having a total investment value of approximately \$16,688,000, including vehicles. There are 70 single-family residential structures with an average value of \$122,300, and 1 multi-family residential structure.

Within the Westgate Boulevard – Bayton Loop reach along Williamson Creek, there are 118 structures within the 0.2% ACE flood plain, having a total investment value of approximately \$17,945,000, including vehicles. There are 56 single-family residential structures with an average value of \$139,100, 61 multi-family residential structures with an average value of \$112,500, and 1 commercial structure. Table A-6 displays a summary of the number of structures, and the value of the structures and contents within the 0.2-percent ACE flood plain for the Williamson Creek reaches.

Table A-6
Depreciated Replacement Value: Structures and Contents
Williamson Creek
(\$000; December 2001 price level)

<u>Reach</u>	<u>Damage Category</u>	<u>Number</u>	<u>Structure Value</u>	<u>Content Value</u>	<u>Total Value</u>
<u>Heartwood</u>	Single-Family	132	10,902	0	10,902
	Multi-Family	<u>1</u>	<u>92</u>	<u>0</u>	<u>92</u>
TOTAL		133	10,994	0	10,994
<u>Radam - Salem Walk</u>	Single-Family	109	10,797	0	10,797
TOTAL		109	10,797	0	10,797
<u>Broken Bow - Buckskin Pass</u>	Single-Family	70	8,558	0	8,558
	Multi-Family	<u>1</u>	<u>230</u>	<u>0</u>	<u>230</u>
TOTAL		71	8,788	0	8,788
<u>Westgate Boulevard - Bayton Loop</u>	Single-Family	56	7,787	0	7,787
	Multi-Family	61	6,862	0	6,862
	Commercial	<u>1</u>	<u>363</u>	<u>456</u>	<u>819</u>
TOTAL		118	15,012	456	15,288
<u>Sunset Valley</u>	Single-Family	15	1,662	0	1,662
<u>TOTAL ALL REACHES</u>	Single-Family	382	39,706	0	39,706
	Multi-Family	63	7,184	0	7,184
	Commercial	<u>1</u>	<u>363</u>	<u>456</u>	<u>819</u>
GRAND TOTAL		446	45,591	456	47,709

Table A-7 displays the number and value of privately owned vehicles within the 0.2-percent ACE flood plain for the Onion Creek reaches:

Table A-7						
Williamson Creek - Number and Value of Privately Owned Vehicles						
(\$000; December 2001 price level)						
	<u>Heartwood</u>	<u>Radam</u>	<u>Broken Bow</u>	<u>Bayton Loop</u>	<u>Sunset Valley</u>	<u>TOTAL</u>
Number	133	109	71	117	8	438
Value	\$1,786	\$1,728	\$1,400	\$2,657	\$257	\$7,828

SINGLE EVENT AND EXPECTED ANNUAL DAMAGES

Onion Creek

Table A-8 displays a summary of the number of structures inundated, by damage category, and single event damages for selected annual chance exceedence (ACE) flood events for each reach on Onion Creek, as well as expected annual damages. Table A-9 is a summary of total expected annual damages including privately owned vehicles (POV). The following paragraphs provide a summary for each reach on Onion Creek.

Within the Timber Creek reach along Onion Creek, flood damages begin between the 20- and 10-percent ACE flood event. The 4-percent ACE flood event affects 67 structures resulting in damages of \$926,000. The 1-percent ACE flood event affects 99 structures resulting in damages of \$2,639,000. Total expected annual damages are estimated at \$185,300, separated by structures and contents (\$140,000) and POV (\$45,300). Of the total expected annual damages to structures and contents, 82-percent (\$116,100) are attributable to mobile homes.

Within the Onion Creek Forest - OCFYB reach along Onion Creek, flood damages begin between the 20- and 10-percent ACE flood event. Significant damages occur at the 10-percent ACE. The 4-percent ACE flood event affects 510 structures resulting in damages of \$14,624,000. The 1-percent ACE flood event affects 777 structures resulting in damages of \$35,295,000. Total expected annual damages are estimated at \$2,266,400, separated by structures and contents (\$1,931,800) and POV (\$334,600). Of the total expected annual damages to structures and contents, 85-percent (\$1,638,500) are attributable to single-family residential structures.

Within the Bluff Springs Road - Perkins Valley reach along Onion Creek, flood damages begin between the 10- and 4-percent ACE flood event. The 4-percent ACE flood event affects 16 structures resulting in damages of \$772,000. The 1-percent ACE flood event affects 65 structures resulting in damages of \$3,408,000. Total expected annual damages are estimated at \$150,200, separated by structures and contents (\$133,100) and POV (\$17,100). Of the total expected annual damages to structures and contents, 74-percent (\$99,100) are attributable to single-family residential structures.

Within the Onion Creek Subdivision reach along Onion Creek, flood damages begin between the 10- and 4-percent ACE flood event. The 4-percent ACE flood event affects 32 structures resulting in damages of \$4,500,000. The 1-percent ACE flood event affects 192 structures resulting in damages of \$22,661,000. Total expected annual damages are estimated at \$1,257,300, separated by structures and contents (\$1,102,500) and POV (\$154,800). Of the total expected annual damages to structures and contents, 69-percent (\$760,400) are attributable to single-family residential structures.

Within the Bear-Onion Confluence reach along Onion Creek, flood damages begin between the 10- and 4-percent ACE flood event. The 4-percent ACE flood event affects 4 structures resulting in damages of \$12,000. The 1-percent ACE flood event affects 10 structures resulting in damages of \$985,000. Total expected annual damages are estimated at \$58,800, separated by structures and contents (\$51,000) and POV (\$7,800). All of the expected annual damages to structures and contents are attributable to single-family residential structures.

Table A-8
Onion Creek - Without Project Conditions
Single Event and Expected Annual Damages by ACE, Reach, Damage Category, and Reach Structures and Contents
(\$000; December 2001 price level)

ACE Event	10%		4%		2%		1%		0.2%		EAD*
Reach and Category	#	Damage	#	Damage	#	Damage	#	Damage	#	Damage	
Timber Creek											
Single-Family	2	\$46	4	\$116	4	\$171	5	\$214	8	\$315	\$19.9
Mobile Homes	11	\$102	62	\$715	89	\$1,587	93	\$2,239	135	\$3,619	\$120.1
Total	13	\$148	67	\$926	94	\$1,909	99	\$2,639	144	\$4,141	\$140
OCFYB											
Single-Family	101	\$2,046	385	\$12,707	542	\$21,512	606	\$29,448	666	\$41,870	\$1,638.5
Mobile Homes	19	\$69	94	\$978	127	\$2,291	130	\$3,945	130	\$5,761	\$170.2
Multi-Family	14	\$246	31	\$939	40	\$1,456	41	\$1,902	57	\$3,072	\$123.1
Total	134	\$2,361	510	\$14,624	709	\$25,259	777	\$35,295	853	\$50,703	\$1,931.8
Bluff Springs											
Single-Family	0	\$0	12	\$402	39	\$1,605	54	\$2,770	69	\$4,561	\$99.1
Mobile Homes	0	\$0	1	\$1	4	\$16	4	\$36	5	\$100	\$1.7
Multi-Family	0	\$0	1	\$7	3	\$50	4	\$95	4	\$153	\$3.3
Industrial	0	\$0	0	\$0	0	\$0	1	\$20	1	\$41	\$0.7
Commercial	0	\$0	2	\$362	2	\$460	2	\$487	2	\$535	\$28.3
Total	0	\$0	16	\$772	48	\$2,131	65	\$3,408	81	\$5,390	\$133.1
Onion Creek Subdivision											
Single-Family	0	\$0	24	\$3,216	68	\$8,105	144	\$17,163	242	\$36,627	\$760.4
Mobile Homes	0	\$0	6	\$444	35	\$2,274	46	\$3,880	61	\$6,278	\$168.0
Industrial	0	\$0	2	\$840	2	\$1,178	2	\$1,618	2	\$2,673	\$174.1
Total	0	\$0	32	\$4,500	105	\$11,557	192	\$22,661	305	\$45,578	\$1,102.5
Bear Onion Confluence											
Single-Family	0	\$0	4	\$12	8	\$423	10	\$985	29	\$2,869	\$51.0
Total	0	\$0	4	\$12	8	\$423	10	\$985	29	\$2,869	\$51.0
Total All Reaches	147	\$2,509	629	\$20,834	964	\$41,279	1143	\$64,988	1402	\$108,681	\$3,358.4

*POV damages are shown in table A-9

Table A-9 shows the total expected annual damages for the without project damages. This includes structures and contents, as well as for privately owned vehicles for all reaches in the Onion Creek damage centers.

Table A-9
Expected Annual Damages
Privately Owned Vehicles and Total
Onion Creek
(\$000; December 2001 price level)

<u>Reach</u>	<u>Total Structures and Contents</u>	<u>Privately Owned Vehicles</u>	<u>Total</u>
Timber Creek	\$140	\$45.3	\$185.3
Onion Creek Forest – OCFYB	\$1,931.8	\$334.6	\$2,266.4
Bluff Springs Road – Perkins Valley	\$133.1	\$17.1	\$150.2
Onion Creek Subdivision	\$1,102.5	\$154.8	\$1,257.3
Bear – Onion Confluence	\$51.0	\$7.8	\$58.8
GRAND TOTAL	\$3,358.4	\$559.6	\$3,918.0

Williamson Creek

Table A-10 displays a summary of the number of structures inundated, by damage category, and single event damages for selected annual chance exceedence (ACE) flood events for each reach on Williamson Creek, as well as expected annual damages. Table A-11 is a summary of total expected annual damages including privately owned vehicles (POV). The following paragraphs provide a summary for each reach on Williamson Creek.

Within the Heartwood reach along Williamson Creek, flood damages begin between the 20- and 10-percent ACE flood event. The 4-percent ACE flood event affects 16 structures resulting in damages of \$702,000. The 1-percent ACE flood event affects 91 structures resulting in damages of \$3,416,000. Total expected annual damages are estimated at \$186,800, separated by structures and contents (\$163,700) and POV (\$23,100). Of the total expected annual damages to structures and contents, 98-percent (\$160,000) are attributable to single-family residential structures.

Within the Radam - Salem Walk reach along Williamson Creek, flood damages begin prior to a 20 ACE flood event (not shown in Table A-10). The 20-percent ACE flood event affects 2 structures resulting in damages of \$85,000. The 4-percent ACE flood event affects 31 structures resulting in damages of \$1,319,000. The 1-percent ACE flood event affects 80 structures resulting in damages of \$3,747,000. Total expected annual damages are estimated at \$261,900, separated by structures and contents (\$229,900) and POV (\$32,000). The total expected annual damages to structures and contents are attributable to single-family residential structures.

Within the Broken Bow - Buckskin Pass reach along Williamson Creek, flood damages begin between the 10- and 4-percent ACE flood event. The 4-percent ACE flood event affects 23 structures resulting in damages of \$1,134,000. The 1-percent ACE flood event affects 45 structures resulting in damages of \$3,240,000. Total expected annual damages are estimated at \$197,400, separated by structures and contents (\$174,400) and POV (\$23,000). Of the total expected annual damages to structures and contents, 97-percent (\$169,300) are attributable to single-family residential structures.

Within the Westgate Boulevard - Bayton Loop reach along Williamson Creek, flood damages begin prior to a 20 ACE flood event (not shown in Table A-10). The 20-percent ACE flood event affects 3 structures resulting in damages of \$8,000. The 4-percent ACE flood event affects 44 structures resulting in damages of \$2,662,000. The 1-percent ACE flood event affects 88 structures resulting in damages of \$4,985,000. Total expected annual damages are estimated at \$485,000, separated by structures and contents (\$415,600) and POV (\$69,400). Of the total expected annual damages to structures and contents, 51-percent (\$213,100) are attributable to single-family residential structures, and 48-percent are attributable to multi-family residential structures.

Table A-10
Without Project Conditions - Williamson Creek
Single Event and Expected Annual Damages by ACE, Reach, and Damage Category
(\$000; December 2001 price level)

ACE Event	10%		4%		2%		1%		0.20%		EAD
Reach and Category	#	Damage	#	Damage	#	Damage	#	Damage	#	Damage	
Heartwood											
Single-Family	1	\$96	16	\$702	47	\$1,799	91	\$3,416	132	\$6,302	\$160.00
Multi-Family	0	\$0	0	\$0	0	\$0	0	\$0	1	\$29	\$3.70
Total	1	\$96	16	\$702	47	\$1,799	91	\$3,416	133	\$6,331	\$163.70
Radam-Salem Walk											
Single-Family	8	\$315	31	\$1,319	64	\$2,546	80	\$3,747	109	\$5,904	\$229.60
Total	8	\$315	31	\$1,319	64	\$2,546	80	\$3,747	109	\$5,904	\$229.60
Broken Bow - Buckskin Pass											
Single-Family	0	\$0	12	\$402	39	\$1,605	54	\$2,770	70	\$5,494	\$169.30
Multi-Family	0	\$0	1	\$7	3	\$50	4	\$95	1	\$127	\$5.10
Total	0	\$0	13	\$409	42	\$1,655	58	\$2,865	71	\$5,621	\$174.40
Westgate - Bayton Loop											
Single-Family	10	\$474	20	\$1,490	35	\$2,301	41	\$2,888	56	\$3,867	\$214.30
Multi-Family	11	\$222	24	\$1,172	38	\$1,94	46	\$2,077	61	\$2,879	\$201.30
Total	21	\$0	44	\$2,662	73	\$2,764	87	\$4,965	117	\$6,746	\$415.60
Sunset Valley											
Single-Family	2	\$91	3	\$189	7	\$626	8	\$784	15	\$961	\$99.60
Total	2	\$91	3	\$189	8	\$626	8	\$784	15	\$961	\$99.6
Total All Reaches	11	\$502	102	\$4,462	214	\$9,390	316	\$14,659	443	\$24,157	\$1,082.90

* POV damages are shown in table A-11

Table A-11
Expected Annual Damages
Privately Owned Vehicles and Total
Williamson Creek
(\$000; December 2001 piece level)

<u>Reach</u>	<u>Total Structure and Contents</u>	<u>Privately Owned Vehicles</u>	<u>Total</u>
HeartWood	\$163.7	\$23.1	\$186.8
Radam - Salem Walk	\$229.6	\$32.0	\$261.6
Broken Bow - Buckskin Pass	\$174.4	\$23.0	\$197.4
West Gate - Bayton Loop	\$415.6	\$69.4	\$485.0
Sunset Valley	\$99.6	\$8.9	\$108.5
GRAND TOTAL	\$1,082.9	\$156.4	\$1,239.3

PHASE I PRELIMINARY SCREENING OF ALTERNATIVES WITH PROJECT FLOOD DAMAGES AND BENEFITS

GENERAL

A preliminary analysis was completed to estimate flood damages that would occur under with-project conditions. For this study two alternatives were investigated for each reach along Onion and Williamson Creek. The first was a “non-structural” alternative involving the permanent evacuation (buy-out) of the 25-percent ACE flood plain for each reach. The second set was “structural” alternatives and includes such measures as channel modifications, levees and floodwalls, diversion channels, alone or in combinations, including permanent evacuation. Table A-12 summarizes the structural alternatives investigated for each reach. A detailed description of the alternatives is contained in the main report.

**Table A-12
Summary Description of Alternatives by Reach**

<u>Reach</u>	<u>Description of Structural Alternative Investigated</u>
<i>Onion Creek:</i>	
Timber Creek	Diversion channel
Onion Creek Forest – OCFYB	Diversion channels, levees, floodwalls,
Bluff Springs Road – Perkins Valley	Levee, diversion, swale
Onion Creek Subdivision	Floodwall
Bear – Onion Confluence	Levee, diversion
<i>Williamson Creek:</i>	
Heartwood	Channel Modifications
Radam – Salem Walk	Channel Modifications
Broken Bow – Buckskin Pass	Channel Modifications
Westgate Boulevard – Bayton Loop	Channel Modifications

METHODOLOGY

Single event and expected annual damages were estimated for each of the with-project (alternative) conditions. For the permanent evacuation, the FDA structure database was revised to remove those structures within the 25-year ACE flood plain, and the FDA program executed. Those damages remaining after the removal of the structures were subtracted from the without-project condition damages, and the difference identified as the monetary benefit attributable to the buy-out. For channel modifications, diversions, and swales, FDA was executed using hydraulically modeled flood profiles (lower stages) expected within the damage areas. For levees and floodwalls, expected flood damages below the top of the levee or floodwall were eliminated. For the structural alternatives the difference between the without- and with-project damages represents the monetary benefit attributable to the alternatives analyzed.

SINGLE EVENT AND EXPECTED ANNUAL DAMAGES

This section is a summary of the single event and expected annual damages under with project conditions for each reach on Onion Creek and Williamson Creek. Tables A-13 displays a summary of the number of inundated structures, single event damages and expected annual damages realized under with project conditions for all reaches within Onion Creek and Williamson Creek. Table A-15 is a summary of expected annual damages and annual benefits for both watersheds.

ONION CREEK

Within the Timber Creek reach, the buy-out of the 4-percent ACE flood plain would remove 67 structures eliminating \$926,000 in single event damages at the 4-percent ACE, and reduce damages for the 1-percent ACE by \$1,892,000. The buy-out would reduce annual damages by 73-percent. Remaining expected annual damages (including vehicles) are estimated at \$49,500, for an annual benefit of \$135,800. 5 swale widths were evaluated as possible structural alternatives. The swales were evaluated by width rather than level of protection. The largest and most effective swale (570 feet wide) reduces single event damages by \$664,000 and \$1,022,000 for the 4- and 1-percent ACE flood event, respectively. The structural alternative would reduce annual damages by 24-percent. Remaining expected annual damages (including vehicles) are estimated at \$140,100, for an annual benefit of \$45,200.

Within the Onion Creek Forest – OCFYB* reach, the buy-out of the 4-percent ACE flood plain would remove 510 structures eliminating \$14,624,000 in single event damages, and reduce damages for the 1-percent ACE by \$27,010,000. The buy-out would reduce annual damages by 81-percent. Remaining expected annual damages (including vehicles) are estimated at \$431,300, for an annual benefit of \$1,835,100. The 1% Ace levee eliminates single event damages at and below the 1-percent ACE flood event. Remaining expected annual damages (including vehicles) are estimated at \$417,100, for an annual benefit of \$1,849,300.

Within the Bluff Springs reach, the buy-out of the 4 percent- ACE flood plain would remove 16 structures eliminating \$772,000 in single event damages, and reduce damages for the 1-percent ACE by \$1,212,000. The buy-out would reduce annual damages by 37-percent. Remaining expected annual damages (including vehicles) are estimated at \$95,100, for an annual benefit of \$55,100. The 4% Ace levee, a diversion, and swale reduce single event damages by \$257,000 and \$2,336,000 for the 4- and 1-percent ACE flood event, respectively. The structural alternative would reduce annual damages by 72-percent. Remaining expected annual damages (including vehicles) are estimated at \$42,700, for an annual benefit of \$107,500.

Within the Onion Creek Subdivision (OCS) reach, the buy-out of the 4 percent- ACE flood plain would remove 32 structures eliminating \$4,500,000 in single event damages, and reduce damages for the 1-percent ACE by \$7,870,000. The buy-out would reduce annual damages by 45-percent. Remaining expected annual damages (including vehicles) are estimated at \$689,700, for an annual benefit of \$567,600. The flood wall eliminates single event at and below the 1-percent ACE flood event. Remaining expected annual damages (including vehicles) are estimated at \$376,000, for an annual benefit of \$881,300.

Within the Bear - Onion Confluence* reach, the buy-out of the 4 percent- ACE flood plain would remove 4 structures eliminating \$12,000 in single event damages, and reduce damages for the 1-percent ACE by \$409,000. The buy-out would reduce annual damages by 32-percent. Remaining expected annual damages (including vehicles) are estimated at \$40,800, for an annual benefit of \$18,800. The 1% ACE levee eliminates single event damages at and below the 1-percent ACE flood event. The structural alternative would reduce annual damages by 38-percent. Remaining expected annual damages (including vehicles) are estimated at \$36,600, for an annual benefit of \$22,200.

*The structural project that was run for the Bear Creek, OCS, and OCFYB reaches were 1% ACE levees. In this case, single event damages are truncated to zero for the 1% and below events. All that remains to be reported are the .4 and .2% ACE event levels. This makes the single event damages appear artificially low in relation to the EAD which is calculated based on

the event that the levee breaches. All numbers in table A-13, with project alternative, can be compared to table A-8 without project conditions

Table A-13
Onion Creek - With Project (Alternative) Condition
Number of Structures, Total Single Event and Expected Annual Damages
(\$000, December 2001 price level)

Timber Creek											
Alternative	10%		4%		2%		1%		0.20%		EAD
	#	Damage	#	Damage	#	Damage	#	Damage	#	Damage	
Buyout	0	\$0	0	\$0	27	\$181	32	\$372	77	\$1,152	\$49.50
Structural	0	\$0	16	\$261	52	\$783	90	\$1,614	107	\$3,165	\$140.10
Onion Creek Forest-OCFYB											
Alternative	10%		4%		2%		1%		0.20%		EAD
	#	Damage	#	Damage	#	Damage	#	Damage	#	Damage	
Buyout	0	\$0	0	\$0	199	\$4,218	267	\$8,285	343	\$14,518	\$431.30
Structural*	0	\$0	0	\$0	0	\$0	0	\$0	76	\$2,488	\$417.10
Bluff Springs- Perkins Valley											
Alternative	10%		4%		2%		1%		0.20%		EAD
	#	Damage	#	Damage	#	Damage	#	Damage	#	Damage	
Buyout	0	\$0	0	\$0	32	\$1,101	49	\$2,196	65	\$3,977	\$95.10
Structural	0	\$0	11	\$515	14	\$856	16	\$1,072	16	\$1,324	\$42.70
Bear- Onion Confluence											
Alternative	10%		4%		2%		1%		0.20%		EAD
	#	Damage	#	Damage	#	Damage	#	Damage	#	Damage	
Buyout	0	\$0	0	\$0	4	\$238	7	\$576	25	\$2,278	\$40.00
Structural*	0	\$0	0	\$0	0	\$0	0	\$0	17	\$1,433	\$36.60
OCS											
Alternative	10%		4%		2%		1%		0.20%		EAD
	#	Damage	#	Damage	#	Damage	#	Damage	#	Damage	
Buyout	0	\$0	0	\$0	73	\$4,990	160	\$14,791	274	\$36,076	\$689.7
Structural*	0	\$0	0	\$0	0	\$0	0	\$0	51	\$4,125	\$376

*see previous comment on levees

WILLIAMSON CREEK

All structural alternatives to Williamson Creek consist of modifications to the existing channel. There are no structural alternatives being considered in the Sunset Valley reach. The results discussed are shown in table A-14 and can be compared with the without project conditions in table A-10

Within the Heartwood reach, the buy-out of the 4 percent- ACE flood plain would remove 16 structures eliminating \$702,000 in single event damages, and reduce damages for the 1-percent ACE by \$1,225,000. The buy-out would reduce annual damages by 37-percent. Remaining expected annual damages (including vehicles) are estimated at \$118,500, for an annual benefit of \$68,300. The structural alternative reduces single event damages by \$283,000 and \$554,000 for the 4- and 1-percent ACE flood event, respectively. The structural alternative would reduce annual damages by 20-percent. Remaining expected annual damages (including vehicles) are estimated at \$149,200, for an annual benefit of \$37,600.

Within the Radam - Salem Walk reach, the buy-out of the 4 percent- ACE flood plain would remove 31 structures eliminating \$1,319,000 in single event damages, and reduce damages for the 1-percent ACE by \$1,830,000. The buy-out would reduce annual damages by 64-percent. Remaining expected annual damages (including vehicles) are estimated at \$95,300, for an annual benefit of \$166,600. The structural alternative reduces single event damages by \$1,015,000 and \$1,529,000 for the 4- and 1-percent ACE flood event, respectively. The structural alternative would reduce annual damages by 52-percent. Remaining expected annual damages (including vehicles) are estimated at \$124,600, for an annual benefit of \$137,300.

Within the Broken Bow - Buckskin Pass reach, the buy-out of the 4 percent- ACE flood plain would remove 23 structures eliminating \$1,134,000 in single event damages, and reduce damages for the 1-percent ACE by \$2,090,000. The buy-out would reduce annual damages by 65-percent. Remaining expected annual damages (including vehicles) are estimated at \$68,700, for an annual benefit of \$128,700. The structural alternative reduces single event damages by \$1,134,000 and \$2,248,000 for the 4- and 1-percent ACE flood event, respectively. The structural alternative would reduce annual damages by 69-percent. Remaining expected annual damages (including vehicles) are estimated at \$61,300, for an annual benefit of \$136,100.

Within the Westgate Boulevard – Bayton Loop reach, the buy-out of the 4 percent- ACE flood plain would remove 44 structures eliminating \$2,662,000 in single event damages, and reduce damages for the 1-percent ACE by \$3,112,000. The buy-out would reduce annual damages by 67-percent. Remaining expected annual damages (including vehicles) are estimated at \$160,100, for an annual benefit of \$324,900. The structural alternative reduces single event damages by \$2,521,000 and \$3,053,000 for the 4- and 1-percent ACE flood event, respectively. The structural alternative would reduce annual damages by 78-percent. Remaining expected annual damages (including vehicles) are estimated at \$108,800, for an annual benefit of \$376,200.

Table A-14
Williamson Creek-With Project (Alternative) Condition
Number of Structures, Total Single Event and Expected Annual Damages
(\$000, December 2001 price level)

Heartwood											
Alternative	<u>10%</u>		<u>4%</u>		<u>2%</u>		<u>1%</u>		<u>0.2%</u>		EAD
	#	Damage	#	Damage	#	Damage	#	Damage	#	Damage	
Buyout	0	\$0	0	\$0	31	\$769	75	\$2,191	116	\$4,919	\$118.5
Structural	0	\$0	13	\$419	38	\$1,429	83	\$2,862	125	\$5,905	\$149.2
Radam - Salem Walk											
Alternative	#	Damage	#	Damage	#	Damage	#	Damage	#	Damage	EAD
	Buyout	0	\$0	0	\$0	33	\$1,034	49	\$1,917	78	\$3,798
Structural	2	\$73	8	\$304	25	\$1,014	53	\$2,128	86	\$4,176	\$124.6
Broken Bow - Buckskin Pass											
Alternative	#	Damage	#	Damage	#	Damage	#	Damage	#	Damage	EAD
	Buyout	0	\$0	0	\$0	13	\$572	22	\$1,150	48	\$3,148
Structural	0	\$0	0	\$0	0	\$0	6	\$992	50	\$3,181	\$61.3
Westgate Boulevard - Bayton Loop											
Alternative	#	Damage	#	Damage	#	Damage	#	Damage	#	Damage	EAD
	Buyout	0	\$0	0	\$0	33	\$1,206	48	\$1,873	78	\$3,390
Structural	0	\$0	0	\$0	2	\$1,113	60	\$2,143	118	\$5,712	\$108.8
Sunset Valley											
Alternative	#	Damage	#	Damage	#	Damage	#	Damage	#	Damage	EAD
	Buyout	1	47	2	\$150	7	\$383	7	\$456	14	\$750
Structural	NA										

Table A-15 displays a summary of expected annual damages under without- and with project conditions, as well as annual benefits for all alternatives investigated by reach.

Table A-15
Summary of Expected Annual Damages
Without- and With Project Conditions and Annual Benefits
(\$000, December 2001 price level)

Reach	Without Project Damages	With Project – Buy Out		With Project - Structural	
		Damages	Benefits	Damages	Benefits
Onion Creek:					
Timber Creek	\$185.3	\$49.5	\$135.8	\$140.1	\$45.2
CFYB	\$2,266.4	\$431.3	\$1,835.1	\$417.1	\$1,849.3
Bluff Springs Road	\$150.2	\$95.1	\$55.1	\$42.7	\$107.5
Onion Creek Subdivision	\$1,257.3	\$689.7	\$567.6	\$376.0	\$881.3
Bear/ Onion Confluence	\$58.8	\$40.0	\$18.8	\$36.6	\$22.2
Williamson Creek:					
Heartwood	\$186.8	\$118.5	\$68.3	\$149.2	\$37.6
Radam	\$261.9	\$95.3	\$166.6	\$124.6	\$137.3
BrokenBow	\$197.4	\$68.7	\$128.7	\$61.3	\$136.1
Bayton Loop	\$485.0	\$160.1	\$324.9	\$108.8	\$376.2
Sunset Valley	108.6	\$90.2	\$18.4	None	None

PHASE I CONCLUSIONS

An evacuation of the 4% ACE floodplain in Bluff Springs would require the buy-out of 15 buildings, including 12 single-family residences. As can be seen in Figure 4-3 of the main report, the development is scattered. A large portion of the cost associated with a buyout plan would be cost of lands. Alternative land uses such as recreation or ecosystem restoration would be necessary in conjunction with any buyout plan, if a favorable benefit-to-cost ratio is to be achieved. Implementation of the 4% ACE floodplain evacuation would cost approximately \$2.3 Million. This cost does not include any conversion to other land uses. This amount is substantial, given it only addresses flooding to 12 residential structures. These findings were discussed with the primary sponsor for this area, Travis County. The County concluded that they were not interested in carrying this plan forward into the detailed analysis using the alternate uses for the land.

Onion Creek Subdivision was dropped from further analysis due to lack of any plan having a positive BCR being suitable to the sponsor.

Sunset Valley and Bear Creek will be analyzed for small buyouts. Analyses from the first phase of the feasibility section of this study indicate that only three major damage centers be carried forward for further analysis. Those areas are, Timber Creek, OCFYB/Onion Creek Forest, and all reaches in Williamson Creek.

PHASE II DETAILED INVESTIGATION OF ALTERNATIVES

CITY SURVEY AND STRUCTURE VALUE UPDATES

The Phase II analysis focuses on those reaches which merited further consideration as determined in Phase I. The economic data was also refined to improve accuracy and reflect current price levels.

Some characteristics attributed to structures in the previous phase of this study were assumed rather than measured. This introduces error into the data that required correction to move forward to a more refined analysis. The finished floor elevations in the initial feasibility report were based on assumed ground elevations for both OCFYB/Onion Creek Forest and the Williamson reaches. Assumptions were applied to structures based on information on type of foundation and structure type found in the Travis County Appraisal District (TCAD) database. Initial data on structure value were also taken from the 2001 TCAD database.

More detailed analyses could only be performed upon obtaining more precise data about the individual structures. Specifically, finished floors and structure values were surveyed or calculated to more closely reflect the actual field conditions. A field survey of floor corrections for each structure in all reaches was supplied by the City of Austin in 2003. Finished floor elevations were previously surveyed for all structures in Timber Creek during the feasibility phase of this study and did not need repeating. The City of Austin, or its contractor, provided finished floor elevations on all remaining structures in all OCFYB and Williamson Creek reaches. The finished floor elevations provided from the survey were given as one figure per structure. Separate figures were not provided for ground elevations and floor corrections. Only the finished floor elevations of a structure are required to calculate structure damages in HEC-FDA. Ground elevation is required to calculate damages for private vehicles associated with each structure. Calculation of the vehicle damages required separation of the ground elevation and the floor correction. In order to make some determination of the approximate floor correction, it was assumed that the original ground elevation from the feasibility phase was correct.

Structure replacement values were updated from 2001 to 2004 market approximations using Marshall and Swift Residential Estimator[®] in conjunction with local sales data and Travis County Appraisal data. Using this information, multipliers were calculated for and applied the Williamson Creek reaches and the OCFYB subdivisions. Structure values were increased by 2.4% to bring them in line with the sales data provided from the Real Estate division on 1/09/04. Williamson Creek flow data was also refined at this time.

In addition, refined water surface profiles were added for the Williamson Creek reaches.. Because water surface profiles were refined, damages in some floodplains have changed. This is notable particularly in the Bayton Loop reach. The resulting EAD was the new basis for determining project benefits. Hereafter, the Onion Creek Forest/OCFYB reach will be referred to as OCFYB. Tables A-16 and A-17 show that the refinements made changes both to number of structures in various reaches, as well as in the event damages. The updated single even damages are discussed in tables A-18 and A-19 for all reaches.

2004 Updated Depreciated Replacement Values

Table A-16

Depreciated Replacement Value: Structures and Contents
Onion Creek
(\$000; December 2004 price level)

Reach	Damage Category	Number	Structure Value	Content Value	Total Value
Timber Creek	Single-Family	8	486	0	486
	Mobile Homes	135	3,166	0	3,166
	Sub-Total	143	3,652	0	3,652
	POVs	143	822	0	822
	Total	286	4,477		4,477
	Onion Creek Forest/ OCFYB	Single-Family	666	41,498	0
Bluff Springs Road/ Perkins Valley	Mobile Homes	130	3,051	0	3,051
	Multi-Family	57	4,201	0	4,201
	Sub-Total	853	48,750	0	48,750
	POVs	869	10,352	0	10,352
	Total	1,722	59,102	0	59,102
	Onion Creek Subdivision	Single-Family	69	5,232	0
Mobile Homes		5	92	0	92
Multi-Family		4	146	0	146
Industrial		1	33	58	91
Commercial		2	319	398	717
Sub-Total		81	5,822	456	6,278
POVs		73	1,101	0	1,101
Total		154	6,923	456	7,379
Bear Onion Confluence	Single-Family	242	45,037	0	45,037
	Multi-Family	61	9,212	0	9,212
	Commercial	2	3,791	926	4,717
	Sub-total	305	58,040	926	58,966
	POVs	283	8,908	0	8,908
TOTAL ALL REACHES	Total	588	66,948	926	67,874
	Single-Family	29	3,900	0	3,900
	Sub-total	29	3,900	0	3,900
	POVs	26	565	0	565
	Total	55	4,465	0	4,465
GRAND TOTAL	Single-Family	1,014	96,153	0	96,153
	Mobile Homes	270	6,309	0	6,309
	Multi-Family	122	13,559	0	13,559
	Industrial	1	33	58	91
	Commercial	4	4,110	1,324	5,434
	POVs	1,394	21,748	0	21,748
GRAND TOTAL		1,411*	141,912	1,382	143,294

2004 Updated Depreciated Replacement Values

Table A-17

Depreciated Replacement Value: Structures and Contents

Williamson Creek

(\$000; December 2004 price level)

Reach	Damage Category	Number	Structure Value	Content Value	Total Value
Heartwood	Single-Family	146	12,583	0	12,583
	Multi-Family	3	3,156	0	3,156
	Sub-Total	149	15,739	0	15,739
	POVs	156	3,297	0	3,297
	Total	305	19,036	0	19,036
Radam	Single-Family	168	15,089	0	15,089
	Multi-Family	7	776	0	776
	Sub-Total	175	15,865	0	15,865
	POVs	179	3,348	0	3,348
	Total	304	19,213	0	19,213
Broken Bow	Single-Family	75	9,382	0	9,382
	Multi-Family	1	230	0	230
	Sub-Total	76	9,612	0	9,612
	POVs	76	1,998	0	1,998
	Total	152	11,610	0	11,610
Bayton Loop	Single-Family	64	4,987	0	4,987
	Multi-Family	49	8,319	0	8,319
	Sub-Total	113	13,306	0	13,306
	POVs	168	2,829	0	2,829
	Total	281	16,135	0	16,135
Sunset Valley	Single-Family	15	1,702	0	1,702
	Sub-Total	15	1,702	0	1,702
	POVs	8	355	0	355
	Total	23	2,057	0	2,057
TOTAL ALL REACHES	Single-Family	468	43,743	0	43,743
	Multi-Family	60	12,481	0	12,481
	POVs	587	11,828	0	11,828
	GRAND TOTAL		528*	68,052	0

* Total number does not include POVs. Total values do include POVs

Table A-18
Total Single Event and Expected Annual Damages – Onion Creek
Onion Creek Reaches
(\$000s; December 2004 Price Level)

ACE Event			10%		4%		2%		1%		0.20%		EAD
Reach	Category	Structure Value	#	Damage	#	Damage	#	Damage	#	Damage	#	Damage	
Timber Creek	Mobile Home	\$3,585	22	\$210	95	\$1,370	106	\$2,559	110	\$3,356	135	\$5,084	\$197
	Single-Family	\$459	2	\$69	4	\$170	5	\$249	8	\$314	8	\$432	\$24
	Sub-Total	\$4,044	24	\$279	99	\$1,540	111	\$2,808	118	\$3,670	143	\$5,516	\$221
	POV	\$953	13	\$101	71	\$467	96	\$634	97	\$644	143	\$953	\$38
	Total	\$4,997	37	\$380	170	2007	207	3442	215	4314	286	6469	259
OCFYB	Mobile Home	\$3,557	18	\$132	94	\$1,108	119	\$2,195	130	\$4,243	130	\$6,652	\$198
	Multi-Family	\$5,767	12	\$312	25	\$981	34	\$1,494	40	\$2,102	57	\$3,945	\$138
	Single-Family	\$56,030	3	\$343	241	\$8,801	420	\$17,919	588	\$28,855	666	\$50,809	\$1,391
	Sub-Total	\$65,354	33	\$787	360	\$10,890	573	\$21,608	758	\$35,200	853	\$61,406	\$1,727
	POV	\$13,467	21	\$120	268	\$2,017	461	\$4,849	687	\$7,902	869	\$12,083	\$361
Total	\$78,821	54	\$907	628	\$12,907	1034	\$26,457	1445	\$43,102	1722	\$73,489	\$2,088	
Bear Creek	Single Family	\$5,288	1	\$19	1	\$100	9	\$702	16	\$1,577	29	\$4,140	\$67
	Sub-Total	\$5,288	1	\$19	1	\$100	9	\$702	16	\$1,577	29	\$4,140	\$67
	POV	\$826	1	\$3	1	\$5	6	\$66	10	\$170	26	\$457	\$15
	Total	\$6,114	2	\$22	2	\$105	15	\$768	26	\$1,747	55	\$4,597	\$82

Table A-18 Continued
Total Single Event and Expected Annual Damages – Onion Creek
Onion Creek Reaches
(\$000s; December 2004 Price Level)

ACE Event			10%		4%		2%		1%		0.20%		EAD
Bluff Springs	Commercial	\$312	0	\$0	2	\$362	2	\$460	2	\$487	2	\$535	\$28
	Industrial	\$33	0	\$0	0	\$0	0	\$0	1	\$20	1	\$41	\$1
	Multi-Family	\$259	0	\$0	1	\$9	3	\$59	4	\$111	4	\$179	\$4
	Mobile Home	\$105	0	\$0	1	\$1	4	\$19	4	\$42	5	\$117	\$199
	Single Family	\$6,457	0	\$0	11	\$370	38	\$1,737	53	\$3,076	69	\$5,149	\$334
	Sub-Total	\$7,166	0	\$0	15	\$742	47	\$2,275	64	\$3,736	81	\$6,021	\$566
	POV	\$869	0	\$0	4	\$20	37	\$253	55	\$529	73	\$817	\$1,917
Total	\$8,035	0	\$0	19	\$762	84	\$2,528	119	\$4,265	154	\$6,838	\$2,483	
Onion Creek Subdivision	Commercial	\$3,702	0	\$0	2	\$840	2	\$1,178	2	\$1,618	2	\$2,673	\$106
	Multi-Family	\$11,498	0	\$0	19	\$1,110	36	\$3,219	47	\$5,030	61	\$7,677	\$197
	Single Family	\$58,661	0	\$0	24	\$3,763	68	\$9,483	144	\$20,081	242	\$42,854	\$155
	Sub-Total	\$73,861	0	\$0	45	\$5,713	106	\$13,880	193	\$26,729	305	\$53,204	\$458
	POV	\$8,165	0	\$0	34	\$777	74	\$1,906	166	\$3,721	283	\$7,318	\$889
Total	\$82,026	0	\$0	79	\$6,490	180	\$15,786	359	\$30,450	588	\$60,522	\$1,347	
Total	Structure	\$155,713	58	\$1,085	520	\$18,985	846	\$41,273	1,149	\$70,912	1,411	\$130,287	\$3,039
Grand Total		\$179,993	93	\$1,309	898	\$22,271	1520	\$48,981	2164	\$83,878	2805	\$151,915	\$6,259

Table A-19
Total Single Event and Expected Annual Damages – Williamson Creek
(\$000s; December 2004 Price Level)

ACE Event			20%		10%		4%		2%		1%		0.20%		EAD
Reach and	Category	Structure Value	# Damage		# Damage		# Damage		# Damage		# Damage		# Damage		
Heartwood	Single-Family	\$12,583	0	\$0	0	\$0	4	\$161	20	\$580	47	\$1,500	146	\$5,724	\$87
	Multi-Family	\$3,156	0	\$0	0	\$0	0	\$0	0	\$0	0	\$0	3	\$1,123	\$9
	Sub-Total	\$15,739	0	\$0	0	\$0	4	\$161	20	\$580	47	\$1,500	149	\$6,847	\$96
	POVs	\$1,027	0	\$0	0	\$0	4	\$29	20	\$102	47	\$265	156	\$1,027	\$17
	Total	\$16,766	0	\$0	0	\$0	8	\$190	40	\$682	94	\$1,765	305	\$7,874	\$113
Radam	Single-Family	\$15,089	0	\$0	0	\$0	5	\$1,466	25	\$2,184	53	\$2,250	168	\$7,510	\$121
	Multi-Family	\$776	0	\$0	0	\$0	0	\$0	0	\$0	0	\$759	7	\$206	\$2
	Sub-Total	\$15,865	0	\$0	0	\$0	5	\$1,466	25	\$2,184	53	\$3,009	175	\$7,716	\$123
	POVs	\$937	0	\$0	0	\$0	5	\$243	25	\$415	53	\$577	179	\$937	\$22
	Total	\$16,802	0	\$0	0	\$0	10	\$1,709	50	\$2,599	106	\$3,586	304	\$8,653	\$145
Broken Bow	Single-Family	\$9,382	0	\$0	12	\$382	27	\$1,151	35	\$1,999	48	\$2,888	75	\$5,680	\$185
	Multi-Family	\$230	0	\$0	0	\$0	1	\$26	1	\$49	1	\$65	1	\$105	\$5
	Sub-Total	\$9,612	0	\$0	12	\$382	28	\$1,177	36	\$2,048	49	\$2,953	76	\$5,785	\$190
	POVs	\$1,021	0	\$0	9	\$67	21	\$208	39	\$361	47	\$521	76	\$1,021	\$33
	Total	\$10,633	0	\$0	21	\$449	49	\$1,385	75	\$2,409	96	\$3,474	152	\$6,806	\$223
Bayton Loop	Single-Family	\$4,987	2	\$181	12	\$541	27	\$1,466	35	\$2,184	48	\$2,954	64	\$4,659	\$267
	Multi-Family	\$8,319	0	\$0	3	\$82	12	\$377	19	\$581	31	\$893	49	\$1,588	\$68
	Sub-Total	\$13,306	2	\$181	15	\$623	39	\$1,843	54	\$2,765	79	\$3,847	113	\$6,247	\$335
	POVs	\$1,157	0	\$0	0	\$0	5	\$44	25	\$141	53	\$338	168	\$1,157	\$59
	Total	\$14,463	2	\$181	15	\$623	44	\$1,887	79	\$2,906	132	\$4,185	281	\$7,404	\$394
Sunset Valley	Single-Family	1,662	0	\$0	2	\$127	3	\$265	7	\$876	8	\$1,098	15	\$1,345	\$139
	Sub-Total	1,662	2	0	2	127	3	265	7	876	8	1,098	15	1,345	\$139
	POVs	\$124	0	\$0	3	\$18	4	\$44	6	\$94	8	\$109	8	\$124	\$9
	Total	1,786	2	\$0	5	\$145	7	\$309	13	\$970	16	\$1,207	23	\$1,469	\$148
Structure	Total	56,184	2	181	29	1,132	79	4,912	142	8,453	236	12,407	528	27,940	883
Total		\$60,450	4	\$181	32	\$1,217	80	\$5,480	171	\$9,566	289	\$14,217	772	\$32,206	\$1,023

INVESTIGATED STRUCTURAL MEASURES

Structural Alternatives, Timber Creek and OCFYB Investigations: Designs were examined in a progressive manner starting in the OCFYB reach. Preliminary screening of alternatives was conducted to identify feasible structural alternatives, and later, nonstructural alternatives. In all, 6 structural plans were analyzed using HEC-FDA. All hydraulic plans were analyzed using risk and uncertainty factors provided with the water surface profiles. Structural alternatives for Timber Creek were analyzed earlier and none were found to be feasible. First tested plans were various sizing for a detention pond near Buda in southern Travis County. Three different sizes of outlets, 3, 4, and 5 20-foot conduits, were tested. Results of those FDA runs are in table A-20 below.

Table A- 20
Buda Detention Alternatives
Selected Onion Creek Reaches
(\$000s: December 2004 Price and Development Levels)

PLAN DESCRIPTION	Expected Annual Damage	Damages Reduced / Benefit	Percent Damages Reduced
Without Project	***	***	***
Onion Creek Subdivision	\$1,519.00	***	***
Yarabee Bend	\$2,087.00	***	***
Total Without Project	\$3,553.00	***	***
3 Conduit Detention			
Onion Creek Subdivision	\$1,278.60	\$240.40	15.83%
Yarabee Bend	\$1,995.44	\$91.56	4%
Total 3 Conduit Plan	\$3,274.04	\$331.96	9%
4 Conduit Detention			
Onion Subdivision	\$1,226.60	\$292.40	19.25%
Yarabee Bend	\$1,933.15	\$153.85	7%
Total 4 conduit plan	\$3,159.75	\$446.25	12.5%
5 Conduit Detention			
Onion Creek Subdivision	\$1,090.00	\$429.00	28.24%
Yarabee Bend	\$1,827.20	\$259.80	12.4%
Total 5 conduit Plan	\$2,917.20	\$688.80	19.4%

Several factors eliminated the detention measure from further consideration. First, the amount of damages reduced was minor. Second, the Timber Creek reach received no benefits at all from the detention pond approach. Finally, the detention pond overtops the adjacent highway causing induced flooding and cutting off traffic flow on I-35. These inducements would lower benefits. The levees or floodwalls would be required to contain this flooding would be cost prohibitive given the low level of benefits.

The next set of alternative plans was a series of swales of differing sizes on Onion Creek through the OCFYB reach. The swale would start roughly where Vine Hill Rd meets Onion Creek Drive and runs approximately 1500 linear feet, under William Cannon Drive, and empties into the

creek again. In all, five swales ranging in size from 100- to 570-foot width were examined. When adding the initial 100-foot wide swale, the initial decrease in EAD was 26% in the OCFYB reach. It was 5% in Timber Creek. EAD decreases were marginally very small after the initial 100-foot swale. Each additional increment of 100-feet of width realized an approximate 1% to 2% decrease in EAD in OCFYB, with no changes in Timber Creek. Only the 100-foot swale had a positive BCR. The swales alone were eliminated from further analysis due to the remaining flood problems.

The final piece of the flood control plan for OCFYB is levees on both sides of Onion Creek. It was planned to connect at Highway 183 and run to William Cannon Drive with a height of 545.40 feet. The levee was added to the 200-foot swale and run through HEC-FDA. EAD was reduced in Timber Creek by an additional 18% and in OCFYB by an additional 29%. Although total damages were reduced by 23% and 57% respectively, this plan leaves \$187,000 in damages in Timber Creek and \$881,000 in OCFYB. Table A- 19 shows the results for these analyses. After closer examination of how to locate the levee, it was determined that this plan was not feasible due to a number of constraints. The addition of the levees causes water to build up upstream inducing more damages than previously existed. Relief of induced damages would require moving buried sewer pipes and old growth trees growing in the existing park/floodway. The City of Austin was not in favor of these options. Therefore the levee plan was removed from further consideration. Table A-21 shows the Benefits for both the swale and the levee plans.

Table A-21
OCFYB Swales and Levee
(\$000s; December 2004 Price and Development Levels)
Onion Creek Structural Alternatives

	Damages	Benefits	Reduction
Without Project			
OCF/YB	\$2,087	*	*
100-foot swale			
OCFYB	\$1,547	\$540	26%
200-foot swale			
OCFYB	\$1,505	\$582	28%
300-foot swale			
OCFYB	\$1,476	\$593	29%
400-foot swale			
OCFYB	\$1,451	\$636	30%
570-foot swale			
OCFYB	\$1,435	\$652	31%
Levees			
OCFYB	\$864	\$1,223	58%

BEAR CREEK

No new structural alternatives were examined in phase II.

WILLIAMSON CREEK

During this phase of the analysis, possible structural plans were examined. Channelization that would contain the 10%-, 4%, and 1% ACE events were studied. None of these plans maximized benefits in all four Williamson reaches. The result is that different levels of protection were analyzed for different reaches. Parts of the Radam, Heartwood and Bayton Loop reaches would have a benched channel built to prevent flooding at the 4% ACE event and the Broken Bow reach would be channelized to protect against the 1% ACE event. Results are displayed in Table A – 22. The selected plans are based on total net benefits. These calculations can be found in Table 12 of Chapter 4 in the main report.

**Table A-22
Williamson Creek Alternatives
Channelization
Combined Structural Plan Residual EAD Comparisons**

	Plan A	Plan B	Plan C	Combined Plan	
Heartwood	\$ 113	\$ 82	\$ 72	\$ 82	plan B
Radam	\$ 124	\$ 127	\$ 89	\$ 127	plan B
Broken Bow	\$ 156	\$ 156	\$ 130	\$ 130	plan C
Bayton Loop	\$ 145	\$ 95	\$ 90	\$ 145	plan A
Total	\$ 526	\$ 448	\$ 373	\$ 484	

RISK AND PROBABILITY ANALYSIS FOR THE PERFORMANCE OF THE SELECTED PLAN

In addition to flood damage assessment, the HEC-FDA program has the capacity to calculate exceedence probabilities based on a selected target stage. FDA selects the target stage, in feet, based on a 5% residual of the damages calculated at the 1% ACE event. FDA then calculates the probability of the target stage being exceeded for all plans. In Heartwood, the probability (in any year) of an event exceeding 596.48 feet in 5.6% under existing conditions. Project plan B lowers that risk to 3.7% for a total risk reduction of 33.9%. The stage determined includes start of damages to landscaping, foundation, and utilities in addition to structural damages. Table A-23 displays the target stages, the percent risk, and risk reduced for the with and without project conditions in Williamson Creek.

**Table A-23
Williamson Creek
Target Stage Annual Exceedence Probability
Plan B**

Reach	Target Stage	Without Project	With Project	Residual	Total% Reduced
Heartwood	596.48	5.6%	3.7%	66.1%	33.9%
Radam	61.17	6.5%	4.1%	63.1%	36.9%
Broken Bow	638.46	13.3%	9.2%	69.2%	30.8%
Bayton Loop	656.53	18.4%	1.7%	9.2%	90.8%

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-24 displays the risk under with and without project conditions for a 50 year period under the combined plan.

Table A-24
Williamson Creek
Risk and Uncertainty
Long term Risk with the Selected Plan

Reach	Elevation	Without Project			With Project		
		10 year	25 year	50 year	10 year	25 year	50 year
Heart wood	596.48	48%	81%	96%	36%	67%	89%
Radam Broken	621.17	54%	86%	98%	39%	71%	92%
Bow	638.46	82%	99%	100%	68%	94%	100%
Bayton Loop	656.53	88%	99%	100%	26%	53%	78%

NON-STRUCTURAL ALTERNATIVES

Given the alternatives evaluated and costed on the Onion Creek reaches, it was concluded that protection of the project area by means of structural alternatives would produce a BCR less than one. A non-structural solution was determined to be the only viable alternative for both the Timber Creek and OCFYB damage centers. Possible non-structural alternatives considered were flood proofing, flood warning systems, and permanent floodplain evacuation.

FLOOD PROOFING AND FLOOD WARNING

Timber Creek

The nature of flooding in the Timber Creek damage center is flash flooding. Major damages occur at the 4% ACE level and above. Currently, most of the 157 damageable structures are mobile homes. Many of these homes are already elevated several feet above the state mandated 30" above the highest ground elevation. Further elevation is not an option. The flash nature of the flooding in Timber Creek renders a flood warning system ineffective. Considering both of these conditions, it was concluded that flood plain evacuation in this area was the feasible alternative for flood damage reduction.

OCFYB

The OCFYB damage reach is developed to full capacity as a residential neighborhood. Very few damages from water entering houses occur before the 4% ACE event. Without project conditions show that there are 354, 758, and 893 structures damaged by the 4-, the 2-, and the .2% ACE events respectively, in and around OCFYB. While the effectiveness of flood proofing measures is unique to each structure, flood proofing was considered a non-feasible alternative due to the large numbers of structures at the 4% ACE. Flood warning was considered and rejected as an alternative due to the lack of lead-time in knowing when the water would rise to flood levels.

Williamson Creek

Raising in place was considered for each structure damaged in the 25 year floodplain. Foundation increases were calculated to raise those structures in the 25 year above the water level of the 4% ACE event. They were then rerun through the HEC-FDA program. The amounts contributed to the EAD by each structure for the with and without project were calculated to determine the benefits by structure. When compared to the costs of raising each structure, it was found that the benefit cost calculation for all but 8 of the 69 structures examined, was less than 1. This alternative was eliminated from further consideration.

Floodplain Evacuation Criteria

Identification of a feasible buy-out plan also depends on meeting several criteria. The evaluation only considered residential structures based on topographical location within each targeted exceedence zone, regardless of the finished first floor elevation. Ideally, the BCR for the group of structures should exceed 1.0. However, a BCR between .6 and 1.00 would initiate an investigation of the potential for the addition of recreation facilities to offset the benefit deficit. This evaluation considers spatial proximity of the structures and suitability of the neighborhood for a land use change.

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.

NONSTRUCTURAL BUYOUT OF TIMBER CREEK

The Timber Creek reach was analyzed for a non-structural buyout of the flood plain. The buyout was designed to facilitate contiguous recreation as an alternate use of the land within the buyout area. The 50%-, 20%-, 10%-, and 4%- ACE events have elevations of 433.4, 440.1, 443.5, and 447.6 feet respectively at the index point (station 33290). The 1% ACE reaches a depth of 451 feet. To lift the structures above the 1% ACE would require structures at the lowest contours to be raised 18 feet off the ground. The timber Creek 4% ACE floodplain is very mildly sloping. The rise in ground elevation from the 50% Ace event is roughly 14- feet across approximately 1753 linear feet of floodplain at its highest point. For the water to reach even the 4% ACE level, there is a virtual wall of water coming from the creek. The proposed buyout plan is slightly smaller than a complete 4% ACE buyout with 13 mobile homes remaining along Whirlaway Drive. Three of these properties are damaged in the 10% ACE; the remaining 10 are damaged in the 4% ACE. The proposed Timber Creek buyout consists of 81 primarily mobile homes all in the 4% ACE floodplain. There are also 9 vacant properties in private ownership in

the buyout plan. Not all of the properties located in the 4% ACE flood plain are damaged at that level. Some residents have raised the foundations of their homes so they are not damaged until the 1% ACE flood. For the sake of continuity, these structures are included in the buyout plan. In all, the buyout will include 61 mobile homes and 4 single family structures that are damaged at the 4% level with an additional 16 that are damaged between the 4% and the 1%.

In addition to the buyout proposed by the Corps, Travis County has been undertaking an ongoing buyout of property in this reach. During November of 2001, a 2.5% ACE level flood occurred along this section the creek. Many structures were washed off their foundations leaving them totally demolished by the force of the floodwaters. Since then, Travis County has acquired 63 properties in conjunction with FEMA. The total reduction in EAD for the Timber Creek reach after the buyout is \$216,000. There is an additional \$42,000 in EAD remaining after the flood plain evacuation.

Table A-25A shows a comparison of the Timber Creek results before and after the buyout.

Table A-25 A
Timber Creek Buyout Results
(\$000s; December 2004 prices and Level of Development)

Reach Name	10% ACE		4% ACE		2% ACE		1% CE		.2% ACE		EAD
	#	Damage	#	Damage	#	Damage	#	Damage	#	Damage	
Existing Damages											
Mobile Homes	22	\$210	74	\$1,370	85	\$2,559	89	\$3,356	128	\$5,084	\$181
Single Family	2	\$69	4	\$170	5	\$249	8	\$314	8	\$432	\$23
POVs	13	\$18	71	\$450	96	\$624	97	\$659	136	\$789	\$54
Evacuation											
Mobile	2	\$18	13	\$162	15	\$380	16	\$606	43	\$1,337	\$32
Single Family	0	\$0	0	\$0	1	\$50	4	\$100	4	\$197	\$4
POVs	0	\$0	10	\$72	16	\$81	23	\$194	62	\$460	\$6
Total	2	\$18	13	\$234	16	\$511	23	\$900	47	\$1,994	\$42
Benefits											\$216

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OCFYB COMBINED PLAN A

Onion Creek wraps around the OCFYB reach and inundates it from three sides during a flood, also in a flash flood scenario. Levees and floodwalls previously investigated for this area were nonviable alternatives. Several floodplain properties in the more frequent ACE events have already been acquired by the city of Austin. Those buyouts that form a contiguous strip of land in the 50%, 20% and 10% ACE floodplains have been turned into greenways under city ownership. Damages along these greenways do not begin until above the 10% ACE event.

There is a small slope to the floodplains above the 10% ACE floodplain. The floodplain is approximately 3500 linear feet wide with a total change in ground elevation of 10 feet. Investigation of a flood plain evacuation shows that there are currently 354 structures in the 4% ACE that are susceptible to damage. To facilitate continuity in the buyout, not all structures proposed for buyout are in the same floodplain. The proposed buyout encompass all the structures in the 4% ACE floodplain as well as structures above that level. There are 397 structures in the proposed buyout in the flood plain as it was in 2002. A few of the mobile homes that are proposed for removal are not affected until a 2% ACE flood. These properties are surrounded by low-lying structures and are cut off in more frequent events. All structures damaged by the 4% ACE event would be acquired under this buyout. Total reduction in EAD, or benefits, of implementing this plan is \$1,458,000 down from the without project EAD of \$2,087,000. Results for this alternative are displayed in A-25B. Additional flood damage reduction benefits will be claimed from removal of structures from the 1% ACE floodplain, and reduction costs related to public, health, and utilities.

Table A-25 B
OCFYB Reach Combined Plan A Buyout
(\$000s; December 2004 Prices and Level of Development)

	<u>10% ACE</u>		<u>4% ACE</u>		<u>2% ACE</u>		<u>1% CE</u>		<u>.2% ACE</u>		<u>EAD</u>
Reach Name	#	Damage	#	Damage	#	Damage	#	Damage	#	Damage	
Existing Damages											
Multi-Family	12	312	25	981	34	1,494	40	2,102	61	3,945	138
Mobile Home	18	132	94	1,108	119	2,195	130	4,243	130	6,652	197
POVs	31	120	268	2,017	461	4,849	687	7,902	869	12,083	361
Single Family	3	343	235	8,801	411	17,919	566	28,855	702	50,809	1,391
Evacuation											
Multi-Family	0	0	0	0	3	110	14	465	35	1,704	18
POVs	0	0	0	0	88	529	283	2,708	496	3,720	104
Single Family	0	0	0	0	173	5,585	347	3,172	461	29,898	507
Total	0	0	0	0	264	6,224	722	6,345	980	35,321	629
Benefits											1,458

OCF/YB COMBINED PLAN B BUYOUT

There are 736 structures in the 1% ACE floodplain. A total of 700 structures are in the proposed buyout, including the 37 that have already been bought out by the City of Austin. This number for the 1% ACE buyout is 76% larger than the 4% ACE buyout. Several of the structures in this buyout proposal are in the .4% and the .2% ACE floodplains for the sake of continuity. They are located on a small rise in the middle of the floodplain not included in the 4% ACE buyout. The additional structures in this buyout, above the 4% level, are located at the lower edge of the reach. They back up to the City's greenway and open space on Wild Onion, Katydid, Ladybug, and Onion Creek Drive. Figure A-25C shows the detail of the 4% and 1% buyouts.

Table A-25C
OCF/YB Combination Plan B Buyout
(\$000s; December 2004 Prices and Level of Development)

Reach Name	10%ACE		4%ACE		2%ACE		1%ACE		.2%ACE		EAD
	#	Damage	#	Damage	#	Damage	#	Damage	#	Damage	
Existing Damages											
Multi-Family	12	312	25	981	34	1,494	40	2,102	61	3,945	138
Mobile Home	18	132	94	1,108	119	2,195	130	4,243	130	6,652	197
POVs	31	120	268	2,017	461	4,849	687	7,902	869	12,083	361
Single Family	3	343	235	8,801	411	17,919	566	28,855	702	50,809	1,391
With Project Damages											
Multi-Family	0	\$0	0	\$0	0	\$0	0	\$0	24	\$742	\$7
POVs	0	\$0	0	\$0	0	\$0	9	\$74	99	\$997	\$11
Single Family	0	\$0	0	\$0	12	\$360	103	\$874	125	\$5,931	\$82
Total	0	\$0	0	\$0	12	\$360	112	\$948	245	\$7,670	\$100
Benefits											\$1,987

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BEAR CREEK NONSTRUCTURAL BUYOUT

Bear Creek is a small damage reach southwest of Yarrabee Bend. The analyses in phase showed that structural flood damage reduction was not feasible for this reach. Four lowest lying structures are on Stagecoach Way and were analyzed for flood proofing. None of them had a BCR of 1 or greater. They were considered further for permanent evacuation. Evacuation of these 4 lowest structures in Bear Creek would reduce EAD from \$83 thousand to \$53 thousand dollars. In addition to the 4 structures and parcels, there are 2 parcels without structures that are also in the buyout area. These were evaluated for NER purposes. The analysis can be seen table 4-11 of the main report. Table A-26 shows the details of the Bear Creek buyout proposal.

**Table A-26
Bear Creek Buyout Results
(\$000s; December 2004 Prices and Level of Development)**

Reach Name	<u>10% ACE</u>		<u>4% ACE</u>		<u>2% ACE</u>		<u>1% CE</u>		<u>.2% ACE</u>		EAD
	#	Damage	#	Damage	#	Damage	#	Damage	#	Damage	
Existing Damages											
Single Family	1	\$19	1	\$100	8	\$527	11	\$1,186	29	\$3,395	\$83
Evacuation											
Single Family	0	\$0	0	\$0	4	\$398	8	\$983	26	\$3,146	\$53
Total	0	\$0	0	\$0	4	\$398	8	\$984	26	\$2,371	\$53
Benefits											\$30

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WILLIAMSON CREEK

Non-structural analysis of the Williamson Creek reaches included two analyses. The first analysis was raising structures in place and the second was a flood plain evacuation. The finished floor for the raised structures is the level of the 1% ACE, plus one foot. The 1% ACE level was determined from the station location of each structure; the floor correction for each structure was increased one foot above that level. Average annual damages and benefits were calculated for each structure based on without and with project. Using an average square foot cost of raising in place, the benefits and costs were compared to determine feasibility of the alternative. Only 3 have a BCR greater than 1.1; all are in different reaches. Since all of the residential structures in the analysis require protection, the raise in place alternative was rejected.

The second non-structural solution on Williamson Creek would remove 58 structures from the 4% ACE flood plain. Damages from the buyout are reduced from \$1,023,000 to \$483,000 EAD. Results of the non-structural buyout are displayed in Table A-27. Figure A-4 shows details of the location. The city of Sunset Valley bought out the one lowly structure in the 4%ACE floodplain. No analyses were conducted for nonstructural above the 4% ACE due to the high numbers of structures and values that would be required, combined with decreasing damages.

**Table A-27
4% ACE Level Buyout
Williamson Creek
(\$000s; December 2004 Prices and Level of Development)**

Reach Name	Damage Category	4% ACE		2% ACE		1% ACE		0.2% ACE		EAD
		#	4	#	2	#	1	#	0.2	
Heartwood										
	Multi-Family	0	\$0	0	\$0	0	\$0	3	\$998	\$1
	Single Family	0	\$0	16	\$417	42	\$1,303	142	\$4,482	\$70
	Commercial	0	\$0	0	\$0	0	\$0	2	\$63	\$1
	POVs	0	\$0	16	\$92	42	\$223	145	\$1,176	\$9
Radam										
	Multi-Family	0	\$0	0	\$0	0	\$0	7	\$196	\$1
	Single Family	0	\$0	21	\$586	48	\$1,848	164	\$5,868	\$95
	POVs	0	\$0	21	\$126	48	\$287	181	\$1,293	\$11
Broken Bow										
	Single Family	5	\$392	19	\$974	27	\$1,698	55	\$4,099	\$88
	POVs	5	\$74	19	\$193	27	\$272	55	\$786	\$12
Bayton Loop										
	Multi-Family	0	\$0	7	\$216	20	\$403	38	\$860	\$25
	Single Family	4	\$260	14	\$626	27	\$1,095	43	\$2,300	\$75
	POVs	4	\$50	21	\$164	47	\$218	81	\$502	\$12
Sunset Valley										
	Single Family	0	\$0	0	\$0	4	\$313	8	\$518	\$81
	POVs	0	\$0	0	\$0	4	\$51	8	\$91	\$3
Total		9	\$776	77	\$3,394	170	\$7,711	465	\$23,232	\$484
Benefits										\$540

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RECREATION PLANNING

Recreation Plan

Both the city of Austin and Travis County requested recreation plans as a combined project with the non-structural buyouts. Residents of Travis County have expressed an above average demand for recreation throughout the County. While this fact has been widely known for sometime, it had not previously been quantified. To be certain that the recreation planning met the demands of the residents, the Corps of Engineers and its partners designed and contracted for a recreation needs study that covered all of Travis County. Details of the survey design can be found in Appendix I.

The Corps of Engineers hired Responsive Management to conduct a comprehensive recreation needs survey covering all planning regions throughout Travis County. Responsive Management administered the survey using census tract data from the year 2000 and further aggregated it to the planning region level. Accepted statistical methodologies were used to determine the number of households needed for an accurate sample for Travis County. The survey was administered randomly across the regions. Tracts were not used as individual units in the analyses; all tracts were summed into their appropriate regions. That data was weighted to assure that the sample proportions and actual tract numbers, then adjusting for the differences between them by creating multiplying factor to make the sample match the population. The result of this was the best of both worlds, 1). Data that represents the region in the appropriate proportions at the sampling errors specified (no greater than 5.01, 2). The responses are spread around the survey area so error levels are evenly distributed.

Self-selection and non-response was reduced by good methodology design. Compensation for the non-response issue was accomplished in this survey by making 5 attempts at each randomly selected valid number. Self-selection was addressed by splitting the survey into thirds. As designed, the time to administer the survey exceeded the recommended 12-15 minute target length. To achieve the recommended time length, the survey was broken into three segments that were administered randomly. The stratification from the original survey to the three groups was randomized by Responsive Management software written specifically for this survey. Every household called in every tract had an equal chance of being included in any of the three groups. Because the stratification was random the results can be applied as representative of the whole county regardless of the split. The data was also stratified by tract so it was evenly accurate across all of the tract units. Splitting the survey instrument into thirds also means that there is a balance between error and response rates. The data, however, becomes less accurate when you "zoom" closer and closer in down to the tracts. This is because error is related to both sample size and population size that decrease as the unit under examination becomes smaller.

The Contingent Valuation Method (CVM) was used to determine willingness to pay for quantities of recreation activities. Values for marginal increments were not quantified. The survey responses indicate that county residents, regardless of income or ethnic background, choose walking as the single most popular recreational activity. The results of the recreation survey indicate that the most desired recreation opportunity for Travis County is a system of multipurpose trails. Of the top 60 most popular forms of recreation, 13 involved some type of trail use.

RECREATION DEMAND

Table A-27 shows the results of compiling the responses into a more tangible format. Survey calculations for the entire county show that of the 15.6 million uses desired for recreation on an annual basis, over half (52%) are for trail based activities. Sports court activities, field sports, and picnic/playground activities make up the remaining 48% of expressed demand. Table A-27 also provides WTP per use for each activity and the possible total annual value.

Recreation designs are planned to accommodate the area population as it is projected in 2010 by CAMPO (Capitol Area Metropolitan Planning Organization). The recreation provided is anticipated to draw attendees from an area of approximately a five miles radius for each reach. The radii of the projected draw areas for the OCFYB and Timber Creek buyouts overlap for recreation planning purposes. Since the values of recreation are assumed to be the same in both areas, the population of the "eye" shaped overlap was used for only one of the two planning regions (OCFYB). This avoided double counting of benefits survey results. The total number of desired visits was determined by taking the stated participation rate per family and multiplying it by the total number of households within a 5 mile radius of both Onion and Timber Creeks. To avoid double counting of visits, the population in the overlap of the radii was attributed entirely to the OCFYB recreation demand.

At this time, the population of the Onion Creek watershed is increasing quickly. Extensive new housing developments are being permitted for the areas east and south of the OCBY and Timber Creek damage centers. In the near future, demand should increase significantly. This report has not accounted for this increase in demand.

Recreation Benefits Methods

Recreation benefits can be calculated in a number of ways. The unit day value (UDV) method, the travel cost method (TCM), and the contingent valuation method (CVM) are all acceptable methods of calculating recreation benefits. In all cases, the number of visitors must be assumed or determined for each center of recreation such that it does NOT take benefits from another similar set of recreation opportunities. Double counting the same set of visitors would result in the over counting of demand and benefits.

The UDV approach, although not necessarily the most accurate, is the most widely used since the values are widely accepted and the methodology is straightforward. This method uses values that are determined at IWR and updated on a yearly basis. Points are assigned to the quality of the recreational features, and from there, the total value of the experience per visitor is calculated by type of activity.

TCM is more difficult as it uses the actual cost of the travel related activities to determine the value of the recreation experience for likely users. Identifying the likely users can cause complications to this approach. For a study such as this, where only local demands are involved, there are few or no travel costs associated with reaching the destination.

CVM can be less difficult than TCM but is more difficult than UDV. Proper use will yield more accurate demand and Willingness-to-pay figures than either of the other methods. CVM requires a survey of persons who are likely users of the feature under investigation. Individuals are asked to place a value on a particular non-market feature and in some cases provide marginal values for varying incremental changes of the feature, in this case, local recreation opportunities. CVM responses are referred to as bids. Only bids that are realistic, i.e., that the respondent is willing and able to pay, can be used. For the purposes of the COE recreation projects, questions about values must be asked in such a way as to exclude existence and

bequest values. The only thing being valued is the immediate value to the current user. CVM is the methodology chosen to study the recreation needs of Travis County.

It is widely known throughout the industry (recreational opportunities) that the residents Travis County have a higher demand for recreation than many other locations. County and city officials are generally aware of the types and locations where recreation is needed. Until this survey, which served as a backdrop for this study, demand and value had never before been quantified for recreation in Travis County.

Some of the facilities required for the activities listed in table A-28 are not cost shareable by the Corps. Specifically, tennis courts and Sports courts are not within the scope of the Corps cost sharing activities.

Table A-28
Annual Calculated Demand and WTP by Activity
For Recreation Planning – Total for Travis County 2003

Activity	Willingness to Pay	Total Desired Uses in OCFYB	Total Possible Benefits
Unpaved trails - run/jog/walk	\$1.70	3,720,572	\$6,324,972.40
Playgrounds	\$1.37	1,828,851	\$2,505,525.87
Trail System	\$1.70	1,508,224	\$2,563,980.80
Biking - Paved trails	\$0.95	1,480,829	\$1,406,787.55
Soccer	\$1.59	929,869	\$1,478,491.71
Tennis Courts	\$2.34	830,280	\$1,942,855.20
Outdoor Basket Ball courts	\$1.08	827,986	\$894,224.88
Paved Trails - run/jog/walk	\$1.70	651,748	\$1,107,971.60
Birding	\$1.56	612,957	\$956,212.92
Picnicking	\$2.36	587,109	\$1,385,577.24
Football	\$1.20	457,942	\$549,530.40
Horseback riding on trails	\$5.01	442,735	\$2,218,102.35
Baseball	\$0.93	382,499	\$355,724.07
Wildlife viewing > 1 mile from home	\$2.32	350,286	\$812,663.52
Frisbee golf	\$0.71	333,592	\$236,850.32
Cultural activities/arts/crafts outdoors	\$10.07	204,062	\$2,054,904.34
Softball	\$0.64	204,062	\$130,599.68
Outdoor Volleyball	\$0.74	110,230	\$81,570.20
Cricket	\$0.66	88,090	\$58,139.40
Lacrosse	\$0.66	73,941	\$48,801.06
Rugby	\$0.84	59,156	\$49,691.04
		15,685,020	\$27,163,177

Table A–29 presents the calculated values recreation uses by planning activity. Activities using the same facility are combined so as to avoid redundancy in the recreation planning. These categories include open fields, outdoor cultural activities, and multipurpose trails. The number of uses desired was calculated as a percent of the total that the facility could accommodate. The WTP values were weighted accordingly before the final value was totaled. This procedure permits

the facility to be used for multiple purposes that have differing demand levels and values. They can also be used anywhere in the county without introducing bias

Table A-29
Travis County
Value and Capacity Calculations by Activity For Recreation Planning

Calculated Value per Visitor Use ⁺	Activity	Visitor Capacity per Unit
\$1.14	Open Fields*	16297
\$1.08	Basket ball*	16566
\$0.71	Disk golf**	8333
\$5.01	Equestrian Trails*	1.3
\$2.82	Nature Trails*	7402
\$2.36	Picnic Tables*	2000
\$1.38	Playground*	10499
\$2.34	Tennis*	3826
\$5.97	Paved Trail *	10.9
\$4.62	Un-paved Trail*	10.9
\$0.74	Volleyball*	3826
\$10.07	Outdoor Cultural Events**	28000
\$7.00	Group Shelters**	15000

*Capacity is based on 1990 Texas Outdoor Recreation Plan

** City of Austin Parks and Recreation Department

RECREATION BENEFITS

OCFYB

To calculate benefits, the first question needing to be answered by any provider of a good or service is, what is the demand for this good or service, and will it change over time? The tastes of the consumer are fickle; however, the overall trend in outdoor recreation has been increasing over time. This study makes the assumption that demand will remain constant. For the purposes of calculations, value is measured in 2006 dollars, and the number of persons per household remains constant. Since the demand for the various types of recreation included in this plan already exceeds supply, this is a reasonable assumption. Increased demand will have no effect on the usage capacity of the park unless facilities are increased. This facilitates calculation at a single point in time. Projected recreation values are possible based on CAMPO population projections for 2010 in both the OCFYB and Timber Creek reaches. It should be noted also that the facilities are not planned to meet the highest possible demand. They are planned based on sustaining the condition of the park near its original condition. This approach was taken to keep the value of the recreation experience available at the current WTP levels.

All team members participated in a number of creative planning sessions that produced a basic plan from which to work. Three plans were slated to be calculated; the smallest is eliminated by default. That is, any plan smaller than the 4% ACE buyout would not provide any flood damage reduction because damages below this level are so infrequent in OCFYB. The two larger levels of buyout plans were proposed for recreation. Analysis of the 4%- and the 1%- ACE flood plain recreation plans showed that only the 4% plan was feasible. There are several hundred structures above the 4% ACE that would be required to be removed from the flood plain. Flood damage reduction does not provide a big enough contribution to benefits to bring the total

B/C ratio to unity. Each 1% increase towards unity in the B/C ratio requires an additional \$37,000 in annual benefits, none of which can come from additional flood damage reduction. Table A-30A outlines the 4% ACE plan and benefits as of 2004.

Table A-30A
OCFYB 4% ACE Recreation Plan
Recreation Benefits Calculations* 2004 Plan and Dollars

Visitor Days	Annual Benefits	Activity	Quantity	Measurement
0	\$0	Sports Courts	0	Courts
0	\$0	Tennis	0	Courts
187,416	\$198,660	Open fields (multi use unreserved)	11.5	Acres
49,200	\$462,480	Multi Use (reserved) fields	3	Acres
18,303	\$85,475	Unpaved Trails (equestrian/pedestrian)	13,807	LFT
150,780	\$239,740	Unpaved Trails (pedestrian/mountain bike)	13,807	LFT
33,000	\$21,999	Disk Golf	2	Site
2,915	\$7,665	Nature Trails	.4	Mile
41,996	\$54,175	Playground	4.0	Site
185,654	\$738,905	Paved Trail	17,000	LFT
64,000	\$140,800	Picnic Site	32	Table
64,000	\$140,800	Picnic Site (small group sheltered)	32	Table
15,000	\$105,000	Group shelter	1	Site
0	\$0	Volleyball	0	Courts
Total Recreation Benefit	\$2,195,699			

OCBYF NED Recreation Plan

Table A-30B is the updated 4% ACE recreation plan with total benefits and visitor days . It is adjusted for seasonal differences in visitation as well as inflation to 2006. This plan is also the NED plan. Calculation of the NED plan requires that benefits from certain activities be excluded due to cost sharing restrictions. In an NED plan, the benefits from sports courts, tennis courts and Volleyball pits cannot be counted. Total yearly visitor days with this plan is 698,336.

Table A-30B
OCFYB 4% ACE Recreation Plan
Recreation Benefits Calculations* 2006 Plan and Dollars

Visitor Days	Annual Benefits	Activity	Quantity	Measurement
0	\$0	Sports Courts	0	Courts
200,000	\$228,000	Open fields (multi use unreserved)	12.0	Acres
55,000	\$553,850	Multi Use (reserved) fields	1.0	Acres
13,509	\$67,681	Unpaved Trails (equestrian/pedestrian)	7,400	LFT
85,788	\$396,072	Unpaved Trails (pedestrian/mountain bike)	7,856	LFT
30,000	\$21,300	Disk Golf	2.00	Site
7,402	\$20,873	Nature Trails	1.0	Mile
35000	\$43,000	Playground	4.0	Site
115,237	\$687,954	Paved Trail	10,552	LFT
67,200	\$158,592	Picnic Site	32.0	Table
67,200	\$158,592	Picnic Site (small group sheltered)	32.0	Table
22,000	\$154,000	Group shelter	1.0	Site
0	\$0	Volleyball	0	Courts

Total Recreation Benefit \$2,489,914

* Benefits are adjusted for reduced seasonal usage during the colder months.

A recreation plan was briefly considered for the 2% ACE buyout., It was clear upon calculating the cost of the buyout versus the amount of damages reduces that is was not feasible. The 2% ACE buyout costs were marginally high, but the benefits were low. The amount of recreation needed to offset these costs in the BCR could not be achieved in the space available.

A recreation plan was also calculated based on a 1% level ACE buyout. A few structures located on a rise in the middle of the 1% ACE floodplain were above that level. These were included in the buyout calculations to provide their safety during large flood events, and for continuity. The overall affect on the recreation plan was to increase the length of paved trails, and to move the multipurpose fields to the lower end of the buyout area. The 3.5 acres in the 4% ACE plan were included in the unreserved open fields, increasing benefits those benefits. The city of Austin recreation department estimates that the same number of visitors will come to an event regardless of the space involved. The Reserved field area could be used in a more intense manner; however, the calculations are done for the same number of events as the smaller area in the 4% plan. This is a less intense, more sustainable usage of the open space. Benefit calculations can be found in Tables A-30C and A30D. Table A-30D is the updated 1% ACE recreation plan for OCFYB. The figures are adjusted to reflect decreased visitations during some months of the year. The values are also inflated to reflect 2006 dollars.

**Table A-30C OCFYB
1% ACE Recreation Plan
Recreation Benefits Calculations 2004 Plan and Dollars**

Uses	Annual Benefits	Activity	Units	Measurement
0	\$0	Basketball court	0	Courts
0	\$0	Tennis	0	Courts
236,307	\$250,484.89	Open fields	14.5	Acres
33,332	\$21,999.12	Disk Golf	4.00	Site
2,961	\$7,786.90	Nature Trails	0.4	Miles
41,996	\$54,174.84	Playground	4.0	Site
233,026	\$927,444.26	Paved Trail	21,379	Linear Feet
150,780	\$239,740.20	Unpaved Trail	13,808	Linear Feet
18,303	\$85,475.23	Equestrian (on unpaved trails)	13,808	Linear Feet
64,000	\$140,800.00	Picnic Site	32.0	Table
64,000	\$140,800.00	Picnic Site(small group)	32.0	Tables
15,000	\$105,000.00	Group shelter	1.0	Site
0	0	Volleyball	19.0	Courts
49,200	\$462,480	Multi Use Fields (Reserve)	1.0	13 Acres
<u>Total Benefit From Recreation</u>				
	<u>\$2,436,185</u>			

**Table A-30D
OCFYB - 1% ACE Recreation Plan
Recreation Benefits Calculations 2006 Plan and Dollars**

Uses	Annual Benefits	Activity	Units	Measurement
0	\$0	Basketball court	0	Courts
0	\$0	Tennis	0	Courts
236,307	\$269,389	Open fields	14.5	Acres
33,332	\$23,666	Disk Golf	4.00	Site
7,402	\$20,874	Nature Trails	0.4	Miles
35,000	\$48,300	Playground	4.0	Site
105,779	\$631,494	Paved Trail	9686	Linear Feet
98,230	\$ 453,749	Unpaved Trail	9000	Linear Feet
11,953	\$59,886	Equestrian (on unpaved trails)	9000	Linear Feet
67,200	\$158,592	Picnic Site	32.0	Table
67,200	\$158,592	Picnic Site(small group)	32.0	Tables
22,000	\$209,000	Group shelter	1.0	Site
0	0	Volleyball	19.0	Courts
85,000	\$855,950	Multi Use Fields (Reserve)	1.0	13 Acres
<u>Total Benefit</u>				
	<u>\$2,889,492</u>			

Timber Creek Recreation:

Buyout up to the 10% level was considered as an option. However, this left the area with a non-continuous hop-scotch pattern of properties. Additional properties would have to be acquired for continuity purposes, which would make this design level nearly equal to the 4% design level. Thus, it was a straightforward decision to adopt the 4% floodplain as the target design level. If a multipurpose plan could be designed at this level to make a positive contribution to NED, as well as provide additional ecosystem restoration benefits, then it would meet all the requirements for designation as a Federally Supportable Plan.

A non-structural buyout at the 1% ACE event was neither justified nor desired, leaving only the 4% ACE plan. As previously mentioned, a total of 84 structures would be removed from the 4% ACE flood plain under this plan. Timber Creek 2001 recreation calculations are presented in table A-31A. Table A-31B shows the updated NED recreation plan for Timber Creek as well as 2006 values.

**Table A-31A
Timber Creek 4% ACE Recreation Plan
Recreation Benefits 2004 Plan and Dollars**

Visitor Days	Annual Benefits	Activity	Quantity	Measurement
16,566	\$16,732	Sports Courts	2	Court
162,970	\$172,748	Open Fields	10	Acre
20,998	\$27,087	Playground	2	Site
13,552	\$53,936	Paved Trail	1241	LFT
7,215	\$6,133	Multi Use Unpaved Trails	5305	LFT
31,500	\$69,300	Picnic Site	20	Table
12,600	\$27,720	Picnic Site (small group)	8	Table
12,800	\$64,000	Group Shelter	1	1 site
Total Benefit	\$437,656			

After the Alternative Formulation Briefing, it was determined that benefits from sports courts could not be counted as part of the NED plan. Table A-31B reflects the removal of sports courts while inflating values to 2006 dollars. Maximization of the 4% ACE recreation plan is discussed at the end of this appendix

**Table A-31B
Timber Creek 4% ACE NED Recreation Plan
Recreation Benefits Calculations 2006 Plan and Dollars**

Uses	Annual Benefits	Activity	Units Planned Measure
162,970	\$185,786	Open fields	10 Acre
20,998	\$28,977	Playground	2 Site
13,552	\$57,865	Paved Trail	1241 Linear Feet
7,215	\$12,266	Multi Use Unpaved Trails	5305 Linear Feet
31,500	\$74,340	Picnic Site	20 Sites
12,600	\$29,736	Picnic Site (small group)	8 Table
12,800	\$64,000	Large group shelter	1 site
Total Benefits	\$452,970		

Williamson Creek

The configuration of the flood plains along Williamson Creek is shallow and close to the creek edge. The 4% flood plain after evacuation is conducive to constructing a nature trail. Table A- 32 presents benefit calculations from the presence of an unpaved trail running from the most downstream point of Williamson Creek, up to the confluence of Sunset Valley Creek.

**Table A-32
Williamson Creek
4% ACE Buyout
Recreation Benefits Calculations**

Uses	Annual Benefits	Activity	Units Measure
209,664	\$197,000	Unpaved Trails	4.1 Miles

Total Benefits

From

Recreation \$197,000

For this phase of the Onion and Williamson Creek studies, benefit to cost ratio calculations are included in Chapter 4 of the main report.

Economic Analysis of the Recommended Plan

A final economic analysis of the selected plans was conducted and is shown below. All values have been updated to reflect 2006 dollars. The analysis is conducted using the current interest rate of 5.125% over the 50 year expected life of the project of 2010 to 2060.

VALUE OF FLOOD PLAIN INVENTORY

Values for all areas of Onion Creek were updated to reflect 2006 Marshall and Swift calculations. The exact percentage increases varied. Timber Creek values were adjusted upward by 22%. Both OCFYB and Bear Creek were adjusted upward by 37%. The expected annual damage values shown reflect 2006 structure values and level of development for both the with and without project conditions. All Williamson Creek reaches were updated by 40%. This area of southwest Austin is the fastest growing in the city, and most new home permits are being issued for this area. Tables A-33 and A34 show the number and value of structures in the flood plain for all Onion and Williamson Creek reaches.

Onion Creek:

Table A-33
Onion Creek
Depreciated Replacement Value: Structures and Contents
(\$000; August 2006 price level)

<i>Reach</i>	Damage Category	Number	Structure Value	Content Value	Total Value
<i>Timber Creek</i>					
	Single-Family	8	478	0	478
	Mobile Homes	135	3733	0	3,733
	<u>POVs</u>	<u>142</u>	<u>822</u>	<u>0</u>	<u>822</u>
TOTAL		143	5,162	186	5,033
<i>OCFYB</i>					
	Single-Family	666	55,520	0	55,520
	Mobile Homes	130	4,082	0	4,082
	Multi-Family	57	5,621	0	5,621
	<u>POVs</u>	<u>853</u>	<u>8,348</u>	<u>0</u>	<u>8,348</u>
TOTAL		853	73,571	0	73,571
<i>Bluff Springs</i>					
	Single-Family	69	6,980	0	6980.15
	Mobile Homes	5	123.3	0	123.3
	Multi-Family	4	195.91	0	195.91
	Industrial	1	45.21	58	103.21
	Commercial	2	427.44	398	825.44
	<u>POVs</u>	<u>79</u>	<u>1075</u>	<u>0</u>	<u>1075</u>
TOTAL		81	8,847	456	9,303
<i>Onion Creek Subdivision</i>					
	Single-Family	242	60,254	0	60,254
	Multi-Family	61	12,325	0	12,325
	Commercial	2	5,072	926	5,998
	<u>POVs</u>	<u>303</u>	<u>8699</u>	<u>0</u>	<u>8699</u>
TOTAL		305	86,349	926	87,275
<i>Bear Onion Confluence</i>					
	Single-Family	29	5,218	0	5,218
	<u>POVs</u>	<u>29</u>	<u>552</u>	<u>0</u>	<u>552</u>
TOTAL		29	5,770	0	5,770
<i>TOTAL ALL REACHES</i>					
	Single-Family	1,014	128,450	0	128,450
	Mobile Homes	270	7,938	0	7,938
	Multi-Family	122	18,141	0	18,141
	Industrial	2	174	244	418
	Commercial	4	5,499	1,324	6,823
	<u>POVs</u>	<u>1406</u>	<u>19496</u>	<u>0</u>	<u>19496</u>
GRAND TOTAL		1,412	179,699	1,568	180,952

Williamson Creek

Table A-34
Depreciated Replacement Value: Structures and Contents
Williamson Creek
(\$000; August 2006 price level)

<u>Reach</u>	<u>Category</u>	<u>Number</u>	<u>Value</u>	<u>Value</u>	<u>Value</u>
<u>Heartwood</u>	Single-Family	146	17,616	0	17,616
	Multi-Family	3	4,418	0	3,156
	POVs	<u>156</u>	<u>4,616</u>	<u>0</u>	<u>3,297</u>
TOTAL		149	26,650	0	26,650
<u>Radam</u>	Single-Family	168	21,125	0	21,125
	Multi-Family	7	1086.4	0	1,086
	POVs	<u>179</u>	<u>4,687</u>	<u>0</u>	<u>4,687</u>
TOTAL		175	26,898	0	26,898
<u>Broken Bow</u>	Single-Family	75	13,135	0	13,135
	Multi-Family	1	322	0	322
	POVs	<u>76</u>	<u>2,798</u>	<u>0</u>	<u>2,798</u>
TOTAL		76	16,255	0	16,255
<u>Bayton Loop</u>	Single-Family	64	6,982	0	6,982
	Multi-Family	49	11,647	0	11,647
	POVs	<u>168</u>	<u>3,961</u>	<u>0</u>	<u>3,961</u>
TOTAL		113	22,589	0	22,589
<u>Sunset Valley</u>	Single-Family	15	2,383	0	2,383
	POVs	<u>15</u>	<u>497.56</u>	<u>0</u>	<u>497.56</u>
TOTAL		15	2,880	0	2,880
<u>TOTAL ALL REACHES</u>	Single-Family	468	61,240	0	61,240
	Multi-Family	60	17,473	0	17,473
	POVs	<u>519</u>	<u>11,828</u>	<u>0</u>	<u>11,828</u>
GRAND TOTAL		528	90,542	0	90,542

Without Project Conditions - 2010

To calculate the future conditions it was necessary to update the baseline conditions to the current 2006 figures. These will be used to calculate all future conditions. Tables A-35 and A-36 are updated from the original single event damages shown in tables A-18 and A-19, detailed investigation of alternatives. The water surfaces used are those expected for 2010.

Table A-35 displays a summary of the number of structures inundated, by damage category, and single event damages for selected annual chance exceedence (ACE) flood events. They include single event damages and expected annual damages for all reaches on Onion Creek, using 2006 values and 2010 water surface profiles.

Table A-36 displays a summary of the number of structures inundated, by damage category, and single event damages for selected annual chance exceedence (ACE) flood events. They include single event damages and expected annual damages for all Williamson Creek reaches, using 2006 values and 2010 water surface profiles.

Table A-35

Total Single Event and Expected Annual Damages for 2010 Onion Creek Reaches (\$000s; August 2006 Price Level)													
ACE Event			10%		4%		2%		1%		0.20%		EAD
Reach	Category	Structure Value	#	Damage									
Timber Creek	Mobile Home	\$4,374	22	\$256	95	\$1,671	106	\$3,122	110	\$4,094	135	\$6,202	\$240
	Single-Family	\$560	2	\$84	4	\$207	5	\$304	8	\$383	8	\$527	\$29
	Sub-Total	\$4,934	24	\$340	99	\$1,879	111	\$3,426	118	\$4,477	143	\$6,730	\$270
	POV	\$1,163	13	\$123	71	\$570	96	\$773	97	\$786	143	\$1,163	\$46
	Total	\$6,096	37	\$464	170	\$2,449	207	\$4,199	215	\$5,263	286	\$7,892	\$315
OCFYB	Mobile Home	\$4,873	18	\$181	94	\$1,518	119	\$3,007	130	\$5,813	130	\$9,113	\$271
	Multi-Family	\$7,901	12	\$427	25	\$1,344	34	\$2,047	40	\$2,880	57	\$5,405	\$189
	Single-Family	\$76,761	3	\$470	241	\$12,057	420	\$24,549	588	\$39,531	666	\$69,608	\$1,906
	Sub-Total	\$65,354	33	\$65,354	360	\$65,354	573	\$65,354	758	\$65,354	853	\$65,354	\$2,366
	POV	\$18,450	21	\$164	268	\$2,763	461	\$6,643	687	\$10,826	869	\$16,554	\$495
Total	\$78,821	54	\$78,821	628	\$78,821	1034	\$78,821	1445	\$78,821	1722	\$78,821	\$2,861	
Bear Creek	Single Family	\$7,245	1	\$26	1	\$137	9	\$962	16	\$2,160	29	\$5,672	\$92
	Sub-Total	\$7,245	1	\$26	1	\$137	9	\$962	16	\$2,160	29	\$5,672	\$92
	POV	\$1,132	1	\$4	1	\$7	6	\$90	10	\$233	26	\$626	\$21
	Total	\$8,376	2	\$30	2	\$144	15	\$1,052	26	\$2,393	55	\$6,298	\$112

Table A-35 Continued
Total Single Event and Expected Annual Damages for 2010
Onion Creek Reaches
(\$000s; August 2006 Price Level)

ACE Event		10%		4%		2%		1%		0.20%		EAD
Bluff Springs	Commercial	\$427	0 \$0	2 \$496	2 \$630	2 \$667	2 \$733	\$38				
	Industrial	\$45	0 \$0	0 \$0	0 \$0	1 \$27	1 \$56	\$1				
	Multi-Family	\$355	0 \$0	1 \$12	3 \$81	4 \$152	4 \$245	\$5				
	Mobile Home	\$144	0 \$0	1 \$1	4 \$26	4 \$58	5 \$160	\$3				
	Single Family	\$8,846	0 \$0	11 \$507	38 \$2,380	53 \$4,214	69 \$7,054	\$107				
	Sub-Total	\$7,166	0 \$0	15 \$1,016	47 \$3,117	64 \$5,118	81 \$8,248	\$154				
	POV	\$1,191	0 \$0	4 \$27	37 \$347	55 \$725	73 \$1,119	\$23				
Total	\$8,357	0 \$0	19 \$1,043	84 \$3,364	119 \$5,843	154 \$8,285	\$177					
Onion Creek Subdivision	Commercial	\$5,072	0 \$0	2 \$1,151	2 \$1,614	2 \$2,217	2 \$3,662	\$145				
	Multi-Family	\$15,752	0 \$0	19 \$1,521	36 \$4,410	47 \$6,891	61 \$10,517	\$270				
	Single Family	\$80,366	0 \$0	24 \$5,155	68 \$12,992	144 \$27,511	242 \$58,710	\$212				
	Sub-Total	\$101,190	0 \$0	45 \$7,827	106 \$19,016	193 \$36,619	305 \$72,889	\$627				
	POV	\$11,186	0 \$0	34 \$1,064	74 \$2,611	166 \$5,098	283 \$10,026	\$1,218				
Total	\$112,376	0 \$0	79 \$8,891	180 \$21,627	359 \$41,717	588 \$82,915	\$1,845					
Total	Structure	\$185,888	58 \$79,024	520 \$86,917	846 \$98,599	1,149 \$116,369	1,411 \$55,805	\$4,003				
Grand Total		\$214,026	93 \$79,315	898 \$91,348	1520 \$109,063	2,164 \$134,037	2,805 \$185,293	\$5,311				

Table A-35 A
Timber Creek Buyout Results
(\$000s; August 2006 prices and Level of Development)

	10% ACE		4% ACE		2% ACE		1% CE		.2% ACE		EAD
Reach Name	#	Damage	#	Damage	#	Damage	#	Damage	#	Damage	
Existing Damages											
Mobile											
Homes	19	\$224	74	\$1,411	85	\$2,731	89	\$3,628	128	\$56,473	\$214
Single											
Family	2	\$84	4	\$207	5	\$305	8	\$383	8	\$527	\$25
POVs	13	\$101	71	\$467	96	\$634	97	\$644	120	\$953	\$76
Evacuation											
Mobile											
	2	\$22	13	\$198	15	\$464	16	\$739	43	\$1,631	\$39
Single											
Family	0	\$0	0	\$0	1	\$61	4	\$122	4	\$240	\$5
POVs	0	\$0	10	\$72	16	\$81	23	\$194	62	\$460	\$6
Total	2	\$22	13	\$270	16	\$606	23	\$1,055	47	\$2,331	\$50
Benefits											\$265

Table A-36

Total Single Event and Expected Annual Damages for 2010 - Williamson Creek (\$000s; August 2006 Price Level)															
ACE Event			20%		10%		4%		2%		1%		0.20%		EAD
Reach and	Category	Structure Value	# Damage	# Damage	# Damage	# Damage	# Damage	# Damage	# Damage	# Damage	# Damage	# Damage	# Damage	# Damage	
Heartwood	Single-Family	\$17,616	0	\$0	0	\$0	4	\$225	20	\$812	47	\$2,100	146	\$8,014	\$122
	Multi-Family	\$4,418	0	\$0	0	\$0	0	\$0	0	\$0	0	\$0	3	\$1,572	\$13
	Sub-Total	\$22,035	0	\$0	0	\$0	4	\$225	20	\$812	47	\$2,100	149	\$9,586	\$134
	POVs	\$144	0	\$0	0	\$0	4	\$4	20	\$14	47	\$37	156	\$144	\$2
	Total	\$22,178	0	\$0	0	\$0	8	\$229	40	\$826	94	\$2,137	305	\$9,730	\$137
Radam	Single-Family	\$21,125	0	\$0	0	\$0	5	\$2,052	25	\$3,058	53	\$3,150	168	\$10,514	\$169
	Multi-Family	\$1,086	0	\$0	0	\$0	0	\$0	0	\$0	0	\$1,063	7	\$288	\$3
	Sub-Total	\$22,211	0	\$0	0	\$0	5	\$2,052	25	\$3,058	53	\$4,213	175	\$10,802	\$172
	POVs	\$1,312	0	\$0	0	\$0	5	\$340	25	\$581	53	\$808	179	\$1,312	\$31
	Total	\$23,523	0	\$0	0	\$0	5	\$2,393	25	\$3,639	53	\$5,020	179	\$12,114	\$203
Broken Bow	Single-Family	\$13,135	0	\$0	12	\$535	27	\$1,611	35	\$2,799	48	\$4,043	75	\$7,952	\$259
	Multi-Family	\$322	0	\$0	0	\$0	1	\$36	1	\$69	1	\$91	1	\$147	\$7
	Sub-Total	\$13,457	0	\$0	12	\$535	28	\$1,648	36	\$2,867	49	\$4,134	76	\$8,099	\$266
	POVs	\$1,429	0	\$0	9	\$94	21	\$291	39	\$505	47	\$729	76	\$1,429	\$46
	Total	\$14,886	0	\$0	12	\$629	21	\$1,939	39	\$3,373	47	\$4,864	152	\$9,528	\$312
Bayton Loop	Single-Family	\$6,982	2	\$253	12	\$757	27	\$2,052	35	\$3,058	48	\$4,136	64	\$6,523	\$374
	Multi-Family	\$11,647	0	\$0	3	\$115	12	\$528	19	\$813	31	\$1,250	49	\$2,223	\$95
	Sub-Total	\$18,628	2	\$253	15	\$872	39	\$2,580	54	\$3,871	79	\$5,386	113	\$8,746	\$469
	POVs	\$1,620	0	\$0	0	\$0	5	\$62	25	\$197	53	\$473	168	\$1,620	\$83
	Total	\$20,248	2	\$253	15	\$872	39	\$2,642	54	\$4,068	79	\$5,859	113	\$10,366	\$552
Sunset Valley	Single-Family	\$2,327	0	\$0	2	\$178	3	\$371	7	\$1,226	8	\$1,537	15	\$1,883	\$195
	Sub-Total	2,327	2	0	2	178	3	371	7	1,226	8	1,537	15	1,883	195
	POVs	\$174	0	\$0	3	\$25	4	\$62	6	\$132	8	\$153	8	\$174	\$13
	Total	2,500	2	0	5	203	7	433	13	1,358	16	1,690	23	2,057	207
Structure Total	78,801	2	253	29	1,585	79	6,881	142	11,848	236	17,407	528	39,260	1,239	
Total	\$83,336	4	\$253	32	\$1,704	80	\$7,635	171	\$13,264	289	\$19,570	772	\$43,794	\$1,411	

Outline of the Selected Plans

The selected plan for the OCFYB and Timber Creek reaches are not the NED plan in either case. Components the OCFYB and Timber Creek selected plans include flood plain evacuation, recreation, and environmental restoration. The selected recreation plan for the OCFYB and Timber Creek reaches are the LPP designed by the city of Austin and Travis County. Both plans include benefits for sports courts and volleyball courts that were not allowable under the NED plan due to cost sharing restrictions. The selected plans in all the Williamson Creek reaches is the NED plan which includes flood damage reduction and environmental restoration, as outlined in chapter 5 of the main report.

Tables A-37 and A-38 gives details of the selected plan benefits for the OCFYB and Timber Creek reaches. Both flood plain evacuation plans in these reaches leave structures above the 4% ACE that will continue to be subject o future flooding. Table A-39 provides a summary of risks over 10- 25- and 50-year time periods for without and with project conditions.

Table A-37
OCFYB 4% ACE Recreation Plan
Recreation Benefits Calculations* 2006 Plan and Dollars

Visitor Days	Annual Benefits	Activity	Quantity	Measurement
50,000	\$54,000	Sports Courts	4.0	Courts
200,000	\$228,000	Open fields (multi use unreserved)	12.0	Acres
55,000	\$553,850	Multi Use (reserved) fields	1.0	Acres
13,509	\$67,681	Unpaved Trails (equestrian/pedestrian)	7,400	LFT
85,788	\$396,072	Unpaved Trails (pedestrian/mountain bike)	7,856	LFT
30,000	\$21,300	Disk Golf	2.00	Site
7,402	\$20,873	Nature Trails	1.0	Mile
35000	\$43,000	Playground	4.0	Site
115,237	\$687,954	Paved Trail	10,552	LFT
67,200	\$158,592	Picnic Site	32.0	Table
67,200	\$158,592	Picnic Site (small group sheltered)	32.0	Table
22,000	\$154,000	Group shelter	1.0	Site
56,360	\$41,706	Volleyball	19.0	Courts
Total Visitor Days	804,696			
Total Recreation Benefit	\$2,590,922			

* Benefits are adjusted for reduced seasonal usage during the colder months.

Table A-38
Timber Creek 4% ACE Recreation Plan
Recreation Benefits Calculations 2006 Plan and Dollars

Uses	Annual Benefits	Activity	Units Planned Measure
16,566	\$17,891	Sports courts	2 Court
162,970	\$185,786	Open fields	10 Acre
20,998	\$28,977	Playground	2 Site
13,552	\$57,865	Paved Trail	1241 Linear Feet
7,215	\$12,266	Multi Use Unpaved Trails	5305 Linear Feet
31,500	\$74,340	Picnic Site	20 Sites
12,600	\$29,736	Picnic Site (small group)	8 Table
12,800	\$64,000	Large group shelter	1 site
<u>Total Visitor Days</u>	<u>278,201</u>		
<u>Total Benefits</u>	<u>\$470,862</u>		

Table A-39
Risk and Uncertainty for the Selected Plan
Onion and Timber Creeks
Risk and Uncertainty*
Long term Risk

Reach	Elevation	Without Project			With Project			
		10 year	25 year	50 year	Elevation	10 year	25 year	50 year
OCFYB	536.5	62%	91%	99%	539.2	41%	73%	93%
Timber Creek	442.3	75%	97%	100%	444.5	59%	89%	99%

*This will apply only to structures not removed from the flood plain

Equivalent Annual Damages for the NED plans

Onion Creek:

Table A-40 through A-42 display Annual Damage calculations by reach for the with and without projects. The tables are calculations for the beginning year, the final year, and both 2010 results. Table A-40 shows the updated damages with and without plan using 2006 values for all structures. The water surfaces that are used in the calculation reflect those that are expected in 2010 at the beginning of the project life. In addition, there are municipal costs and FEMA flood insurance costs that are reduced there is a benefit to the project of Comparing damages to benefits, it is expected that damages throughout the Onion Creek project would be immediately reduced an average of 72%. The table displays the reduction by reach as well as total.

Table A-40
Onion Creek
Expected Annual Damages
(August 2006 Dollars and Development Levels)

Without Project	Selected Plan	Damage Reduction*	Municipal and Insurance Costs	Reduction
<i>Reflects 2010 Water Surfaces</i>				
Timber Creek	\$315	\$57	\$258	\$54.60 82%
OCFYB	\$2,859.20	\$861.40	\$1,997.80	\$130.40 70%
Bear Creek	\$124	\$93.70	\$30.30	\$3.00 24%

Table A-41 shows the updated damages with and without plan using 2006 values for all structures. The water surfaces that are used in the calculation reflect those that are expected in 2060 at the beginning of the project life. Onion Creek project would be reduced an average of 78%. The table displays the reduction by reach as well as total.

Table A-41
Expected Annual Damages
(August 2006 Dollars and Development Levels)

Without Project	Selected Plan	Damage Reduction	Municipal and Insurance Costs	Reduction
<i>(Reflects 2060 Water surface)</i>				
Timber Creek	\$467	\$76.8	\$390.2	\$54.60 84%
OCFYB	\$3,916.10	\$1,085.30	\$2830.8	\$130.40 72%
Bear Creek	\$149.60	\$110.90	\$38.70	\$3.00 26%

Table A-42 shows the updated damages with and without plan using 2006 values for all structures. The water surfaces that are used in the calculation reflect those that are expected in 2010 and 2060 at the beginning of the project life. Values reflect 2006 values for all structures. This means the value of the structures in 2060 are the same as they are in 2006. This is an unrealistic assumption. Therefore the Expected Annual Damages (also called EAD) have been discounted back to 2006 in order to compare the 2060 damage levels directly with 2010 damages. This calculation gives an Equivalent Annual Damage figure. Comparing damages to benefits, it is expected that damages throughout the Onion Creek project would be reduced an average of 71%. The table displays the reduction by reach as well as total.

Table A-42
Onion Creek
Equivalent Annual Reduction in Damages
(Dollars Discounted to 2006 Equivalents)

	Total Without Project	Total With Project	Damage Reduction	Municipal and Insurance Costs	Reduction
<u>Timber Creek</u>	\$395.5	\$67.5	\$328	\$54.60	83%
<u>OCFYB</u>	\$3,418.70	\$979.90	\$2,438.70	\$130.40	71%
<u>Bear Creek</u>	\$137.50	\$102	\$35.5	\$3.00	25%
Total	\$4,002.90	\$1,146.10	\$2,856.8	\$188.00	

Williamson Creek:

Table A-43 through A-45 display Annual Damage calculations by reach for the with and without projects. The tables are calculations for the beginning year, the final year, and both 2010 results. Table A-44 shows the updated damages with and without plan using 2006 values for all structures. The water surfaces that are used in the calculation reflect those that are expected in 2010 at the beginning of the project life. Comparing damages to benefits, it is expected that damages throughout the Onion Creek project would be immediately reduced an average of 35%. The table displays the reduction by reach as well as total.

Table A-43
Williamson
Expected Annual Damages
(August 2006 Dollars and Development Levels)

	<u>Without Project</u> (reflects <u>2010</u> Water Surface)	<u>NED Plan</u> (reflects <u>2010</u> Water Surface)	Damage Reduction	% Reduction
<u>Heartwood</u>	\$122.70	\$103.70	\$19.00	15%
<u>Radam Broken</u>	\$171.90	\$158.20	\$13.70	8%
<u>Bow</u>	\$290.90	\$186.50	\$104.40	36%
<u>Bayton Loop</u>	\$365.90	\$165.80	\$200.10	55%
TOTAL	\$951.40	\$614.20	\$337.20	29%

Table A-44 shows the updated damages with and without plan using 2006 values for all structures. The water surfaces that are used in the calculation reflect those that are expected in 2060 at the beginning of the project life. Comparing damages to benefits, it is expected that damages throughout the Williamson Creek project would be reduced an average of 29%. The table displays the reduction by reach as well as total.

Table A-44
Williamson
Expected Annual Damages
(2006 Dollars and Development Levels)

	Without Project (reflects 2060 Water Surface)	NED Plan (reflects 2060 Water Surface)	Damage Reduction	% Reduction
Heartwood	\$138.10	\$112.90	\$25.20	18%
Radam Broken	\$173.80	\$164.10	\$9.70	6%
Bow	\$315.20	\$202.40	\$112.80	36%
Bayton	\$411.30	\$186.70	\$224.50	55%
TOTAL	\$1,038.40	\$666.10	\$372.20	29%

Table A-45 shows the updated damages with and without plan using 2006 values for all structures. The water surfaces that are used in the calculation reflect those that are expected in 2010 and 2060 at the beginning of the project life. Values reflect 2006 values for all structures. This means the value of the structures in 2060 are the same as they are in 2006. This is an unrealistic assumption. Therefore the Expected Annual Damages (called EAD) have been discounted back to 2010 in order to compare the 2060 damage levels directly with 2010 damages. This calculation gives an Equivalent Annual Damage (also called EAD) figure. Comparing damages to benefits, it is expected that damages throughout the Williamson Creek project would be reduced an average of 29%. The table displays the reduction by reach as well as total.

Table A-45
Williamson Creek
Equivalent Annual Reduction in Damages
(Dollars Discounted to 2006 Equivalents)

	Total Without Project	Total With Project	Damage Reduction	Municipal and Insurance Costs	Reduction
Heartwood	\$127.90	\$107.00	\$20.90		16%
Radam Broken	\$173.20	\$160.70	\$12.50		7.50%
Bow	\$299.40	\$192.20	\$107.30		36%
Bayton	\$381.40	\$172.90	\$208.50		55%
All Reaches				\$59.30	
Total	\$981.90	\$632.70	\$349.20	\$59.30	29%

SOCIOECONOMIC EFFECTS OF PLAN IMPLEMENTATION

The potential economic and social effects from implementation of the investigated plan on the study area are comprised of the value of the long-term reduction in periodic flood damages, direct and indirect short-term income, and employment impacts of project construction. The permanent reduction in periodic flood damages would effectively increase the income available to floodplain property owners released from the financial burden inherent to residing in the floodplain.

To the extent that this additional disposable income is spent within the city, it would result in a local "multiplier effect": increases in business revenues, employment, and personal income rippling throughout the local economy as each new dollar brought in is spent and re-spent. Property values, and local tax revenues, could also increase as a general result since the public perception of the area would be improved by project implementation.

Short-term impacts associated with project construction results from the temporary presence of construction workers and expenditures for construction materials and services. These expenditures would be expected to result in a positive multiplier effect on the local economy and would last for about two years. The lasting economic and social effects of project implementation would be the benefits resulting from the permanent reduction in flood damages and designation of the land for recreational and restoration purposes.

FINANCIAL CAPABILITY ANALYSIS

A financial capability analysis of the City of Austin and Travis County was conducted in accordance with ER 1105-2-100 to ascertain the sponsors' financial conditions and their 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 include population, per capita income and property tax information. Table 5-25 provides a key of the financial indicator ratings. Tables 5-26a and 5-26b show the indicator values and rating for the City of Austin and Travis County, respectively. 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 5-27a and 5-27b.

The population for the city of Austin between 2000 and 2005 exhibits a 1.01 percent annual rate of change. Over the same period, the population of Travis County grew at an annual rate of change of 1.8%. 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. This would indicate a growing economic base from which to draw future revenues to support additional debt.

The proportion of surplus/deficit expenditures to total expenditures is also a significant indicator of the community's strength. For the Austin, the ratio indicates a surplus condition and is within average range. Travis County is currently operating at a deficit with expenditures exceeding revenues. This is a weak indicator, but reviewing trends in the county's budgets overtime show the deficit narrowing in recent years.

The third indicator measures the efficiency of the city's tax collection system. Both entities have a collection rate of 98%, at the upper end of the rating range, providing 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 Austin is mixed, while the situation for Travis County is very stable based on these indicators. 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 Austin exhibits a weak value of 7.2 percent. Travis County's indicator is .70, indicating a strong position here to take on additional debt.

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 Travis County were used to estimate the per capita income of Austin. In 2004, the personal income of Travis County was \$31,482,920,000. 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 \$32,173,601,000. Using population data for Austin, the estimated personal income for 2004 would be \$25,003,689,000.

Indicator six shows net debt representing about 19.5% of personal income for the City of Austin, which shows a weak position. For Travis County, the ratio is 1.34%, indicating a strong position.

Indicators' seven and eight represent the per capita direct and overall net debt. For Austin, the direct net per capita is \$1,150, which is within the average range of most cities. It's

overall net debt per capita is \$5,168, significantly higher than average. For Travis County, both indicators are strong, with the per capita debts at \$476.

Finally, indicator nine compares the percentage of direct net debt due within five years to total outstanding direct net debt. Both sponsor's have fall within the strong range of the scale, with 39.7% for Austin and 42.7% for Travis County.

Table A46
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-47
Community Financial Indicator Values
For the City of Austin

Indicator	Value	Rating
1. Annual rate of change in population	1.01%	Strong
2. Current surplus/deficit as a percent of total current expenditures	1.42%	Average
3. Real property tax collection rate	98%	Average
1. Property tax revenues as a percent of full market value of real property	.437%	Strong
5. Overall net debt as a percent of full market value of real property	7.17%	Weak
6. Overall net debt outstanding as a percent of personal income	19.5%	Weak
7. Direct net debt per capita	\$1,150	Average
8. Overall net debt per capita	\$5,168	Weak
9. Percent direct net debt outstanding due within next 5 years	39.7%	Strong

Travis County shows strong indicators in the majority of the categories, while Austin shows a more mixed result. Looking at other trends, including population growth, unemployment rates and bond ratings for the areas, there are no strong indicators that would suggest the two sponsor's would find difficulty in meeting their financial obligations or their cost apportionment of the projects.

Table A-48
Community Financial Indicator Values
For the Travis County

Indicator	Value	Rating
1. Annual rate of change in population	1.8%	Strong
2. Current surplus/deficit as a percent of total current expenditures	-2.8%	Weak
3. Real property tax collection rate	98%	Average
4. Property tax revenues as a percent of full market value of real property	.50%	Strong
5. Overall net debt as a percent of full market value of real property	.70%	Strong
6. Overall net debt outstanding as a percent of personal income	1.34%	Strong
7. Direct net debt per capita	\$476	Strong
8. Overall net debt per capita	\$476	Strong
9. Percent direct net debt outstanding due within next 5 years	42.7%	Strong

Table A-49
City of Austin
Summary of Financial Capability

A. BOND RATINGS	Rating	Date	
General Obligation	Aa2, AA+	Sep 05	
Revenue Bond			
Utility Prior Lien	A2, A+	Sep 05	
Utility Sub Lien	A2, A, A+	Sep 05	
Utility Sep Sub Lien	A3, A2, A, A+	Sep 05	
B. DEBT	Outstanding	Projected	Total
General Obligation Bonds	\$927,401,000		\$927,401,000
Revenue Bonds	\$3,157,400,000		\$3,157,400,000
Gross Direct Debt	\$1,610,934,000		\$1,610,934,000
Direct Net Debt	\$805,352,000		\$805,352,000
Overlapping Net Debt 1/	\$2,813,991,000		\$2,813,991,000
Overall Net Debt	\$3,619,343,000		\$3,619,343,000
Other Debt 2/	\$416,412,000		\$416,412,000
Estimated Future Debt	\$292,335,000		\$292,335,000
C. DEBT REPAYMENT SCHEDULE (principle only)			
	Outstanding	Projected	Total
Year 1	\$566,634,000	0	\$566,634,000
Year 2	\$230,388,000	0	\$230,388,000
Year 3	\$225,802,000	0	\$225,802,000
Year 4	\$211,074,000	0	\$211,074,000
Year 5	\$203,929,000	0	\$203,929,000
D. DEBT LIMITS			
<p>¹ Overlapping net debt is the sponsor's share of taxes owed to other taxing bodies within the community, ie., a flood district.</p> <p>² Other debt obligations include outstanding leases, unfunded pension liabilities, and notes with a maturity.</p>			

**Table A-50
Travis County
Summary of Financial Capability**

A. BOND RATINGS	Rating	Date	
General Obligation	AAA	Sep 05	
Revenue Bond			
B. DEBT	Outstanding	Projected	Total
General Obligation Bonds	\$430,316,881		\$430,316,881
Revenue Bonds	\$0		\$0
Gross Direct Debt	\$430,316,881		\$430,316,881
Direct Net Debt	\$422,728,919		\$422,728,919
Overlapping Net Debt 1/	\$0		\$0
Overall Net Debt	\$422,728,919	\$422,728,919	\$422,728,919
Other Debt 2/	\$1,070,327		\$1,070,327
Estimated Future Debt			
C. DEBT REPAYMENT SCHEDULE (principle only)			
	Outstanding	Projected	Total
Year 1	35,181,000	0	35,181,000
Year 2	35,181,000	0	35,181,000
Year 3	35,181,000	0	35,181,000
Year 4	35,181,000	0	35,181,000
Year 5	35,181,000	0	35,181,000
			175,905,000
D. DEBT LIMITS			
<p>Article III, Section 52 of the Texas Constitution and Section 1471.011 of the Texas Government Code. Article III, Section 52 debt outstanding cannot exceed 25% of taxable assessed value within the County. Article VIII, Section 9 of the Texas Constitution and Subchapter C, Chapter 271 of the Texas Local Government Code Texas Constitution and Chapter 331 of the Texas Local Government Code.</p>			
<p>¹ Overlapping net debt is the sponsor's share of taxes owed to other taxing bodies within the community, ie., a flood district.</p> <p>² Other debt obligations include outstanding leases, unfunded pension liabilities, and notes with a maturity.</p>			

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 and for ecosystem restoration projects it is 35 percent. The recommended plan's B/C ratio of 1.5 was divided by four to yield a BBF of 38 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, for Austin, Sunset Valley, and Travis County it is 116.75, 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 -7.76 was calculated for Austin, Sunset Valley, and Travis County. 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 38 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 sponsors do 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.

Recreation Maximization Analysis

The local sponsors identified facilities they wanted within a recreation facility if one were to be used as an alternate use of the vacated land. Three levels of these plans were then evaluated. The only difference among the plans was the amount of recreation facilities included. These included a low, medium, and high density recreation plan. The LPP was also evaluated to find the maximized plan. Costs of acquiring the land are the same in all cases. For the purposes of comparing recreation benefits alone, these costs have been excluded from the analysis.

Table A-51
Recreation Analysis
Timber Creek
Values in 2004 Dollars

	Low Density Plan	LPP Plan	Mid Density Plan	High Density Plan
Annual Recreation charges	\$93,748	\$93,748	\$110,556	\$145,766
Total Annual Benefits	\$420,000	\$470,000	\$484,903	\$529,948
NET BENEFITS	\$593,294	\$609,860	\$424,903	\$384,181
BENEFIT-TO-COST RATIO	4.31	4.74	4.3	3.64

OCFYB Alternatives
Values in 2004 Dollars

	Low Density Plan	LPP Plan	Mid Density Plan	High Density Plan
Annual Recreation charges	\$315,590	\$315,590	\$382,189	\$486,500
Total Annual Benefits	\$2,220,699	\$2,490,000	\$2,676,830	\$3,475,408
NET BENEFITS	\$1,905,109	\$2,003,816	\$2,294,641	\$2,988,908
BENEFIT-TO-COST RATIO	6.03	6.4	6	6.14

The low density plans were selected as the NED plans for the 2004 analysis. The LPP plans are the recommended plans for the both Timber Creek and OCFYB areas in combination with the proposed evacuation of the floodplains.

Depth-Percent Damage Relationships.

**A-52
Depth-Percent Damage Relationship for Residential Structure**

Stage	Percent Damage		Stage	Percent Damage	
	Structure	Contents ⁽¹⁾		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.

**Table A-53
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 impact the vehicle, and is assumed to be 1-foot above the ground elevation.