US Army Corps

of Engineers

Little Rock District

PRAIRIE CREEK AND TRIBUTARIES

RUSSELLVILLE, ARKANSAS

SECTION 205 FEASIBILITY STUDY

ECONOMIC ANALYSIS

June 2015

CESWL-PE

Contents

Economic Analysis

1 STUDY AREA

Russellville is the county seat of Pope County, Arkansas. The study area is located within the Arkansas River Basin, extending along Prairie Creek. Prairie Creek, including Engineers Ditch and the tributaries, has a 12.6 square mile drainage basin. The project area is generally centered in the center of the city of Russellville. The study area includes Prairie Creek, Prairie Creek Tributaries, and Engineers Ditch.

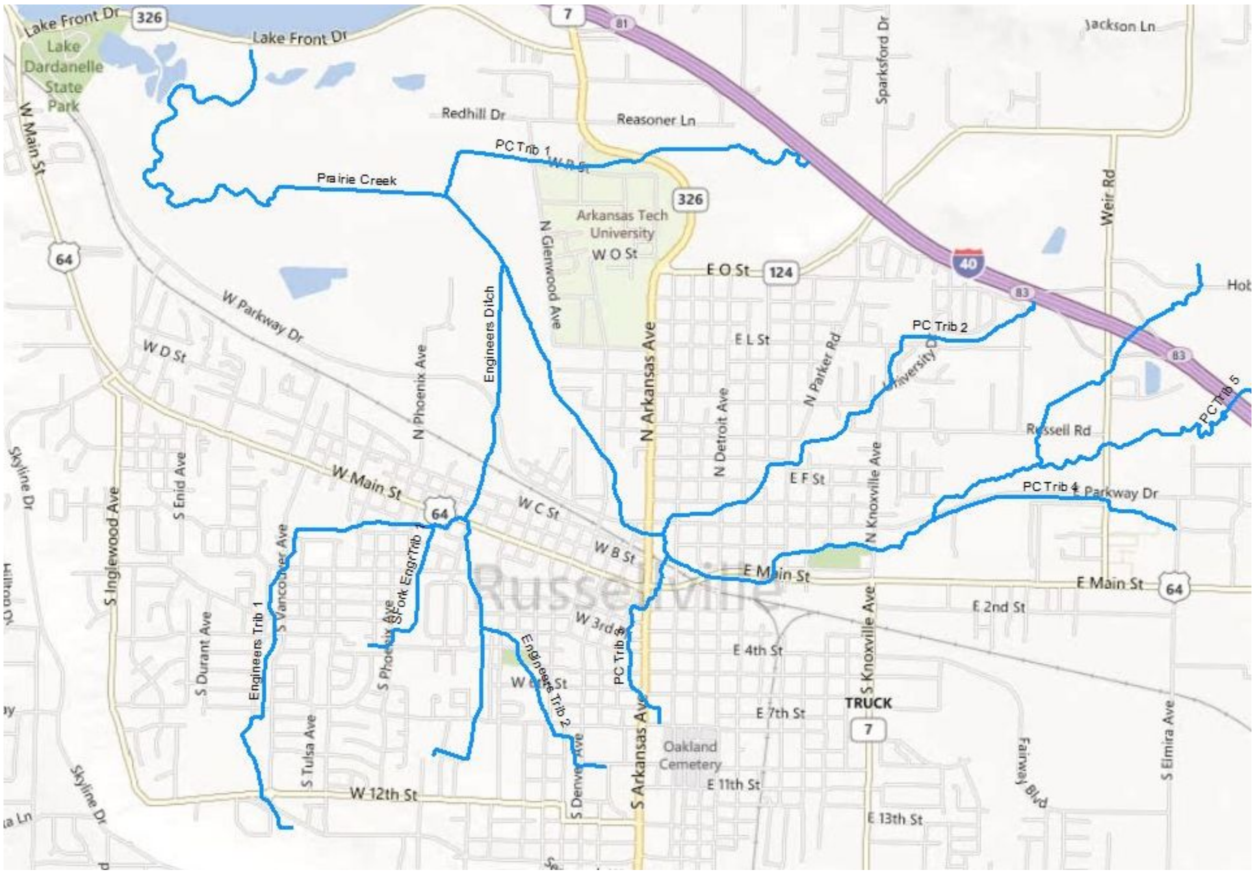
Substantial residential, commercial, and industrial development has occurred on the floodplain. Historical flood events indicate that flooding along the basin is flashy in nature with the water rising to maximum flows in about an hour and then receding over the next few hours. Flooding will continue along the entire length of the study area, causing additional economic damages to residential, commercial, light industrial, and public property.

Prairie Creek runs through the downtown business district, residential neighborhoods, city parks, and commercial and industrial areas. For analysis purposes, the Study area was delineated into "reaches," all of which exhibit fairly dense urban land use. Figure 1 illustrates the delineation of the reaches and Table 1 lists the reaches by title, description, and river stationing.

Table 1: Reach Delineation

Reach Name	**Description**	**Beginning Station**
Engineers Ditch 1,2	Mixed commercial, industrial, and residential to the northwest of downtown	0.00 on Engineers Ditch
Engineers Ditch 3	Mostly residential with a few government offices and one large commercial store to the northwest of downtown	4,975.00 on Engineers Ditch
Engineers Tributary 1	Mixed commercial and residential to the southwest of downtown	0.00 on Engineers Tributary 1
Prairie Creek 1,2,3	Mixed commercial, industrial, and residential to the north and through downtown	0.00 on Prairie Creek
Prairie Creek 4,5A,5B	Mixed commercial and residential east of downtown	18,250.00 on Prairie Creek
Prairie Creek Trib 2	Mostly residential to the northeast and through downtown	0.00 on Prairie Creek Tributary 2
Prairie Creek Trib 3	Mostly commercial to the south and through downtown	0.00 on Prairie Creek Tributary 3

Figure 1: Study Reaches



2 DEMOGRAPHIC DATA

Population is one parameter of community change. As the population in an area increases or decreases, so does the demand for infrastructure. Population estimates from the 2010 US Census shows growth in Russellville, Pope County, Arkansas and the US. This data is shown in Table 2.

Table 2: Population Change 2000 - 2010

Location	Population 2000	Population 2010	Population Change 2000-2010
Russellville	23,682	27,920	17.8%
Pope County	54,469	61,754	13.4%
Arkansas	2,673,400	2,915,918	9.1%
United States	281,421,906	308,745,538	9.7%
Data source: 2000 and 2010 US Census			

As shown in Table 2, from 2000-2010, Russellville's population grew over 17 percent while Arkansas grew about 9 percent. The national population grew just over 9 percent along the same period of time. Such rapid growth in population greatly increases the demand for public services and infrastructure such as schools, roads, medical care facilities, etc.

More detailed Russellville population characteristics are listed in Table 3.

Table 3: Population Characteristics of Russellville, AR

	Estimate	Percent	U.S.
Total Population	27,920	-	-
White	23,238	83.2%	72.4%
Black or African American	1,536	5.5%	12.6%
American Indian or Alaska Native	182	0.7%	0.9%
Asian	433	1.6%	4.8%
Native Hawaiian and Other Pacific Islander	11	0.0%	0.2%
Some other race	1,867	6.7%	6.2%
Two or more races	653	2.3%	2.9%
Age			
Under 18 years	8,150	29%	24%
between 18 and 64 years	16,318	59%	63%
65 years and over	3,452	12%	13%
Income (2010 Dollars)*			
Per Capita Income	19,610	-	27,334
Median housing value (owner occupied)	108,700	-	188,400
Persons below poverty level		22.2%	13.8%
Unemployment rate		4.8%	7.8%
Education level for those over 25 years old*		-	-
High school graduate and over	-	84.4%	85%
Bachelor's degree or higher	-	24.5%	27.9%

Data source: US Census 2010 estimates
*Data source: US Census 2010 American Community Survey, Selected Social Characteristics, Selected Economic Characteristics, 5-year estimates: 2006 - 2010

As Table 3 shows, the population in the study area is primarily white and slightly younger than the United States population on average. Although, the median per capita income in Russellville is only 72 percent of the national median, the population is not as poor as these numbers suggest. The median housing value is 58 percent of the national median. If housing values are used as a rough measure of cost of living, then although the per capita income is lower than the nation as a whole, it is offset by a reduction in the cost of living. The percentage of persons in Russellville below the poverty level is significantly higher than the national rate. Russellville had an unemployment rate of 4.8 percent compared to 7.8 percent nationally.

Russellville has a slightly lower rate of those completing high school than the national rate, and the rate of earning a bachelor's degree or higher is slightly lower than the national rate.

2.1 Housing

Russellville has larger percentage of occupied housing units as the nation, but significantly fewer of the housing units are owner-occupied. The average household size for both owner-occupied and renter-occupied housing units is similar than the national average. Housing data is presented in Table 4.

Table 4: Housing and Vehicles

	Russellville Estimate	%	U.S. Estimate
Total Housing Units	**10,809**	**-**	**130,038,080**
Occupied housing units	10,050	92.9%	88.6%
Owner occupied housing units	5430	50.2	66.6%
Average household size of owner-occupied	2.54	-	2.67
Average household size of renter-occupied	2.47	-	2.42
Vehicles Available in Occupied Housing Units			
No Vehicle	585	5.8%	8.9%
1 vehicles	3,562	35.4%	33.3%
2 vehicles	4,075	40.5%	37.9%
3 or more vehicles	1,828	18.2%	20%
Data source: US Census American Community Survey, Selected Housing Characteristics, 5 year estimates: 2006-2010			

2.2 Families

The city of Russellville has fewer households residing as families than the nation as a whole, with more households with individuals under 18 years old and fewer houses with individuals over 65 years old. Russellville has a smaller average household size than the nation as a whole. Family data is in Table 5.

Table 5: Family Data

	Russellville Estimate	%	U.S. Estimate
Total Households	10,050	-	114,235,996
Family Households	6,470	64.4	66.8%
Households with individuals under 18 years	3,444	34.3	33.9%
Households with individuals 65 years and over	2089	20.8	24.0%
Average household size	2.51	-	2.59
Data source: US Census American Community Survey, Selected Social Characteristics, 5 year estimates: 2006-2010			

2.3 EMPLOYMENT AND LABOR FORCE

2.3.1 Employment

The distribution of employment in Russellville is representative of the nation as a whole, except for higher percentages in manufacturing and retail trade and lower percentages in service related industries, as shown in Table 6.

Table 6: Total and Part-Time Employment by Major Industry Sector by Place of Work, 2010

Employment	**Russellville Estimate**	**U.S. Estimate**
Total Employment	13.147	141,833,331
Percent Distribution of Employment by Industry Sector		
Farming, Forestry, Mining	1.2	1.9
Construction	4.1	7.1
Manufacturing	17.4	11.0
Wholesale Trade	2.0	3.1
Retail Trade	16.6	11.5
Transportation, Communication, Utilities	6.4	5.1
Information	1.0	2.4
Finance, Insurance, Real Estate	5.5	7.0
Professional, Scientific, Management, Administrative Services	6.5	10.4
Educational, Health Care, Social Services	20.7	22.1
Arts, Entertainment, Recreation, Accommodation and Food Services	10.6	8.9
Other Services	4.9	4.9
Public Administration	3.3	4.8
Data Source: US Census Bureau, American Community Survey, Selected Economic Characteristics, 5 year estimates: 2006-2010.		

2.3.2 Labor Force

General employment statistics for Russellville are similar to the nation as a whole, as seen in Table 7.

Table 7: Employment Status

	Russellville Estimate	**%**	**U.S. Estimate**
Population 16 years and over	**21,806**		**238,733,844**
In labor force	14.196	65.1	65.0%
Employed	13,147	60.3	59.4%
Unemployed	1,038	4.8	5.1%
Not in labor force	7,610	34.9	35%
Data Source: US Census Bureau, American Community Survey, Selected Economic Characteristics, 5 year estimates: 2006-2010.			

3 ECONOMIC EVALUATION PROCEDURES, ASSUMPTIONS, AND METHODOLOGIES

The economic analysis evaluated the alternatives on the basis of flood-related costs and damages avoided. Flood damages and costs considered in the economic analysis included flood damages to residential and nonresidential structures and contents, damages to vehicles, and public damages (infrastructure and emergency response expenditures).

The economic justification of an alternative was determined by comparing the expected annual benefits to the expected annual costs. If the annual benefits for an alternative exceed the annual costs, then the alternative was considered economically justified. In such cases, the benefit-to-cost ratio (BCR) was greater than 1.0. For this analysis, the expected annual cost of an alternative was determined by considering a number of factors, including construction cost, timing of construction period, interest during construction, and operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) costs. The costs were based on an October 2014 price level, a period of analysis of 50 years, and were annualized to an annual equivalent cost using the FY 2015 Federal Discount Rate of 3.375 percent. The expected annual cost for an alternative was subtracted from the expected annual benefit to compute the net annual benefit. For Prairie Creek study, the year the proposed project is expected to be in operation (the base year) was set at 2018. The most likely future year was set at 2068.

3.1 FIRST FLOOR ELEVATIONS

To identify the structures to include in the study, digital maximum floodplain maps were used. A windshield survey was performed to assign the structures with a "Corps ID" number which was retained throughout the study. The ground elevation for each structure indentified from the maps, were obtained by querying a LIDAR layer and foundation heights were assumed to be 0.5 foot.

3.2 STRUCTURE AND CONTENT VALUES

Knowledge of existing residential and nonresidential development located in a floodplain is critical to evaluating an FRM project. Potential flood damages to residential and nonresidential structures in the study area were evaluated through a structure inventory. The purpose of the structure inventory was to collect data on residential and nonresidential structures located in the Study area.

3.2.1 Data Collection

Most commercial, industrial, and residential property values were obtained from the Pope County Tax Assessor whose estimates are updated every 2 years and can be accessed online. The assessor's estimates, confirmed by the assessor's office, are derived by taking the structure's replacement cost less its depreciation.

There were 10 structures (mostly public) for which there was no assessment. The values of these structures were obtained by doing a price per square foot estimate based on the type of the structure.

3.2.1.1 Residential Structures

Structure values for residential properties were retrieved from the county tax assessor's office. Residential properties were classified first by whether they are a single or multi family home then by the number of stories and if they have a basement or not. Structure counts are listed in Table 8.

Table 8: Residential Structures

Structure type	Structure Count	Structure values ($)
Single Family - 1 Story	133	5,507,850
Single Family - 1 Story w/ Basement	0	0
Single Family - 2 Story	7	832,800
Multi-Family - 1 Story	24	2,192,050
Multi-Family - 2 Story	12	2,232,800
Total	**176**	**10,765,500**

Content values of residential structures were calculated based on US Army Corps of Engineers Economic Guidance Memorandum #04-01.

3.2.1.2 Commercial and Industrial Structures

Commercial and industrial structure values were retrieved from the Greene County tax assessor's office. Structures were categorized by the type of business and the number of stories. The counts of commercial and industrial structures that fall within the maximum projected floodplain are included in Table 9.

Table 9: Commercial and Industrial Structures

Structure type	Structure Count	Structure values ($)
Commercial	**87**	**20,697,800**
Furniture Store	2	216,750
Grocery Store	2	2,900,000
Medical - 1 Story	11	2,150,500
Office - 1 Story	32	4990400
Office - 2 Story	2	891,900
Restaurant - 1 Story	4	940,150
Fast Food Restaurant - 1 Story	2	321,700
Retail - 1 Story	24	5,438,750
Shopping - 1 Story	2	1,663,600
Vacant	**5**	**277,050**
Industrial	**21**	**2,611,450**
Warehouse - 1 Story	12	2,012,900
Light Manufacturing - 1 Story	9	598,550
Total	**108**	**23,309,250**

Content values and depth-damage curves for non-residential properties were estimated using US Army Corps of Engineers (USACE) Sacramento District American River Watershed Project Folsom Dam Modification Draft Economic Reevaluation Report Appendix D, Attachment II Technical Report: Content Valuation and Depth-Damage Curves for Nonresidential Structures (ARW). It was assumed that non-residential structures in the Prairie Creek floodplain were similar to the prototypical structures used in the development of the non-residential depth-damage curves created in ARW. As noted in the invitation packet to expert-elicitation participants, "Depth refers to the depth of flooding above or below the first floor of the structure." Given these instructions to the panel, with photographs and sample properties depicting the 14 prototypes of commercial structures in the ARW study, a team of economists on the Prairie Creek study used professional judgment to determine that the depth damage curves are applicable to Prairie Creek structures. Refer to the ARW report for further information on how the depth-damage curves were created.

ARW was also used because the study developed a way to calculate non-residential content values based on the type of structure. Content value was determined by applying a value per square foot based on the type of business occupying the structure. It was assumed that content distribution and content type was similar in structures in the Prairie Creek floodplain to those structures used in ARW. ARW's content value derivation methodology was approved by the US Army Corps of Engineers. A windshield survey was taken to determine commercial vacancies and vacant buildings were assumed to have no content inside the structure. ARW values from 2009 were updated to October 2014 using the Producer Price Index for all finished goods.

3.2.1.2.1 Public Structures

Most public structures were not included in the county's assessment of structure values. The values of public structures were not included in the tax assessments. Square feet estimates for public structures were not taken by the county tax assessor; square footage was estimated with digital imagery and GIS tools. Public structures are identified in Table 10.

Table 10: Public Structures

Structure type	**Structure Count**	**Structure values ($)**
Church	5	129,000
Government	5	6,209,500
Recreational	1	10,000
School	1	3,300,000
Total	**12**	**9,648,500**

Content values for public structures were found using the ARW methodology described above.

3.2.2 Vehicles

As shown below, it was estimated that .72 vehicles per residence were vulnerable to flooding. Census data for the number of households and vehicles available was used to calculate an average of 1.26 vehicles per household in the city. Vehicles were assumed to be at the one foot below the structure to which they were paired, and damages begin at one foot above the ground level. It was estimated that .80 cars will be at each house at any given time that a flood could occur, as shown in Equation 1. It was assumed that .945 vehicles (75 percent of 1.26) were present during non-work hours and .315 vehicles (25 percent of 1.26) were present during normal working hours. It was assumed that working hours are 40 hours per week, leaving 128 non-working hours per week for a total of 168 hours a week.

Equation 1: (.945*(128/168))+(.315*(40/168))= .80

The city of Russellville does not have a flood warning system and residents are given no formal warning of flash flooding. Russellville officials estimate that residents have less than one hour to evacuate their vehicles from the floodplain. This estimate is based on historical flooding in the Prairie Creek area where it has taken less than an hour for flows to reach peak heights once precipitation began. Precipitation can be very localized resulting in flooding in areas that may not have received much rainfall. Therefore, we assumed that 90 percent of vehicles remained in the floodplain during a high water event.

Equation 2: .80*.90= .72

It was also assumed that a plausible value for a vehicle results by assuming $8,300 per vehicle (USACE Jordan Creek Flood Risk Management Study, Springfield, Missouri). The Jordan Creek methodology was used because the population demographics are not substantially different from those in this study.

Average vehicle value in the maximum projected floodplain (500-year) using this method was approximately $8,300. This was consistent with field observations of vehicles within the project area. Vehicle Value (V) was then multiplied by .72 to represent the value of vehicles left at each residence during a flood event. In summary, the value of damageable vehicles at residential properties = number of vehicles per household x vehicle value x the percent of vehicles remaining during a flood event.

The data available to the District did not allow the implementation of the methods outlined in EGM #09-04 to their full extent. If vehicle data for each structure becomes available, the District will use the process listed in the EGM.

Non-residential (including public) vehicle values, were assumed to be $8,300 per vehicle ($8,300 is the average value of a vehicle in the 500-year floodplain, as explained in the preceding paragraph). Vehicle values for non-residential properties were assumed to be at their locations 8 hours per day, 5 days per week. Therefore, vehicle values at non-residential locations are multiplied by .238 (5/7 * 8/24 = .238) to accurately account for this assumption. Detailed aerial photographs of the floodplain were examined to determine the approximate number of vehicles located at each non-residential structure.

3.3 DEPTH DAMAGE FUNCTIONS

3.3.1 Residential

The city of Russellville, Arkansas is a typical city. The residences are typical to the type of construction represented by the Corps of Engineers' generic depth-damage curves. EGM #04-01 provided depth-damage curves for residential structures based on house type and applied content damages as a percentage of the structure value in which the contents reside.

3.3.2 Commercial, Industrial, and Public Structures

Depth-damage curves for non-residential properties were estimated using ARW. It was assumed that non-residential structures in the Prairie Creek floodplain were similar to the prototypical structures used in the development of the non-residential depth-damage curves created in ARW. As noted in the invitation packet to expert-elicitation participants, "Depth refers to the depth of flooding above or below the first floor of the structure." Given these instructions to the panel, depth damage curves can be applicable to Prairie Creek structures. Refer to the ARW report for further information on how the depth-damage curves were created.

ARW was also used because the study developed a way to calculate non-residential content values based on the type of structure. Content value is determined by applying a value per square foot based on the type of business occupying the structure. It was assumed that content distribution and content type was similar in structures in the Prairie Creek floodplain to those structures used in ARW. ARW's content value derivation methodology was approved by the US Army Corps of Engineers. Vacant buildings were assumed to have no content inside the structure.

3.3.3 Vehicles

Automobile depth-damage curves with uncertainty were obtained from ARW. Automobile depth-damage curves from ARW were adjusted down by one foot, given that, on average, vehicles in the study area were parking one foot below the first floor elevation of residences and businesses. A random sample of residences and businesses was taken of vehicle elevations in relation to the FFE of each structure resulting in an average height difference of negative one foot.

3.4 REACH CHARACTERISTICS

The study area encompasses all or parts of two streams (Prairie Creek and Engineers Ditch) and three of their tributaries (Prairie Creek Trib 2, Prairie Creek Trib 3, Engineers Ditch Trib 1). Prairie Creek is divided into two reaches. Engineers Ditch is divided into two reaches. There is a reach for each of the tributaries. These seven reaches are delineated based on their economic distinctions from the other reaches. The seven economic reaches are further divided into hydrologic sub-reaches in which raise the confidence level of the analysis. Refer to H&H Appendix for sub-reach delineations. The numbers of structures that fall within the maximum projected floodplain are shown in Table 11. The water flows from the east to the west through the middle of Russellville. When flooding occurs along the creek, it is always of short duration.

Table 11: Structure Inventory

Reach	Number of structures in reach	Structures by type				Structure values ($)	Content values ($)
		Residential	Commercial	Industrial	Public		
ED1,2	58	25	23	8	2	6,395,900	8,371,200
ED3	33	23	6	0	4	8,523,300	10,431,500
ET1	3	2	1	0	0	400,700	375,700
PCT2	72	57	13	1	1	5,249,200	6,579,300
PCT3	14	1	11	1	1	7,776,600	5,256,100
PC1,2,3	50	26	18	4	2	7,675,400	13,133,500
PC4,5A,5B	65	42	14	7	2	6,795,200	7,110,800
Total	**296**	**176**	**87**	**21**	**12**	**43,723,300**	**53,812,800**

3.5 DAMAGE CALCULATIONS

Hydrologic Engineering Center – Flood Damage Analysis software (FDA) version 1.2.5a was used to calculate flood damages to structures and their content as well as damages to vehicles. FDA used an index point within each stream reach, a structure's FFE, and a structure's stationing along a stream to determine whether structures were in the floodplain and, if so, used a depth-damage relationship to find how much damage occurred to each structure and its contents given a certain water elevation.

3.6 WITHOUT PROJECT CONDITION

3.6.1 Structures, Contents, and Autos: EAD and Single Event Damages

Equivalent Annual Damages were calculated for damages to structures, contents, and vehicles by FDA. Table 12 displays the without project estimates of Equivalent Annual Damages (EAD) as calculated by FDA.

Table 12: Equivalent Annual Damages, Without Project

Reach	**EAD: Without Project**
ED1,2	602,340
ED3	740,626
ET1	20,766
PCT2	766,883
PCT3	2,333,612
PC1,2,3	717,414
PC4,5A,5B	496,962
Total	**5,678,603**

Without project estimates of single-event damages in each of the reaches in the study area for specified frequency events are provided in Table 13; the damages shown are at October 2015 price levels.

Table 13

Annual Chance Exceedence (Recurrence Interval) Damages,Base Hydrology

	1- yr(0.99)	2-yr(0.5)	5-yr(0.2)	10-yr(0.1)	25-yr(0.04)	50-yr(0.02)	100-yr(0.01)	500-yr(0.002)
Engineers Ditch 1,2 - Damage	-	800	209,700	353,900	1,631,700	4,568,200	5,821,600	7,013,600
Structures	-	4	21	27	33	47	51	52
Engineers Ditch 3 - Damage	-	800	86,500	316,900	1,114,300	6,768,700	7,997,400	8,665,100
Structures	-	3	10	17	19	25	25	29
Eng Trib 1 - Damage	-	-	-	-	28,900	150,500	184,400	213,100
Structures	-	-	-	-	1	2	2	2
PC Trib 2 - Damage	400	66,200	884,700	1,509,200	2,219,300	2,464,500	2,748,600	3,545,300
Structures	7	14	23	31	36	42	42	49
PC Trib 3 - Damage	2,200	28,500	724,900	2,175,800	5,431,000	6,515,600	6,738,300	7,019,700
Structures	1	4	9	10	11	13	13	13
Prairie Creek 1-3 - Damage	800	63,000	253,900	653,200	1,368,800	2,233,900	3,188,400	4,568,200
Structures	1	5	12	25	28	31	32	36
Prairie Creek 4, 5a, 5b - Damage	300	23,300	524,100	970,200	1,353,400	1,760,600	2,177,100	3,372,000
Structures	1	12	33	43	48	51	53	57
Total Damage	3,700	182,600	2,683,800	5,979,200	13,147,400	24,462,000	28,855,800	34,397,000
Total Structures	10	42	108	153	176	211	218	238
Damages per Structure	370	4,348	24,850	39,080	74,701	115,934	132,366	144,525

4 BENEFIT ANALYSIS

4.1 NON-STRUCTURAL MEASURES ANALYSIS

Nonstructural flood risk reduction measures are an important consideration in flood risk management. To analyze the benefits of nonstructural buyout plans, several economists and GIS specialist used FDA output and GIS to identify and analyze "footprint" buyout plans. The buyout plans were analyzed in two rounds, using a 1.5 BCR as a screening tool for plans to move through the first and second rounds.

4.1.1 First Round

The FDA_Struct.out file from the FDA model of Without Project condition was used as the foundation of EAD analysis. A simple EAD calculating spreadsheet was created, with each tab depicting a "footprint" buyout plan. "Footprint" plans were created for structures which were affected by the 1/2 ACE, the 1/5 ACE, the 1/10 ACE, and the 1/25 ACE. The EAD calculating spreadsheet performed lookup functions (tied with links to the FDA output spreadsheet) to create a list of structures impacted by the flood event (for more than $500) and then to complete a damage table for each structure as seen in Figure 2.

Figure 2: Spreadsheet Calculations of EAD

Existing Conditions			Structure :				
Flood Event	Frequency	Change in Frequency	Damage 1000	Interval EAD	Cumulative EAD	Buyout Cost	Average Annual Cost
1	1.0000		$0				
		0.50000		$499	$499		
2	0.5000		$1,995				
		0.30000		$3,194	$3,693		
5	0.2000		$19,297				
		0.10000		$2,486	$6,178		
10	0.1000		$30,414				
		0.06000		$2,381	$8,559		
25	0.0400		$48,937				
		0.02000		$1,088	$9,646		
50	0.0200		$59,827				
		0.01000		$624	$10,270		
100	0.0100		$64,989				
		0.00800		$557	$10,828		
500	0.0020		$74,373				
		0.00200		$149	$10,977		
~	0		$74,373				
	EAD			$10,977		$110,477.50	$4,924.45

Each "footprint" tab calculated a benefit-cost ratio for a buyout plan: with assuming 100 percent removal of damages, an acquisition and demolition cost of 2.5 multiplied by the structure value, and amortization of the cost over 50 years at 3.75 percent interest. The 2.5 multiplier was a rough estimate received from the Real Estate appraiser that included the cost to buy the structure, the cost to buy property, the cost of relocation and administrative and legal fees. The buyout analysis results are presented in Table 14.

Table 14: Non-Structural Analysis for "Footprint" Plans

"Footprint" Plan	Structure Count	EAD	AAC	Net Benefits	BCR
2-year	28	1,055,782	530,577	525,205	2.0
5-year	96	2,187,966	1,783,581	404,385	1.23
10-year	125	2,332,227	2,300,659	31,568	1.01
25-year	159	2,417,545	2,735,542	-317,997	0.88

4.1.2 Second Round

Occasionally, spreadsheet calculations of EAD underestimate the EAD that FDA computes. To verify that spreadsheet analysis of buyout plans was not under-representing the damages, a separate FDA model was built and executed, with structures removed from inventory. FDA calculated the EAD of the 28 structures at $1,314,669 – insignificantly different than the spreadsheet analysis.

Table 15: Non-Structural Analysis for "Footprint" Plans, Economic Analysis

"Footprint" Plan	Structure Count	EAD	AAC	Net Benefits	BCR
2-year	28	1,314,669	530,577	784,092	2.5

4.2 STRUCTURAL MEASURES ANALYSIS

In the plan formulation process, many structural plans were created and analyzed with FDA. Several structural plans were eliminated through four rounds of the formulation process as documented in the main report.

4.2.1 Detention Basins

Detention basin analysis (as described in the H&H Appendix) showed the results of the reservoir routing through the basins to determine the basins that provide the most benefit to the project. The results of the H&H analysis showed two basins provided a significant reduction in flow. In a preliminary analysis, two detention pond FDA models were created: Storage Area 1 and Storage Area 2. The benefits from reducing EAD for the two plans in early formulation were compared to initial cost estimates. Using professional judgment, the engineers on the team determined that given the costs of the two storage areas, Storage Area 1 is the economically efficient detention pond. FDA benefits are shown in Table 16.

Table 16: Benefits and BCR for Detention Pond Measure, Preliminary Economics

Plan	FDA Benefits
Storage Area 1	**887,200**
Storage Area 2	439,900

Given a preliminary cost estimate, the benefit to cost ratio for Detention is shown in Table 17. With a benefit-to-cost ratio greater than 1, Storage Area 1 will be considered in the combined alternatives.

Table 17: Economic Analysis Detention Measure – Storage Area 1

Detention Ponds FEASIBILITY ANALYSIS 15-Apr-2014	
Item	Amount
Interest Rate,%	3.375%
Interest Rate, Monthly	0.281%
Construction Period, Years	2.00
Period of Analysis, Years	50
Project First Cost	$3,085,100
Interest During Construction	101,900
Investment Cost	3,187,000
Annual Cost	
Amortized Cost	132,800
OMRR&R	186,100
Total Annual Cost	318,900
Annual Benefits	
Structures, Contents, Auto	887,200
Total Annual Benefits	887,200
Benefit-to-Cost Ratio	2.8
Excess Benefits over Costs	568,300

4.2.2 Channel Measures

These measures consist of modifying an existing channel by either increasing the cross-sectional area of the stream channel (widening and/or deepening), straightening and realigning the stream channel, and/or reducing the friction losses of an existing channel through concrete lining. The design of the channel modification can vary significantly and is primarily based on the topography of the existing stream channel and the existing development of properties within the floodplain. Other factors to consider in the design of these hydraulic channel improvement alternatives include the existence of known or potential significant ecological and cultural resources as well as contaminated material.

Measures were developed to reduce flood stages in the most significant locations. They were not designed to a specific level of protection; rather, they were designed to maximize the benefits while reducing the real estate required. Due to the separate nature of Engineers Ditch and Prairie Creek, each stream was analyzed separately.

Table 18: Benefits and BCR for Engineers Ditch Measures, Preliminary Economics

Measure	FDA Benefits
Engineers Ditch 8	647,700
Engineers Ditch 9	637,200
Engineers Ditch 10	**650,200**
Engineers Ditch 11	650,100
Engineers Ditch RR Only	582,500

Using professional judgment, the engineers on the team determined that given the costs of the channel measures along Engineers Ditch, Measure ED10 is the economically efficient measure.

Table 19: Economic Analysis Channel Measure – Engineers Ditch 10

Engineer Ditch Channel Measure 10 FEASIBILITY ANALYSIS 15-Apr-2014	
Item	Amount
Interest Rate,%	3.375%
Interest Rate, Monthly	0.281%
Construction Period, Years	2.00
Period of Analysis, Years	50
Project First Cost	$3,949,100
Interest During Construction	130,400
Investment Cost	4,079,500
Annual Cost	
Amortized Cost	174,000
OMRR&R	54,300
Total Annual Cost	224,300
Annual Benefits	
Structures, Contents, Auto	650,200
Total Annual Benefits	650,200
Benefit-to-Cost Ratio	2.9
Excess Benefits over Costs	425,900

Table 20: Benefits and BCR for Prairie Creek Reach 3 Measures, Preliminary Economics

Measure	FDA Benefits
Prairie Creek 6	802,400
Prairie Creek 7	757,400
Prairie Creek 8	**832,400**

Using professional judgment, the engineers on the team determined that given the costs of the three channel measures along Reach 3 of Prairie Creek, Measure PC8 is the economically efficient measure.

Table 21: Economic Analysis Channel Measure – Prairie Creek 8

Reach 3 Prairie Creek Channel Measure 8 FEASIBILITY ANALYSIS 15-Apr-2014	
Item	Amount
Interest Rate,%	3.375%
Interest Rate, Monthly	0.281%
Construction Period, Years	2.00
Period of Analysis, Years	50
Project First Cost	5,020,500
Interest During Construction	165,800
Investment Cost	5,186,300
Annual Cost	
Amortized Cost	216,100
OMRR&R	71,900
Total Annual Cost	288,000
Annual Benefits	
Structures, Contents, Auto	832,400
Total Annual Benefits	832,400
Benefit-to-Cost Ratio	2.9
Excess Benefits over Costs	544,400

Table 22: Benefits and BCR for Prairie Creek Reach 4 and 5 Measures, Preliminary Economics

Measure	FDA Benefits
Prairie Creek 12	638,600
Prairie Creek 13	**684,900**
Prairie Creek 15	641,000

Using professional judgment, the engineers on the team determined that given the costs of the three channel measures along Reach 4 and 5 of Prairie Creek, Measure PC13 is the economically efficient measure.

Table 23: Economic Analysis Channel Measure – Prairie Creek 13

Reach 4 and 5 Prairie Creek Channel Measure 13 FEASIBILITY ANALYSIS 15-Apr-2014	
Item	Amount
Interest Rate,%	3.375%
Interest Rate, Monthly	0.281%
Construction Period, Years	2.00
Period of Analysis, Years	50
Project First Cost	1,870,500
Interest During Construction	61,800
Investment Cost	1,932,300
Annual Cost	
Amortized Cost	80,500
OMRR&R	54,300
Total Annual Cost	136,800
Annual Benefits	
Structures, Contents, Auto	684,900
Total Annual Benefits	684,900
Benefit-to-Cost Ratio	5.1
Excess Benefits over Costs	550,100

4.2.3 Combined Alternatives

For details of how the team screened to the combined alternatives from these reach-specific elements, see the main report.

4.2.3.1 Combined Alternative 1

This alternative targets the frequent rainfall events

- Engineers Ditch – The channel will be widened to a 20 or 25 foot bottom depending on the subreach number. West B and West C Street bridges will both be replaced. Two additional culverts will be placed under the Union Pacific Railroad.
- Prairie Creek Reach 4 and Reach 5 – The channel will be widened to a 20 foot bottom with 1V:2.5H SS.
- Prairie Creek Reach 3 – channel will be widened to 45 or 50 feet depending on the subreach section. Culverts will be added to the Commerce Bridge and the West Parkway Bridge. The North El Paso culverts will be cleaned.

FDA benefits are shown in Table 24.

Table 24: EAD, Alternative 1

Reach	**EAD $**	**Benefits $**
ED1,2	167,535	434,806
ED3	576,061	164,565
ET1	9,739	11,027
PCT2	412,037	354,846
PCT3	1,901,920	431,692
PC1,2,3	135,816	581,598
PC4,5A,5B	278,733	218,229
Total	**3,481,840**	**2,196,763**

With preliminary cost estimates, the benefit-to-cost ratio is shown in Table 25.

Table 25: Economic Analysis, Alternative 1

FEASIBILITY ANALYSIS 01-Oct-2014	
Item	Amount
Interest Rate,%	3. 375%
Interest Rate, Monthly	0.281%
Construction Period, Years	2.00
Economic Life, Years	50
Project First Cost	10,840,118
Interest During Construction	357,900
Investment Cost	11,198,018
Annual Cost	
Amortized Cost	466,703
OMRR&R	131,500
Total Annual Cost	598,200
Annual Benefits	
Structures, Contents, Auto	2,196,763
Total Annual Benefits	2,196763
Benefit-to-Cost Ratio	3.67
Excess Benefits over Costs	1,598,567

4.2.3.2 Combined Alternative 2

This alternative provides the highest level of protection for all frequencies.

- Engineers Ditch –The channel will be widened to a 20 or 25 foot bottom depending on the subreach number. West B and West C Street bridges will both be replaced. Two additional culverts will be placed under the Union Pacific Railroad.
- Prairie Creek Reach 4 and Reach 5 – The channel will be widened to a 20 foot bottom with 1V:2.5H SS.
- Prairie Creek Reach 3 – channel will be widened to 45 or 50 feet depending on the subreach section. Culverts will be added to the Commerce Bridge and the West Parkway Bridge. The North El Paso culverts will be cleaned.
- Include Storage Area 1

FDA benefits are shown in Table 26.

Table 26: EAD, Alternative 2

Reach	**EAD $**	**Benefits $**
ED1,2	170,935	431,406
ED3	575,797	164,828
ET1	9,573	11,193
PCT2	289,496	477,387
PCT3	1,881,893	451,719
PC1,2,3	154,622	562,792
PC4,5A,5B	269,435	227,527
Total	**3,351,751**	**2,326,852**

With preliminary cost estimates, the benefit-to-cost ratio is shown in Table 27.

Table 27: Economic Analysis, Alternative 2

FEASIBILITY ANALYSIS 1-Oct-2014	
Item	Amount
Interest Rate,%	3.375%
Interest Rate, Monthly	0.281%
Construction Period, Years	2.00
Economic Life, Years	50
Project First Cost	13,925,300
Interest During Construction	459,800
Investment Cost	14,385,100
Annual Cost	
Amortized Cost	599,500
OMRR&R	207,300
Total Annual Cost	806,800
Annual Benefits	
Structures, Contents, Auto	2,326,852
Total Annual Benefits	2,326,852
Benefit-to-Cost Ratio	2.88
Excess Benefits over Costs	1,520,030

4.2.3.3 Combined Alternative 3

This alternative targets the low frequency events.

- Engineers Ditch – The channel will be widened to a 20 or 25 foot bottom depending on the subreach number. West B and West C Street bridges will both be replaced. Two additional culverts will be placed under the Union Pacific Railroad.
- Prairie Creek Reach 3 – channel will be widened to 45 or 50 feet depending on the subreach section. Culverts will be added to the Commerce Bridge and the West Parkway Bridge. The North El Paso culverts will be cleaned.
- Include Storage Area 1

FDA benefits are shown in Table 28.

Table 28: EAD, Alternative 3

Reach	EAD $	Benefits $
ED1,2	170,935	431,406
ED3	576,061	164,565
ET1	9,573	11,193
PCT2	289,991	476,892
PCT3	1,890,241	443,371
PC1,2,3	154,754	443,371
PC4,5A,5B	476,074	20,889
Total	**3,567,629**	**2,110,974**

With preliminary cost estimates, the benefit-to-cost ratio is shown in Table 29.

Table 29: Economic Analysis, Alternative 3

FEASIBILITY ANALYSIS 1-Oct-2014	
Item	Amount
Interest Rate,%	3.375%
Interest Rate, Monthly	0.281%
Construction Period, Years	2.00
Economic Life, Years	50
Project First Cost	12,054,800
Interest During Construction	398,100
Investment Cost	12,452,900
Annual Cost	
Amortized Cost	519,000
OMRR&R	201,989
Total Annual Cost	721,000
Annual Benefits	
Structures, Contents, Auto	2,110,974
Total Annual Benefits	2,110,974
Benefit-to-Cost Ratio	2.93
Excess Benefits over Costs	1,389,984

4.2.3.4 Combined Alternative 4

This alternative targets a reduced budget, with an incrementally built plan. Pieces added to the plan, up to a budget which does not exceed $7 million of Federal expenditure.

- Engineers Ditch – The channel will **not** be widened. West B and West C Street bridges will **not** be replaced. Additional culverts will be installed under the Railroad Bridge.
- Prairie Creek Reach 4 and Reach 5 – The channel will be widened to a 20 foot bottom with 1V:2.5H SS.
- Prairie Creek Reach 3 – channel will be widened to 45 or 50 feet depending on the subreach section. Culverts will be added to the Commerce Bridge and the West Parkway Bridge. The North El Paso culverts will be cleaned.

FDA benefits are shown in Table 30.

Table 30: EAD, Alternative 4

Reach	EAD $	Benefits $
ED1,2	244,065	358,275
ED3	577,900	162,726
ET1	11,805	8,961
PCT2	412,231	354,652
PCT3	1,901,920	431,692
PC1,2,3	109,912	607,502
PC4,5A,5B	263,617	233,345
Total	**3,521,449**	**2,157,154**

With preliminary cost estimates, the benefit-to-cost ratio is shown in Table 31.

Table 31: Economic Analysis, Alternative 4

FEASIBILITY ANALYSIS 1-Oct-2014	
Item	Amount
Interest Rate,%	3.375%
Interest Rate, Monthly	0.281%
Construction Period, Years	2.00
Economic Life, Years	50
Project First Cost	8,817,100
Interest During Construction	291,100
Investment Cost	9,108,200
Annual Cost	
Amortized Cost	379,600
OMRR&R	80,800
Total Annual Cost	460,400
Annual Benefits	
Structures, Contents, Auto	2,157,200
Total Annual Benefits	2,157,200
Benefit-to-Cost Ratio	4.69
Excess Benefits over Costs	1,696,800

4.2.3.5 Combined Alternative 5

This alternative targets a reduced budget, with an incrementally built plan. Pieces added to the plan, up to a budget which does not exceed $7 million of Federal expenditure.

- Engineers Ditch – The channel will **not** be widened. West B and West C Street bridges will be removed. Additional culverts will be installed under the Union Pacific Railroad Bridge
- Prairie Creek Reach 4 and Reach 5 – The channel will be widened to a 20 foot bottom with 1V:2.5H SS.
- Prairie Creek Reach 3 – channel will be widened to 45 or 50 feet depending on the subreach section. Culverts will be added to the Commerce Bridge and the West Parkway Bridge. The North El Paso culverts will be cleaned.

FDA benefits are shown in Table 32.

Table 32: EAD, Alternative 5

Reach	EAD $	Benefits $
ED1,2	172,749	429,591
ED3	642,952	193,083
ET1	9,739	11,027
PCT2	437,519	329,364
PCT3	1,901,920	431,692
PC1,2,3	135,816	418,653
PC4,5A,5B	278,733	218,229
Total	**3,579,428**	**2,031,639**

With preliminary cost estimates, the benefit-to-cost ratio is shown in Table 33.

Table 33: Economic Analysis, Alternative 5

FEASIBILITY ANALYSIS 1-Oct-2014	
Item	Amount
Interest Rate,%	3.375%
Interest Rate, Monthly	0.281%
Construction Period, Years	2.00
Economic Life, Years	50
Project First Cost	10,495,000
Interest During Construction	346,600
Investment Cost	10,841,600
Annual Cost	
Amortized Cost	451,800
OMRR&R	90,000
Total Annual Cost	541,800
Annual Benefits	
Structures, Contents, Auto	2,031,600
Total Annual Benefits	2,031,600
Benefit-to-Cost Ratio	3.75
Excess Benefits over Costs	1,489,800

4.2.3.6 Tentatively Selected Plan

Alternative 4 is the NED Plan with the greatest net benefits. Alternative 4 has fewer environmental impacts than Alternative 5, and is preferred by the sponsor to Alternative 5

Table 34: Comparing Net Benefits

Plan	Investment Cost	BC Ratio	Net Benefits $
Buyout (2-Yr)	12,325,000	2.5	784,100
Alternative 1	11,198,000	3.6	1,598,567
Alternative 2	14,385,100	2.8	1,520,030
Alternative 3	12,452,900	2.9	1,389,984
Alternative 4	9,108,200	4.7	1,696,754
Alternative 5	10,841,600	3.8	1,489,800

4.2.4 Further Design and Cost Estimating of the Tentatively Selected Plan

The study team worked on the preliminary design and cost estimate of the Tentatively Selected Plan, Alternative 4. The preliminary cost estimate was copied from another study within the Little Rock District, and was missing several Prairie Creek details. The resulting design and cost estimate are significantly more expensive than the preliminary versions. In discussions with the design engineer and cost engineer, all the alternatives would be significantly higher. However, it was determined that the relative rankings of the alternatives would remain the same. A cost comparison from preliminary design to feasibility level design for selected plan has been added as Attachment D – Cost Difference Summary, Engineering Appendix B, to explain the differences. The updated design and cost estimate Alternative 4 is presented in Table 35.

Table 35: Economic Analysis, Alternative 4

FEASIBILITY ANALYSIS 1-Oct-2014	
Item	Amount
Interest Rate,%	3.375%
Interest Rate, Monthly	0.281%
Construction Period, Years	2.00
Economic Life, Years	50
Project First Cost	13,714,600
Interest During Construction	452,900
Investment Cost	14,167,500
Annual Cost	
Amortized Cost	590,500
OMRR&R	2,700
Total Annual Cost	593,200
Annual Benefits	
Structures, Contents, Auto	2,157,200
Total Annual Benefits	2,157,200
Benefit-to-Cost Ratio	3.6
Excess Benefits over Costs	1,564,000

Project First Cost excludes $648,400 of financial costs resulting from the cost of rebuilding a new facility that is greater than the in-kind replacement cost.