Appendix A
Economic Analysis Appendix

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1 INTRODUCTION

The Economic Analysis Appendix provides information on the methodologies and details of the economic analysis conducted for the Jordan Creek Flood Risk Management (FRM) Study, Springfield, Missouri (Study). Additional information regarding the Study can be found in the main report and appendices of the Study.

1.1 PURPOSE OF THE STUDY

This appendix describes the economic analysis of project alternatives for providing flood risk management measures for the city of Springfield, Missouri. The purpose is to provide a comprehensive review of the methodology applied and results of the economic analysis performed on the FRM alternatives for the Study.

1.2 STUDY AREA

Springfield is the county seat of Greene County and the third largest city in Missouri. The study area is located within the White River Basin, extending approximately six miles along Jordan Creek. Jordan Creek, including North Branch and South Branch Jordan Creek, at its confluence with Wilsons Creek has a 13.75 square mile drainage basin. The project area is generally centered on the Chestnut Expressway between U.S. Highway 65 to the east and U.S. Highway 160 to the west in the northern half of the city of Springfield. The study area includes Jordan Creek, North Branch Jordan Creek, South Branch Jordan Creek and the upstream portion of Wilsons Creek.

Substantial residential, commercial, and industrial development has occurred on the floodplain, with continuing development primarily in the south part of the city. The principal flood problem is insufficient channel size, whether vertical wall culverts, open channels, or narrow bridges. The increase in flood heights resulting from development and the absence of a storm system is also significant. Flood runoff from the headwaters of the North and South Branches of Jordan creek affects flood heights along Jordan Creek, as well as its outfall, Wilsons Creek.

Typically, area rainfall is fairly heavy and well distributed throughout the year. 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.

Jordan 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.

Figure 1: Economic Reaches

Table 1: Streams and Reaches Included in the Springfield Study Area

Reach Name	Description	Beginning Station
E1	Industrial area on the most downstream end of the Lower Branch (including a large pharmaceutical manufacturer with a floodwall protecting up to the 1/10 Annual Chance Exceedance event)	29,145.00 on Wilsons Creek
E2	Mixed industrial and residential area in the center of the Lower Branch	3,859.00 on Lower Branch of Jordan Creek
E3	Downtown Springfield on the upstream end of the Lower Branch	11,000.00 on Lower Branch of Jordan Creek
E4	Industrial area on the downstream end of the North Branch	0.00 on North Branch of Jordan Creek
E5	Residential area on the upper end of the North Branch	2,476.00 on North Branch of Jordan Creek
E6	Heavily Industrial area on the South Branch. Only reach on South Branch	0.00 on South Branch of Jordan Creek

2 CHARACTERISTICS OF THE STUDY AREA

2.1 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 Missouri and significant growth in Greene County. This data is shown in Table 2.

Table 2: Population Change 2000-2010

Location	Population 2000	Population 2010	Population Change 2000-2010
Greene County	240,391	275,174	14.47%
Missouri	5,595,211	5,988,927	7.04%
United States	281,421,906	307,006,550	9.09%
Data source: 2000 and 2010 US Census			

As shown in Table 2, from 2000-2010, Greene County's population grew over 14 percent while Missouri grew about 7 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 Springfield population characteristics are listed in Table 3.

Table 3: Population Characteristics of Springfield, MO

	Estimate	Percent	U.S.
Total Population	159,498	-	-
White	141,526	88.7%	72.4%
Black or African American	6,524	4.1%	12.6%
American Indian or Alaska Native	1,233	0.8%	0.9%
Asian	3,015	1.9%	4.8%
Native Hawaiian and Other Pacific Islander	267	0.2%	0.2%
Some other race	1,889	1.2%	6.2%
Two or more races	5,044	3.2%	2.9%
Age			
Under 18 years	24,176	18.3%	24%
between 18 and 64 years	112,201	67.2%	63%
65 years and over	23,121	14.5%	13%
Income (2010 Dollars)*			
Median per capita money income (last 12 months)	20,793	-	27,334
Median housing value (owner occupied)	103,800	-	188,400
Persons below poverty level	-	21.7%	13.8%
Unemployment rate***		5.5 %	7.8%
Education level for those over 25 years old*		-	-
High school graduate and over	-	86.6%	85%
Bachelor's degree or higher	-	25.6%	27.9%

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

As Table 3 shows, the population in the study area is primarily white and slightly older than the United States population on average. Although, the median per capita income in Springfield is only 76 percent of the national median, the population is not as poor as these numbers suggest. The median housing value is 55 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 Springfield below the poverty level is significantly higher than the national rate. In September 2012, Springfield had an unemployment rate of 5.5 percent compared to 6.9 percent for Missouri and 7.8 percent nationally.

Although Springfield has a slightly higher rate of those completing high school than the national rate, of those aged 25 and older, the rate of earning a bachelor’s degree or higher is slightly lower than the national rate.

2.2 HOUSING AND FAMILIES

2.2.1 Housing

Springfield has approximately the same percentage of occupied housing units as the nation as a whole, but significantly fewer of the housing units are owner-occupied. The average household size for both owner-occupied and renter-occupied housing units is smaller than the national average. Housing data is presented in Table 4.

Table 4: Housing and Vehicles

	Springfield Estimate	%	U.S. Estimate
Total Housing Units*	**76,851**	**-**	**131,704,730**
Occupied housing units	70,167	89.9	88.6%
Owner occupied housing units	35,701	50.9	66.6%
Average household size of owner-occupied	2.2	-	2.67
Average household size of renter-occupied	1.97	-	2.42
Vehicles Available in Occupied Housing Units*			
No Vehicle	6,127	8.7	8.9%
1 vehicles	30,997	44.2	33.3%
2 vehicles	25,046	35.7	37.9%
3 or more vehicles	7,997	11.4	20%

Data source: US Census Quick Facts, American Community Survey, October 2012

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

2.2.2 Families

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

Table 5: Family Data

	Springfield Estimate	%	U.S. Estimate
Total Households	69,754	-	116,716,292
Family Households	35,453	50.8	66.4%
Households with individuals under 18 years	16,312	23.4	33.4%
Households with individuals 65 years and over	16,688	23.9	24.9%
Average household size	2.13		2.58

Data Source: US Census Quick Facts, American Community Survey, October 2012

2.3 EMPLOYMENT AND LABOR FORCE

2.3.1 Employment

The distribution of employment in Springfield is representative of the nation as a whole, except for lower percentages in manufacturing and construction and greater 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	Springfield Estimate	U.S. Estimate
Total Employment	77,689	141,833,331
Percent Distribution of Employment by Industry Sector		
Farming, Forestry, Mining	0.5	1.9
Construction	5.6	7.1
Manufacturing	7.8	11.0
Wholesale Trade	3.1	3.1
Retail Trade	14.1	11.5
Transportation, Communication, Utilities	4.2	5.1
Information	2.2	2.4
Finance, Insurance, Real Estate	6.7	7.0
Professional, Scientific, Management, Administrative Services	9.3	10.4
Educational, Health Care, Social Services	24.6	22.1
Arts, Entertainment, Recreation, Accommodation and Food Services	13.1	8.9
Other Services	6.2	4.9
Public Administration	2.7	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 Springfield are similar to the nation as a whole, as seen in Table 7.

Table 7: Employment Status

	Springfield Estimate	%	U.S. Estimate
Population 16 years and over	**133,308**		**238,733,844**
In labor force	84,652	63.5	65.0%
Employed	77,689	58.3	59.4%
Unemployed	6,852	5.1	5.1%
Not in labor force	48,656	36.5	35%
Data Source: US Census Bureau, American Community Survey, Selected Economic Characteristics, 5 year estimates: 2006-2010.			

2.4 DEMOGRAPHIC AND ECONOMIC PROJECTIONS

Population and employment projections provided by the Missouri Department of Natural Resources show an almost doubling of population and employment in the period of analysis as displayed in Table 8.

Table 8: Greene County Population and Employment Forecast

Year	Population	Employment
2010	275,174	141,359
2020	331,340	158,946
2030	389,303	171,960
2040	445,680	201,541
2050	507,100	233,627
2060	574,630	269,335
Data Source: Missouri Department of Natural Resources, Medium Growth Scenario		

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 2012 price level, a period of analysis of 50 years, and were annualized to an annual equivalent cost using the FY 2013 Federal Discount Rate of 3.75 percent. The expected annual cost for an alternative was subtracted from the expected annual benefit to compute the net annual benefit.

The following sections discuss the types of evaluations and methods used in the economic analysis.

3.1 HYDROLOGIC AND HYDRAULIC MODELING FOR ECONOMIC EVALUATIONS

Refer to Hydrology and Hydraulics (H&H) Appendix for information on the hydrologic and hydraulic input into the Flood Damage Analysis (FDA) model.

3.1.1 Determining the H&H Conditions for Base and Future Economic Modeling

As stated in the H&H Appendix: “Two separate models were created in order to simulate runoff for current land use conditions and expected ultimate development land use conditions. The *current* land use model reflects development in the watershed as of about 2003. This includes current impervious areas and all significant storm-water improvements and detention basins. The *ultimate development* model is a variation of the current model with land uses projected to 2053 based on current zoning. ” Given the model reflecting development in 2003, some GIS analysis was conducted to determine how accurate the model would be for a base year of 2020 and to project the fulfillment of ultimate development.

3.1.1.1 General Assumptions

1. Aerial photography was available for the study area for 1996, 2001, 2005, and 2010. Google earth aerial photography was available for 2011.
2. The ultimate development expected within Jordan Creek watershed included North Branch watershed, South Branch watershed, and Jordan Creek watershed.
3. Real estate parcel geospatial data was available for the study area from 2008.
4. Redevelopment of existing property exists within the watershed. As properties are redeveloped, the city's storm-water management practices are enforced. Over time, gravel driveways and parking lots are upgraded with growth of employment and industry, decreasing the infiltration and increasing runoff.
5. Development of industry and residential areas in undeveloped property exists within the watershed. As undeveloped properties are developed, the city's storm-water management practices are enforced, particularly for development greater than one acre.

3.1.1.2 Determination of Open Land for New Development

A team of an economist and a GIS specialist analyzed the approximately 8,700 acres of Jordan Creek watershed aerial photography using ArcMap 10.0. The GIS specialist compared 1996 photography with 2010 photography to identify areas of development and created a shapefile named "Changes_1996_2010". The economist created a shapefile named "Open" to identify open land which could be developed. Several assumptions were used in the creation of the "Open" shapefile.

1. The horizon of development occurs over multiple generations, such that a constant owner is not assumed unless the property is held in trust.
2. Per city floodplain development rules, no structures will develop within the 1/100 Annual Chance Event (ACE) floodplain.
3. Property owned by the city for recreation (parks) or as part of the storm-water management plan will not be developed.
4. Property owned by the Springfield School District, Greene County, the State of Missouri, or the US Government will be developed. Between 1999 and 2011, these entities developed approximately 5 acres of land.
5. The Springfield airport, with land not owned by a government entity, will not be developed.
6. Land which is surrounded on all sides with other development (such as residential land in the center of a block of other residential buildings with no feasible access to roads) will not be developed.
7. Current land use zoning will be maintained. Open area will be developed according to the zoning of surrounding property. Polygons in residential areas were drawn to complement residences nearby. Polygons in commercial and industrial areas were drawn to complement the businesses nearby.
8. Polygons were no greater than 2/3 of available parcel space, given city storm-water management detention basins.

3.1.1.3 Calculating Land Development Rates

Using the "Changes_1996_2010" shapefile, and the aerial photography from 2001, 2005, and 2010, the "Open" shapefile polygons were categorized as development occurring between 1996 and 2001, development occurring between 2001 and 2005, development occurring between 2005 and 2010, or as empty land still to be developed. The acres of development for each category are presented in Table 9.

Table 9: Land Development for 1996 to Future Period

Time Period	"Open" Acres Developed (incremental)	Total "Open" Acres Developed	Remaining "Open" Acres
1996-2001	104	104	305
2001-2005	41	145	264
2005-2010	52	197	212
Future	212	409	--

Next, the average rate of development over time was calculated as shown in Table 10.

Table 10: Land Development, Average Acres per Time Period

Time Period	"Open" Acres Developed (incremental)	Years	Average acres per year
1996-2001	104	5	20.8
2001-2005	41	4	10.25
2005-2010	52	5	10.4

3.1.1.4 Projecting Future Development

To determine a date at which the Jordan Creek watershed is fully developed, a panel of economists examined the time periods' average developed acres per year, considered the employment during the time periods as seen in Table 11, considered the projected growth of population and employment in Greene County (previously presented in Table 8) over the next 50 years.

Table 11: Business Establishments and Employment in Springfield, Missouri 1998-2011

Year	Business Establishments*	Employment**
1998	9,299	Unavailable
1999	9,361	148,680
2000	9,480	160,690
2001	9,566	160,130
2002	9,748	162,350
2003	10,742	163,270
2004	11,087	165,070
2005	11,336	182,640
2006	11,440	188,800
2007	11,518	192,730
2008	11,508	194,860
2009	11,255	187,600
2010	11,219	181,890
2011	unavailable	181,010
* Data Source: US Census, County Business Profiles, Springfield, MO Metro		
** Data Source: Bureau of Labor Statistics, Springfield, MO Metro		

It appeared that the average acres per year development in the watershed remained relatively constant during the economic expansion between 2002 and 2005 and the economic recession between 2008 and 2010. Given that the watershed is over 8,700 acres, and an analysis showing only 200 acres remaining as "Open" for development in 2010, the study team (with coordination of the vertical team) used professional judgment to determine that by 2020 the watershed would be developed to Ultimate Development condition.

3.1.2 Base and Most Likely Future Year Economic Modeling

For Jordan Creek study, the year the proposed project is expected to be in operation (the base year) was set at 2020. The most likely future year was set at 2030. Given constant ultimate conditions hydrology over the period of analysis, any other most likely future year would produce identical results in FDA modeling. A separate FDA model with 2003 hydrology in the base year and the most likely future year was used as a sensitivity test for the plan formulation. The result of the sensitivity testing is located in Section 8.1.

3.2 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 first floor elevations (FFE) for each structure indentified from the maps, as well as structures requested to be examined by the City of Springfield, were obtained by a professional survey team. FFE, as defined by the surveyors, is the lowest point of the lowest, non-basement floor.

3.3 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 and mailed surveys.

3.3.1 General Assumptions for Most Likely Future Conditions

1. No buildings were added or removed from the floodplain during the period of analysis. After the 2000 flood event, the City of Springfield executed a voluntary buyout of properties in the Wilsons Creek watershed, beyond the southern end of Lower Jordan Creek. In the last 10 years the City of Springfield has continued purchasing properties within the Jordan Creek watershed from willing owners as a part of its floodplain management program. It is unlikely that other owners within the floodplain will be willing to leave.
2. The structure value, content value and type of use remains constant during the period of analysis. Historically, structures which were damaged by flood events within the Jordan Creek floodplain remain in use in the floodplain. These structures have had multiple owners or renters, but continue to exist.
3. Each building's condition will remain constant. Historically, some businesses within the Jordan Creek floodplain have remodeled and renovated over time. Any deterioration of condition to some of the buildings is offset by renovation of other buildings, such that the overall condition and structure valuation remains constant.
4. In the future, the floodplain will increase and additional existing buildings will be flooded. Per the H&H modeling assumptions (current zoning will be followed, storm-water management practices with enforceable inspection and maintenance processes will be followed, all pervious areas will have decreased infiltration when land is redeveloped, existing channels will have higher conveyance with storm-water infrastructure improvements), there is increased runoff and higher stages.

3.3.2 Structure and Contents

The purpose of the structure inventory was to collect data on residential and nonresidential structures located in the Study area. Structures were numbered starting downstream and moving upstream. Structures which were added after the original survey were numbered as they were added, irrelevant of their positioning on a stream.

3.3.2.1 Data Collection

Most commercial, industrial, and residential property values were obtained from the Greene 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 16 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 using RSMeans. RSMeans allowed us to estimate the replacement cost minus depreciation using a building's type of construction, age, and other construction specifications.

3.3.2.1.1 Residential Structures

Structure values for residential properties were retrieved from the county tax assessor's office. The 2009 assessments were used as a base value and then updated to Oct 2012 prices using the Marshall and Swift index for Central District (including the state of Missouri) for Class D Wood Frame structures. 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 12.

Table 12: Residential Structures

Structure type	Structure Count	Structure values ($)
Single Family - 1 Story	43	1,815,300
Single Family - 1 Story w/ Basement	11	488,800
Single Family - 2 Story	1	157,100
Multi-Family - 1 Story	2	112,500
Multi-Family - 2 Story	3	2,901,500
Total	**60**	**5,475,200**

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

3.3.2.1.2 Commercial and Industrial Structures

Commercial and industrial structure values were retrieved from the Greene County tax assessor's office and are from the 2009 assessment. Values were updated to Oct2012 price levels using the Marshall and Swift index for Central District (including the state of Missouri) for Class C Masonry Bearing Walls structures.

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 13.

Table 13: Commercial and Industrial Structures

Structure type	Structure Count	Structure values ($)
Commercial	**92**	**45,828,700**
Food Store - 1 Story	3	511,400
Restaurant - 1 Story	3	191,500
Restaurant - 2 Story	1	96,200
Fast Food Restaurant - 1 Story	1	223,400
Medical - 1 Story	1	10,000,000
Office - 1 Story	20	3,343,500
Office - 2 Story	4	19,824,700
Retail - 1 Story	14	2,532,900
Retail - 2 Story	2	229,800
Service Store - 1 Story	14	1,066,100
Shopping - 1 Story	2	585,900
Vacant	27	7,221,500
Industrial	**114**	**23,596,000**
Specialized Manufacturing	22	4,280,000
Warehouse - 1 Story	66	9,399,100
Warehouse - 2 Story	12	4,507,200
Light Manufacturing - 1 Story	12	2,521,400
Light Manufacturing - 2 Story	2	2,888,400
Total	**206**	**69,424,800**

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 Jordan 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 Jordan Creek study used professional judgment to determine that the depth damage curves are applicable to Jordan 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. Content values were updated from 2009 to Oct 2012 using the

Producer Price Index for finished goods. It was assumed that content distribution and content type was similar in structures in the Jordan 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.

After initial runs of Flood Damage Analysis software, damages to several structures within the Jordan Creek 500-year footprint appeared to not represent historic damages. Several actions of reality check (data confirmation) ensued.

1. Building Materials Company outside inventory – Company provided detailed historic depth information and damage information on an OMB-approved survey in 2006 and follow-up interviews; the depth-damage curve to the inventory in the pipe-yard was created with engineering and economic judgment. Given the FDA output, an adjustment was made to the depth-damage curve of the outside inventory for this unique inventory.
2. Lofts – Building was originally windshield surveyed as an empty warehouse. The warehouse was renovated to loft apartments on second and third floors. The first floor remained vacant, but FDA output reported significant damages at high-frequency events. Further investigation revealed several businesses occupied the first floor of the renovated building, as well as a three-foot rise in first floor elevation since original survey.
3. Warehouse – Building first floor elevation (base of garage doors) was originally surveyed with survey crew in 2004. FDA output reported significant damages at the high-frequency events. Further investigation using aerial and street-view photography revealed two open garage doors with truck bays. First floor elevation was adjusted up three feet to account for true first floor elevation.
4. Public property maintenance garage – The building was originally surveyed and assigned commercial auto structure and content curves based on assumption of vehicles and maintenance use. FDA output reported significant damages at the high-frequency events. Further investigation using street view photography indicated that the building consisted of two adjacent structures with two separate functions: a lower-elevation rectangular office-use space and a higher-elevation warehouse-use space.
5. Building Materials Company – Structure first floor elevation was originally surveyed with survey crew in 2004. FDA output reported significant damages at the high-frequency events. Structure was surveyed again and the first floor elevation was corrected.
6. Park pavilion – Pavilion was originally assigned recreation damage curve (P-REC). FDA output reported significant damages given a simple frame structure and basic recreational facility contents. Structure value was corrected to $5000; content value was corrected to $2000.
7. Medical facility – Structure first floor elevation was originally surveyed with survey crew in 2004. FDA output reported significant damages at frequent events, although structure had never reported damage. First floor elevation was corrected using aerial street view photography.
8. Wholesale building materials company – Structure was originally windshield surveyed as vacant. Re-evaluation of the building in 2010 determined that structure was being used as an inventory warehouse with concrete cement blocks raising the first floor elevation by one foot. Interview with company manager provided structure and content values bundled together. Economic judgment and Greene

County assessor data were used to separate structure and content values. First floor elevation was corrected by one foot.

3.3.2.1.3 Public Structures

Most public structures were not included in the county's assessment of structure values. The value of public structures not included in the tax assessments were derived using RSMeans and the methodology explained above in Section 3.3.2.1. Square feet estimates for public structures were taken by the county tax assessor although no value was assigned during assessment. Values were updated to current price levels using the RS Means historical index. Public structures are identified in Table 14.

Table 14: Public Structures

Structure type	Structure Count	Structure values ($)
Recreational - 1 Story	2	10,800
School - 2 Story	2	950,000
Total	**4**	**960,800**

Content values for public structures were found using the ARW methodology described above. A windshield survey was taken to determine public vacancies.

3.3.3 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 Springfield does not have a flood warning system and residents are given no formal warning of flash flooding. Springfield 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 Jordan 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 the following relationship for each residence: V = (0.15*S) + 1000 where V is the vehicle value and S is the value of the residential structure (USACE Fort Worth District Lower Colorado Basin Phase I Interim Feasibility Report and Integrated

Environmental Assessment). The Colorado Basin 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 $8,300 (using Consumer Price Index Midwest Private Transportation index to update 2009$ to Oct 2012$). 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 (retrieved from US Census, Missouri Department of Motor Vehicles, and Greene County Tax Assessor) 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.

After initial runs of FDA, damages to vehicles within the Jordan Creek 500-year footprint appeared to depict greater damages for flood events than reported historic damages. Several actions of correction ensued.

1. Building Materials Company: Vehicle damages were occurring to specialized trucks instead of sedans, trucks, or SUVs. Vehicle damage curve (C-TRK) created for damages to specialized trucks using photos of the specialized trucks, photos of trucks, and the depth damage curves for vehicles provided by HQUSACE.
2. Cars at the Lofts – Parking lot of the lofts and the first floor elevation of the lofts were originally considered equal. FDA output reported significant damages to vehicles at high-frequency events. The lofts and the parking lot were split into two structure entries; the parking lot elevation remained as originally surveyed. Multiple aerial photos were used to count vehicles in the parking lot during business hours. The average number of vehicles in the aerial photos (50) was multiplied by the vehicle value in the methodology to determine the aggregate parking lot vehicle value. Given that there are 33 loft apartments and assuming 1.5 vehicles per apartment, there are 50 cars parked in the lot at night outside of business hours.
3. Local business – Parking lot of the business and the first floor of the business were originally considered equal. FDA output reported significant damages to vehicles at high-frequency events. After examining aerial and street view photography, the business and the parking lot were split into two structure entries in the structure inventory; the business remains at the surveyed first floor elevation and the

parking lot elevation was raised by one foot to correct for the -1 (negative) foot start of damage in the vehicle depth-damage curve.

4. Auto yard – Building was originally windshield surveyed as an auto body repair shop. Originally, the vehicles located within the fenced-in area in the back were counted and valued in the same way as all other vehicle valuations in the study. The FDA output reported significant vehicle damages at high-frequency events. Further investigation of aerial and street view photography revealed that the business operates as a used-car parts supplier. As a result, further analysis was done which led to the following assumptions:
    a. Due to the nature of the business, we assumed the most each vehicle could be worth was $700. $700 was based on the minimum price of classified ad asking prices of barely running cars.
    b. Due to the nature of the business, the minimum each vehicle could be worth was $200. An average of three scrap metal recycling companies equaled $8 per 100 pounds. Assuming an average weight of 3000 pounds and a removal cost of $40 per vehicle from the auto yard to a metal recycler, $200 was the value of a car that can only be sold for scrap.
    c. Based on aerial photos over time, half of the vehicles were be sold and replaced by others, but the other half stayed indefinitely.
    d. Of the vehicles at the business, 5 of the cars were either employee or customer owned and follow the standard vehicle methodology.
    e. 168 vehicles were easily identifiable from aerial photos. A depth-damage curve was created for the vehicles with a maximum percent damage of 55 percent due to the assumptions made.

Three major parking lots exist within the study area. Using the methodology as describe in this section, the vehicle values for the three parking lots are presented in Table 15.

Table 15: Parking Lots

Structure type	Structure Count	Vehicle values ($)
Parking Lots	3	1,384,300

3.4 DEPTH DAMAGE FUNCTIONS

3.4.1 Residential

The city of Springfield, Missouri is a typical Midwestern 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.

3.4.2 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 Jordan 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 Jordan 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. Content values were updated from 2009 to Oct 2012 using the Producer Price Index for finished goods. It was assumed that content distribution and content type was similar in structures in the Jordan 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.

3.4.3 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.

3.4.4 Mailed Surveys

In October 2005, a request was submitted to the Office of Management and Budget to survey the residences and businesses within the initial projected 0.002 floodplain. The request was approved in November 2005. In January 2006, surveys were mailed to 234 residences and 211 businesses. By February 2006, 33 residential (14 percent response) and 69 commercial (33 percent response) surveys were returned with information. However, most of the returned surveys were judged to be poor and unusable for the study. The few surveys with quality data were used to check the results from FDA.

3.5 REACH CHARACTERISTICS

The study area encompasses all or parts of four streams (North, South, and Lower Branches of Jordan Creek, and Wilsons Creek) and their reaches. The North Branch is divided into two reaches, the Lower Branch is divided into three reaches, and the South Branch is one reach. Wilsons Creek is included in the most downstream reach of the Lower Branch. These six Reaches are delineated based on their economic distinctions from the other reaches. These six 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 16. The water flows from the east to the west through the middle of the City of Springfield. When flooding occurs along the creek, it is always of short duration.

Table 16: Structure Inventory

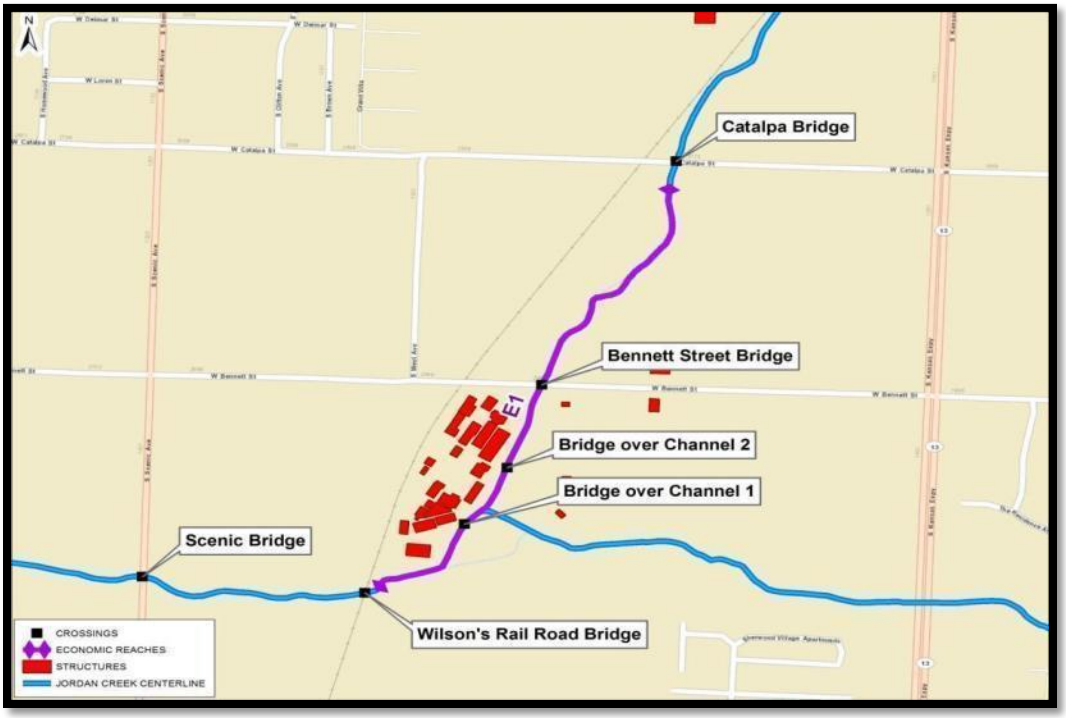
Reach	Number of structures in reach	Structures by type				Structure values ($)	Content values ($)
		Residential	Commercial	Industrial	Public		
E1	32	0	5	27	0	5,438,000	*
E2	54	15	22	17	0	5,068,800	12,131,800
E3	66	2	33	31	0	33,215,800	56,018,400
E4	12	0	4	6	2	1,930,800	5,971,800
E5	50	43	5	0	2	2,447,600	3,665,100
E6	56	0	23	33	0	27,759,800	36,635,200
Total	**270**	**60**	**92**	**114**	**4**	**75,860,700**	*

* Number withheld due to predominance of Archimica's proprietary information that would be revealed.

3.5.1 Reach E1

Reach E1 is at the confluence of Jordan and Fassnight Creeks. This reach is industrial. The Archimica Pharmaceutical plant, Advantage Waste and an old municipal landfill sustain damages during flood events. The Archimica plant has almost 98 percent of the total value of structures, contents, and vehicles within Reach E1. While structural values are approximately $5.4 million, machinery and inventories are significantly more than the structural value of the buildings. Given the unique composition of structure to inventory values and the special type of manufacturing by the company, the damages within Reach E1 are different than other reaches and significant inventory losses are sustained with just a few feet of water. Archimica has constructed a floodwall to elevation 1221.5 that was deemed structurally sound by project delivery team engineers. When water elevations exceed 1221.5, water overtops the floodwall and several feet of water inundate the pharmaceutical plant before pumps can remove the water. In the future without project conditions, the wall is overtopped between the 1/10 ACE and the 1/25 ACE.

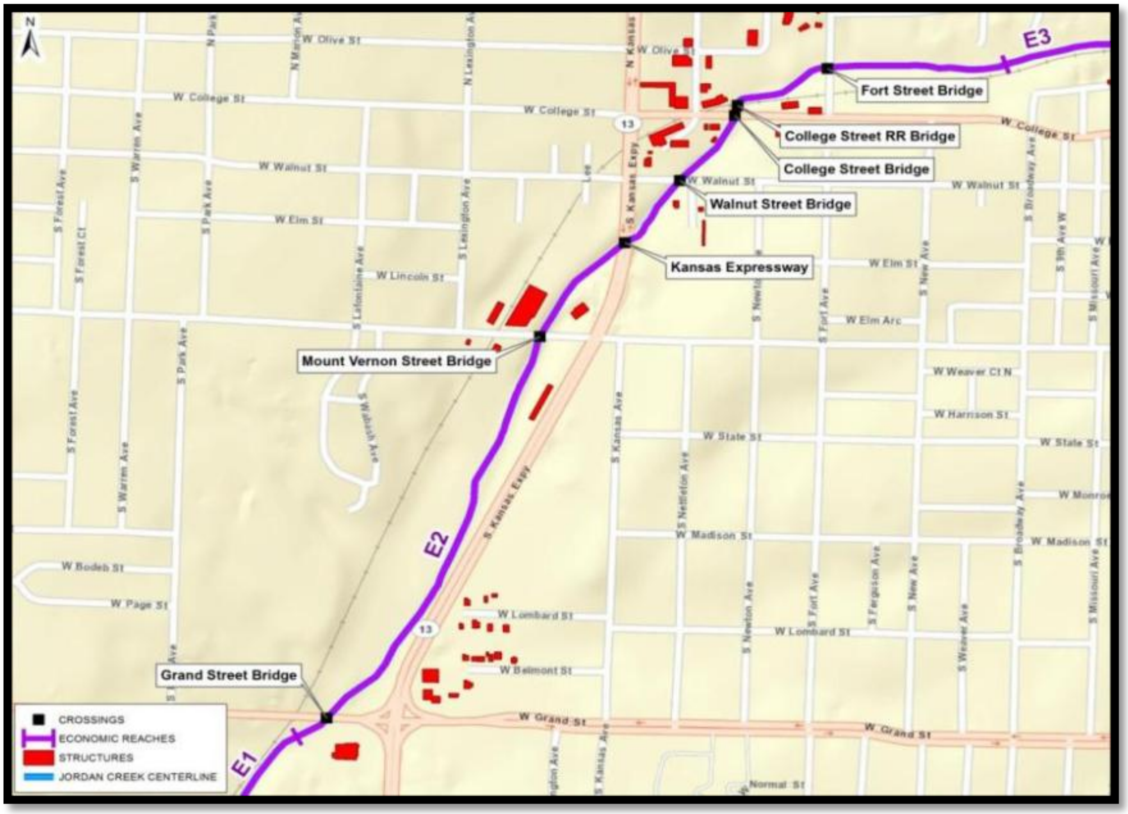
Figure 2: Reach E1



3.5.2 Reach E2

Reach E2 is mainly industrial, but it includes a small neighborhood that starts to sustain damages around the 1/5 ACE. This portion of the stream is mostly natural channel with an assortment of conveyance improvements, bridges, culverts and grade control structures. The 1/10 ACE causes damages to about 15 of the 54 structures in the inventory. Structural values of the 54 structures within Reach E2 are approximately $5 million and content values are approximately $12 million.

Figure 3: Reach E2

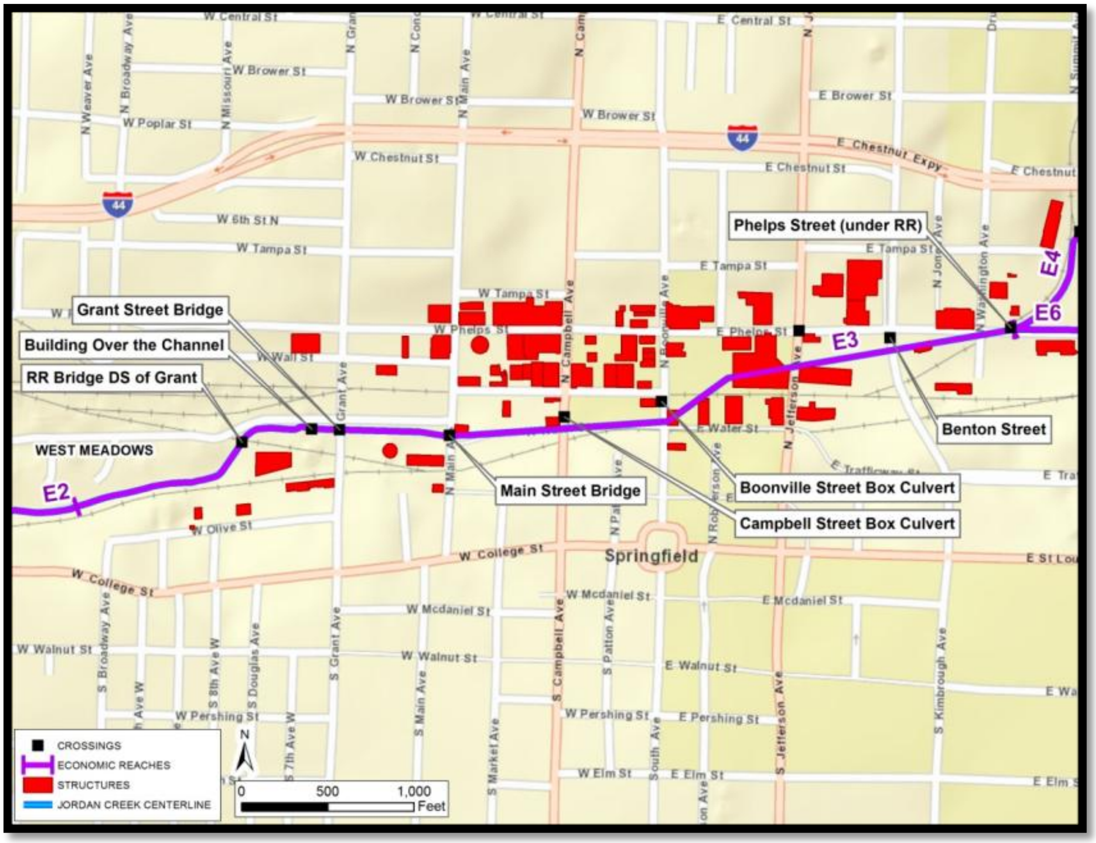


3.5.3 Reach E3

Reach E3 is the downtown area of Springfield and until a few years ago, it primarily consisted of industrial and commercial buildings. However, local Universities are moving into the old warehouses and factories, and it is starting to become a pedestrian- and cyclist- friendly neighborhood.

The upstream end of Reach E3 is at the confluence of North and South Branch where Jordan Creek flows into a set of box culverts capable of conveying the 1/5 to 1/10 ACE. The 30 feet wide, 10 feet tall, dual box culverts extend 3,400 feet underneath most of the downtown area. Once the capacity of these structures has been exceeded, water flows over land, through buildings and over roads, creating downtown flooding until it reaches the areas south of downtown where it can return to the channel. The structural values of the 66 structures within Reach E3 total approximately $33.2 million with contents values of approximately $56 million.

Figure 4: Reach E3

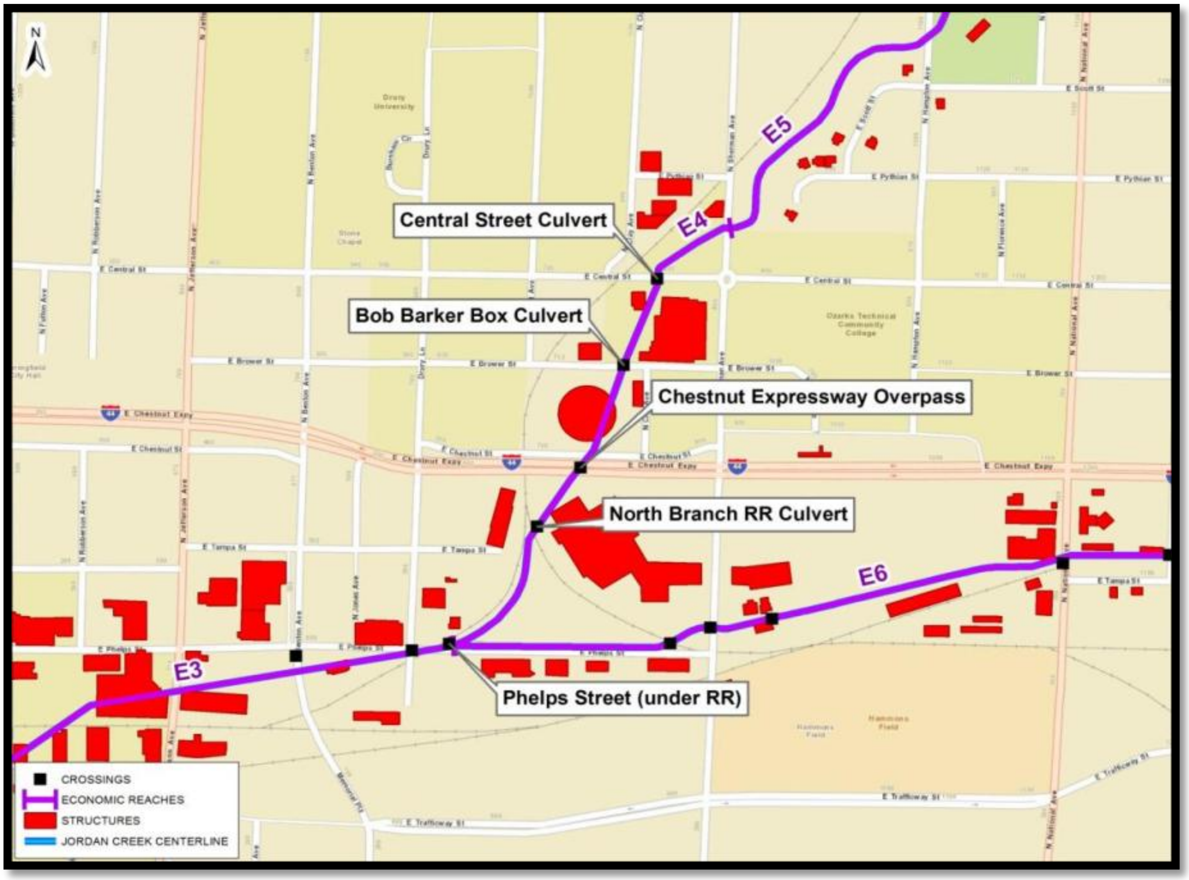


The City's industrial and commercial heart is situated in the Jordan Creek Valley. Along Jordan Creek, it is relatively flat. However, about a city block out on either side of the stream, the terrain gets substantially steeper. This topography concentrates the floodwaters through a narrow corridor. At 1/5 ACE, damages are $570,000. There are substantial damages at the frequent events.

3.5.4 Reach E4

Most of the damages in Reach E4 are to properties on a local university campus and a community college campus. Ozark Technical College has a parking lot that is subject to the 1/50 ACE in the existing conditions. Two buildings receive structure damage and one receives damage to contents at the 1/5 ACE. The structural values of the 12 properties within Reach E4 are approximately $1.9 million with contents values at approximately $6 million.

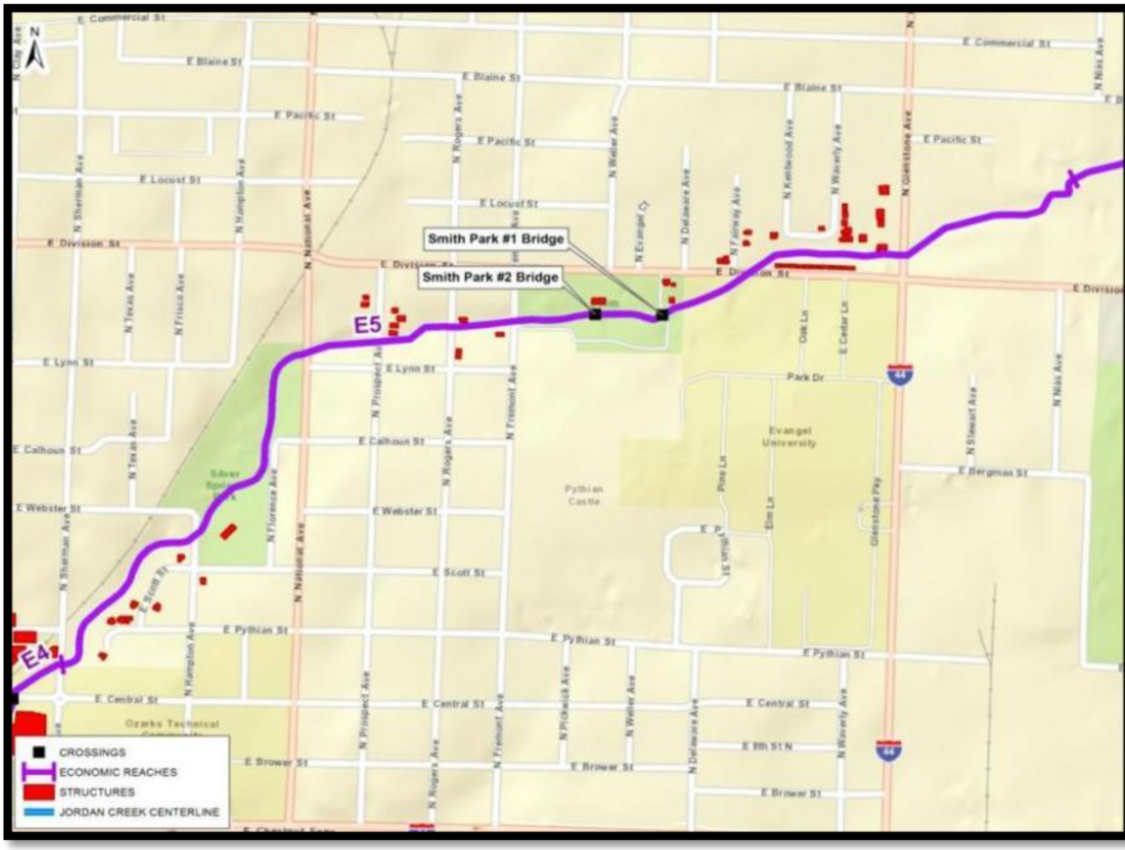
Figure 5: Reach E4



3.5.5 Reach E5

In Reach E5, a park pavilion close to the channel is frequently flooded but with few damages.   At the 1/100 ACE, about six houses are damaged with no single structure receiving more than $400 worth of damage. The majority of the channel in this reach runs through parkland or open space. The structural values of the structures within E5 total approximately $2.5 million with contents valued at approximately $3.7 million.

Figure 6: Reach E5

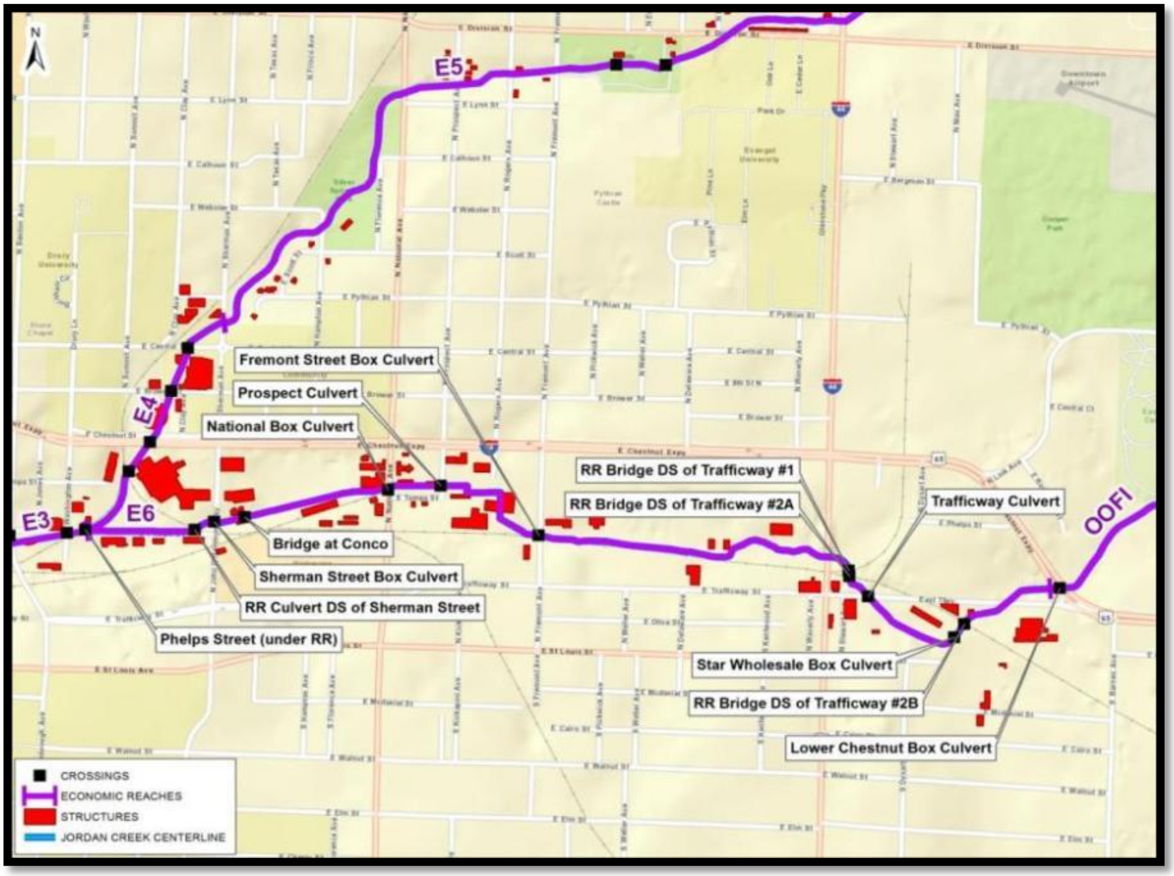


3.5.6 Reach E6

The upstream part of Reach E6 is mainly residential. Once Glenstone Street is crossed, it becomes more industrial. Frequent damages occur at the Loft's Parking Lot and Harry Cooper Supply, a local pipe wholesaler.

The upstream reaches of South Branch of Jordan Creek consist of grass ditches with small culverts capable of carrying a storm that is expected to occur every year. Once the water is out of the ditches, it starts to flow overland. Even at frequent events, the flooding affects buildings. Mostly, the water ponds in intersections before flowing back into the creek. Approximately 80 residential properties in the upstream reaches are within the 1/100 ACE floodplain.   Water surrounds many of the homes once the capacity of the channel is exceeded. The structural values of the structures within E6 total approximately $27.8 million with their contents valued at approximately $36.6 million.

Figure 7: Reach E6



3.6 DAMAGE CALCULATIONS

Hydrologic Engineering Center – Flood Damage Analysis software (FDA) version 1.2.4 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.

3.7 WITHOUT PROJECT CONDITION

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

Equivalent Annual Damages were calculated for damages to structures, contents, and vehicles by FDA. Table 17 displays the without project estimates of Equivalent Annual Damages (EAD) as calculated by FDA.

Table 17: Equivalent Annual Damages, Without Project

Reach	EAD: Without Project
E1	2,242,650
E2	278,992
E3	1,037,289
E4	72,076
E5	9,532
E6	882,811
Total	**4,523,350**

Without project estimates of single-event damages in each of the reaches in the study area for specified frequency events are provided in Table 18; the damages shown are at October 2012 price levels. There is a significant increase in damages between the 1/5 ACE and the 1/10 ACE given the overtopping of a floodwall in Reach 1 and overtopping of the box culvert in Reach 3. Damages significantly increase again from the 1/10 ACE to the 1/25 ACE in Reaches 1, 3, and 6.

Table 18: Single Event Damages, Without Project Condition

	Annual Chance Exceedence (Recurrence Interval) Damages							
	0.99 (1- yr)	**0.5 (2-yr)**	**0.2 (5-yr)**	**0.1 (10-yr)**	**0.04 (25-yr)**	**0.02 (50-yr)**	**0.01 (100-yr)**	**0.002 (500-yr)**
Reach E1								
Damage ($)	-	-	-	10,496,600	21,249,000	24,974,800	27,322,100	29,779,400
Structures (#)	0	0	0	25	29	30	30	30
Reach E2								
Damage ($)	5,600	96,600	419,100	644,800	1,062,600	1,435,600	1,961,000	2,859,400
Structures (#)	2	4	13	15	21	26	28	36
Reach E3								
Damage ($)	-	100,000	786,600	2,813,400	4,261,300	5,666,700	8,745,400	19,234,000
Structures (#)	0	10	21	29	40	41	45	50
Reach E4								
Damage ($)	-	6,300	35,800	150,700	335,500	532,900	848,000	1,657,600
Structures (#)	0	3	3	5	6	6	8	9
Reach E5								
Damage ($)	100	2,800	11,500	23,600	35,500	42,900	58,400	106,300
Structures (#)	1	2	5	6	8	12	15	24
Reach E6								
Damage ($)	-	192,400	714,700	1,495,700	4,087,500	6,175,300	8,725,000	14,741,300
Structures (#)	0	10	18	22	31	33	36	44
Total Damage ($)	5,700	398,200	1,967,700	15,624,800	31,031,500	38,828,200	47,660,000	68,378,100
Total Structures (#)	3	29	60	102	135	148	162	193
Damages per Structure ($)	1,894	13,732	32,795	153,184	229,863	262,353	294,198	354,291

3.7.2 Other Damages

Some damage categories were calculated outside of the FDA program. Emergency protection, public infrastructure (such as roads and bridges), and utility damages are examples of these categories. For these damages, the methodology and results are described.

3.7.2.1 Emergency Protection Measures

Emergency costs were incurred by government agencies in the aftermath of the flood events and were determined using procedures developed in a study by the U.S. Army Engineer District, Louisville, Kentucky. This study, titled Flood Damage Report for Frankfort, Kentucky, July 1981, provided a basis for estimating these types of costs. Emergency costs were computed using a unit cost for each structure based on the number of structures flooded by frequency in the FDA program and relative duration of flooding. Unit costs were assumed to remain constant. Changes in duration compensated for differences for the long single event in Frankfort and the short, flashy events that occur on Jordan Creek. Flood events create adverse socioeconomic effects that vary in duration from a few days to several months or even years following the particular event. Data from the Frankfort report was used to estimate costs associated with flood events in the Jordan Creek study area. Emergency cost items included protection of life, health, and property, evacuation and reoccupation; emergency care, emergency preparedness; and administrative costs. The Frankfort data was adjusted for price changes as well as being modified to reflect local area conditions with regard to flood durations. Table 19 provides an example of calculating emergency costs for the 1/10 ACE. Given that the total expected annual damage for emergency costs equaled less than $1000 and the differences among plans was insignificant, calculation of emergency costs for alternative plans was removed from analysis. The order of magnitude of benefit is within rounding difference of Alternative Plans' benefit calculations.

Table 19: Emergency Costs, 1/10 ACE

Reach	Cost Item	Unit Cost Per day (dollars) (1)	Units Affected (2)	Total Costs Without Project
	Protection of life, health & property (3)	$104	30	$3,116
	Evacuation, transition & reoccupation (4)	$104	0	$0
	Emergency & mass care	$234	0	$0
	Emergency Preparedness	$130	30	$3,895
R-1	Administrative Costs	$208	30	$6,231
	Protection of life, health & property (3)	$104	28	$2,908
	Evacuation, transition & reoccupation (4)	$104	8	$831
	Emergency & mass care	$234	8	$1,869
	Emergency Preparedness	$130	28	$3,635
R-2	Administrative Costs	$208	28	$5,816
	Protection of life, health & property (3)	$104	45	$4,674
	Evacuation, transition & reoccupation (4)	$104	1	$104
	Emergency & mass care	$234	1	$234
	Emergency Preparedness	$130	45	$5,842
R-3	Administrative Costs	$208	45	$9,347
	Protection of life, health & property (3)	$104	8	$831
	Evacuation, transition & reoccupation (4)	$104	0	$0
	Emergency & mass care	$234	0	$0
	Emergency Preparedness	$130	8	$1,039
R-4	Administrative Costs	$208	8	$1,662
	Protection of life, health & property (3)	$104	14	$1,454
	Evacuation, transition & reoccupation (4)	$104	13	$1,350
	Emergency & mass care	$234	13	$3,038
	Emergency Preparedness	$130	14	$1,818
R-5	Administrative Costs	$208	14	$2,908
	Protection of life, health & property (3)	$104	35	$3,635
	Evacuation, transition & reoccupation (4)	$104	0	$0
	Emergency & mass care	$234	0	$0
	Emergency Preparedness	$130	35	$4,544
R-6	Administrative Costs	$208	35	$7,270
	Total Emergency Costs by Project Condition			**$78,049**
	Average Annual Emergency Costs			**$780**
	(1) Data from 1981 Report, Flood Damage Report for Frankfort, Kentucky, July 1981. Dollar values adjusted for price level changes and locality conditions to October 2012$. (2) Numbers of units with damages from FDA Model runs. (3) Includes commercial and residential unit. (4) Residential units only.			

3.7.2.2 Infrastructure Damages: Roads, Bridges, and Utilities

Given the type of flooding in the Jordan Creek watershed (flash-flooding), infrastructure covered with water during high water events does not stay submerged for long periods of time. The City of Springfield did not provide data for infrastructure damages that have occurred during past flood events. Consistent with past Little Rock District flood risk management studies (May Branch Fort Smith Arkansas, Fourche Creek Little Rock Arkansas), infrastructure damages were estimated by creating an FDA model which was stripped of content and other damages. The "infrastructure" model was run to calculate EAD for structural damages. Expected annual infrastructure damage in the Without Project condition is $126,573 as shown in Table 20.

Table 20: Equivalent Annual Damages, Infrastructure Damages, Without Project

Reach	Structural EAD: Without Project $	Percentage of Damage	Infrastructure EAD: Without Project $
E1	175,888	15.6%	27,438
E2	64,222	15.6%	10,019
E3	211,667	15.6%	33,020
E4	22,552	15.6%	3,518
E5	4,588	15.6%	716
E6	342,024	15.6%	53,356
Total	**820,940**		**128,067**

There are two railroads in the floodplain that would be affected by flood events. Information obtained from the railroad companies indicated damages will occur if the flood duration approached 48 hours. Duration analysis was performed for locations that are subjected to flooding. The longest duration of flooding for the 500-year event was approximately 6 hours; therefore damages to railroads and rail commerce were not included in this analysis. In historic flood events, the rail lines were overtopped but the duration was not long enough to result in damages incurred by the inability to move goods.

3.8 TRANSPORTATION DELAY ANALYSIS

Flooding can temporarily impede traffic by covering roads and bridges. Even the threat of flooding and concern for public safety may make it necessary to close roads and detour traffic. The costs of traffic disruption include 1) the additional operating cost for each vehicle, including depreciation, maintenance, and gasoline per mile of detour; and 2) the traffic delay cost per passenger.

Examining historic floods along Jordan Creek shows that flooding is extremely flashy with the water reaching its peak stage from normal flow in less than an hour. Once flooding has peaked, water levels usually subside in only a few hours. Historic floods have also shown that flooding was very localized. There have been reports of areas receiving no rainfall that get flooded by rainfall less than a mile upstream. There are also numerous bridges and crossings along Jordan Creek. In some areas there are stream crossings at every street block.

Given the short duration of flooding, the locality of flooding and the, numerous stream crossings, transportation delays were not analyzed. In the past, vehicles have been successful at finding non-inundated crossings only a short distance from their original route. By not analyzing transportation delays, we assumed the risk that there are costs and benefits not taken into account in the overall analysis of alternatives. This risk was perceived to be very minimal.

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 three rounds, using a 0.8 BCR as a screening tool for plans to move through the first and second rounds (with greater benefits uncertainty) and a 1.0 BCR as a screening tool for plans to move through the third round to a full cost analysis.

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 8.

Figure 8: 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. Five structures could not be cost-valued based on structure value due to their business being based on parked vehicles; those were assigned acquisition and demolition costs of 2.5 multiplied by their associated buildings structure values. The buyout analysis results are presented in Table 21.

Table 21: Non-Structural Analysis for "Footprint" Plans

"Footprint" Plan	Structure Count	EAD	AAC	BCR
2-year	26	$938,835	$2,055,391	0.46
5-year	55	$1,560,445	$2,667,778	0.58
10-year	98	$4,285,810	$4,140,341	1.04
25-year	129	$4,427,333	$5,914,661	0.75

4.1.2 Second Round

A next step of screening was performed for the only plan with a BCR greater than 0.8. The second screening round was for the 10-year "footprint" plan to include other structures which were associated with the 98 structures in the first round of analysis. For example: a buyout plan that only considered a warehouse but not the main business was incomplete. To find associated structures, the GIS specialist used a shapefile of structures within the maximum projected floodplain to create a geodatabase. Next, the "FDA_Struct.out" spreadsheet for the Without Project condition was loaded as a geodatabase table.

The "corps_id" field was a common element in the feature class. Using the "corps_id" the geodatabase table was joined to the feature class. Then, using a definition query within ArcMap, properties were displayed by their damages in certain return-period categories (2-year, 5-year, 10-year, etc). For the 10-year "footprint" plan, 12 structures which shared a common parcel owner were included. The buyout analysis result for the additional screening is presented in Table 22.

Table 22: Further Analysis for Non-Structural "Footprint" Plan

"Footprint" Plan	Structure Count	EAD	AAC	BCR
10-year	110	$4,277,900	$5,082,200	0.84

4.1.3 Third 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 the 110 structures removed from inventory. FDA calculated the EAD of the 110 structures at $4,202,339 – insignificantly different than the spreadsheet analysis. Given the professional judgment of Real Estate specialists that acquisition costs were conservatively estimated at a multiple of 2.5 the structural values, a BCR of less than 1.0 stopped further analysis of a non-structural buyout plan.

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. Plans A, B, C, D, E, F, and G were eliminated from further evaluation due to inefficiency as compared to Plan G and then to Plan G2. Net benefits and benefit-cost ratios which were calculated in early formulation are presented in Table 23.[1]

Table 23: Benefits and BCR for Plans A through G, Early Formulation

Plan	Net Benefits	BCR
A	1,752,500	1.3
B	2,798,200	1.6
C	3,017,000	1.7
D	2,335,300	1.4
E	3,243,200	2.0
F	3,208,300	1.8
G	3,858,300	2.2

[1] Estimated benefits and benefit-cost ratios from early formulation cannot be compared to benefits and benefit-cost ratios for Plans G2 and J. Benefits during early formulation were ordinal correct, meaning that Plan G had greater benefits than Plans A through F; however, the benefits were not accurate. In refined formulation, only Plan G retained a benefit-cost ratio greater than 1.

Plans H and I were eliminated from further consideration due to inefficiency as compared to Plan J. Net benefits and benefit-cost ratios which were calculated in refined formulation are presented in Table 24.

Table 24: Benefits and BCR for Plans H and I, Refined Formulation

Plan	Net Benefits	BCR
G	336,700	1.09
G2	719,500	1.2
H	1,339,900	1.6
I	871,300	1.3
J	1,876,300	2.6

The following sections describe the final array of alternatives.

4.2.1 Detention Basins

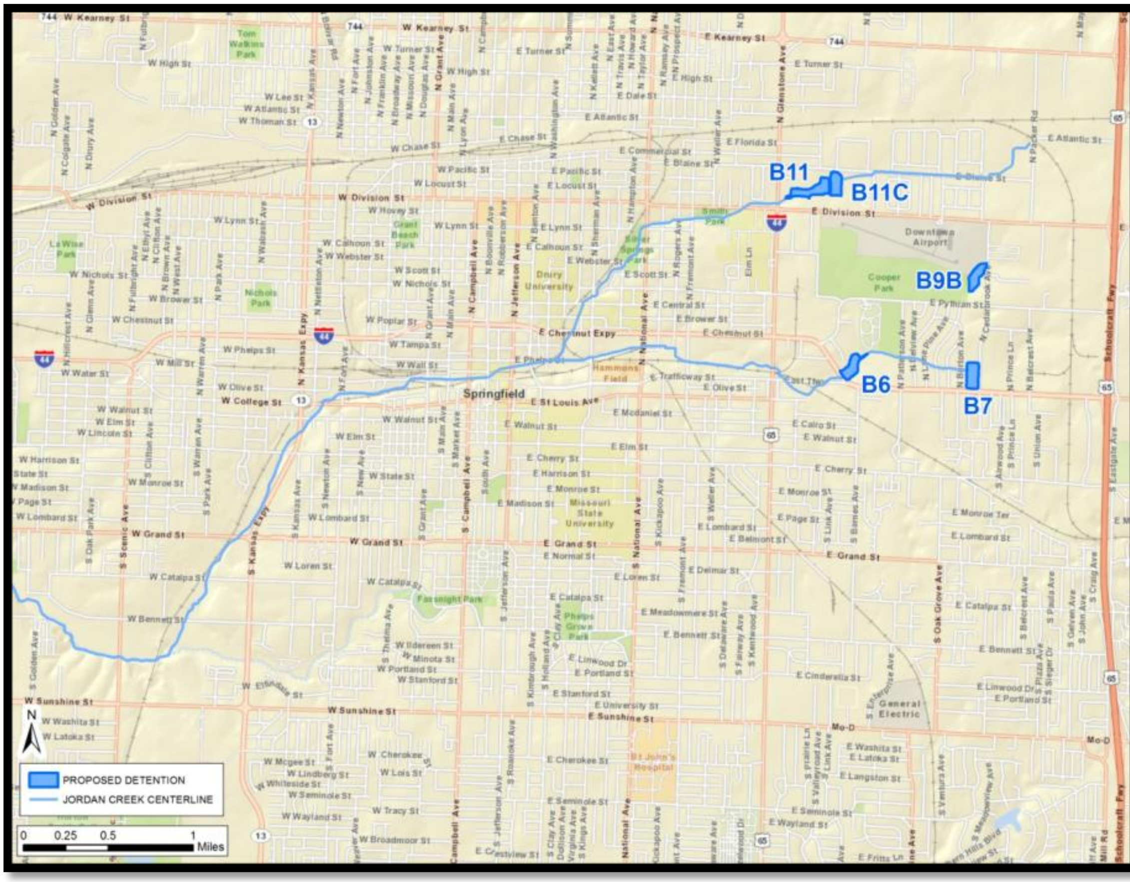
Detention basin analysis (as described in the H&H Appendix) showed the results of the reservoir routing through the basins to determine the basins that provide the most benefit to the project. The resulting basins are shown in Figure 9. The results of the H&H analysis showed five basins provided a significant reduction in flow, two on the North Branch and three on the South Branch. This configuration consists of five detention basins that were deemed efficient in a preliminary H&H analysis. In a preliminary analysis, three detention pond FDA models were created: North Branch only, South Branch only, and All Basins. The benefits from reducing EAD for the three plans in early formulation were compared to initial cost estimates.

Table 25: Detention Pond Screening

Plan	Net Benefits	BCR
North Branch Only	301,900	3.7
South Branch Only	112,500	1.4
All Basins (North and South)	334,700	1.8

The detention plan with all five detention basins provided greater annual net benefits than the North Branch only plan and the South Branch only plan.

Figure 9: Detention Basins



Estimates of single-event damages for Detention Basin Plan, in each of the reaches in the study area for specified frequency events, are provided in Table 26; the damages shown are at October 2012 price levels. There is a significant change in start of damages between the Without Project and the Detention Basins between the 1/10 ACE and the 1/25 ACE given the overtopping of a floodwall in Reach 1 and overtopping of the box culvert in Reach 3. Adding detention basins to the Jordan Creek system adds storage capacity to the system and has the effect of decreasing the flood damages for frequent events (1/2 ACE, 1/5 ACE, 1/10 ACE). As flood events get larger (and less frequent), the detention basins fill to capacity and are not as effective in reducing flood damages.

Table 26: Single Event Damages, Detention Basins

	Annual Chance Exceedence (Recurrence Interval) Damages							
	0.99 (1- yr)	**0.5 (2-yr)**	**0.2 (5-yr)**	**0.1 (10-yr)**	**0.04 (25-yr)**	**0.02 (50-yr)**	**0.01 (100-yr)**	**0.002 (500-yr)**
Reach E1 Damage ($)	-	-	600	38,200	20,867,900	24,533,700	27,003,800	29,678,400
Structures (#)	0	0	1	4	29	30	30	30
Reach E2 Damage ($)	3,000	68,500	361,500	580,200	882,700	1,241,000	1,701,300	2,537,600
Structures (#)	2	4	13	15	17	22	26	34
Reach E3 Damage ($)	-	77,200	437,200	1,607,500	3,699,100	4,757,200	6,590,900	14,997,500
Structures (#)	0	5	17	25	35	41	43	49
Reach E4 Damage ($)	-	1,500	25,400	69,800	238,600	360,300	604,900	1,314,700
Structures (#)	0	2	3	4	5	6	6	9
Reach E5 Damage ($)	-	1,500	5,300	13,300	25,100	33,200	39,900	65,400
Structures (#)	0	2	2	5	6	8	11	16
Reach E6 Damage ($)	-	12,500	393,400	844,600	2,386,900	4,702,500	6,739,300	11,765,900
Structures (#)	0	2	15	22	28	33	36	39
Total Damage ($)	3,000	161,200	1,223,400	3,153,600	28,100,300	35,627,800	42,680,100	60,359,600
Total Structures (#)	2	15	51	75	120	140	152	177
Damages per Structure ($)	1,514	10,745	23,987	42,048	234,169	254,484	280,790	341,015
Damage Reduced %	46.71%	59.53%	37.83%	79.82%	9.45%	8.24%	10.45%	11.73%

The estimates of EAD for Detention Plan as provided by FDA are shown in Table 27.

Table 27: EAD, Detention Plan

Reach	EAD $	Infrastructure EAD $	Total EAD $
E1	2,218,390	26,856	2,245,246
E2	240,857	8,727	249,585
E3	717,055	23,068	740,123
E4	49,363	2,571	51,934
E5	6,106	484	6,590
E6	520,865	31,252	552,117
Total	**3,752,636**	**92,959**	**3,845,595**

4.2.2 Plan G2

Plan G2 provides a varying level of protection through each of the reaches. Plan G2 includes:

- Regional Detention Basins
- Channel modifications included narrowing the channel and linear feet of modified channel to accommodate a lower level of protection than Plan A or B. Channel improvements occur along about 2.2 miles of channel. Channel widths vary from 5 feet on South Branch to about 37 feet on the lower end of Jordan Creek and on Wilsons Creek. Side slopes vary from 3v to 1h to 5v to 1h depending on real estate restrictions.

The estimates of Equivalent Annual Damages for Plan G2 as provided by FDA are shown in Table 28.

Table 28: EAD, Plan G2

Reach	EAD $	Infrastructure EAD $	Total EAD $
E1	21,154	351	21,505
E2	242,470	8,675	251,146
E3	58,765	1,708	60,473
E4	43,280	2,530	45,809
E5	6,038	459	6,497
E6	110,173	3,132	113,306
Total	**481,880**	**16,856**	**498,736**

Plan G2 estimates of single-event damages in each of the reaches in the study area for specified frequency events are provided in Table 29; the damages shown are at October 2012 price levels.

Table 29: Single Event Damages, Plan G2

	Annual Chance Exceedence (Recurrence Interval) Damages							
	0.99 (1- yr)	**0.5 (2-yr)**	**0.2 (5-yr)**	**0.1 (10-yr)**	**0.04 (25-yr)**	**0.02 (50-yr)**	**0.01 (100-yr)**	**0.002 (500-yr)**
Reach E1								
Damage ($)							300	99,300
Structures (#)	0	0	0	0	0	0	1	6
Reach E2								
Damage ($)	3,000	67,800	359,300	577,200	874,100	1,239,100	1,699,700	2,633,200
Structures (#)	2	4	13	15	17	22	27	34
Reach E3								
Damage ($)	-	-	-	33,800	112,600	252,100	514,900	3,731,200
Structures (#)	0	0	0	1	5	11	18	37
Reach E4								
Damage ($)	-	-	28,300	63,200	226,500	344,100	475,600	956,600
Structures (#)	0	0	2	2	4	5	5	9
Reach E5								
Damage ($)	-	1,600	5,300	13,300	25,100	33,200	39,900	65,400
Structures (#)	0	2	2	5	6	8	11	16
Reach E6								
Damage ($)	-	-	5,400	15,900	591,300	1,368,700	1,915,600	4,111,900
Structures (#)	0	0	2	3	5	11	18	29
Total Damage ($)	3,000	69,400	398,300	703,400	1,829,600	3,237,100	4,645,900	11,597,700
Total Structures (#)	2	6	19	26	37	57	80	131
Damages per Structure ($)	1,516	11,565	20,961	27,056	49,448	56,791	58,073	88,532
Damage Reduced %	46.63%	82.58%	79.76%	95.50%	94.10%	91.66%	90.25%	83.04%

4.2.3 Plan J

Plan J is the optimized Plan. It includes only the channel increments that produce the most net benefits. Plan J includes:

- Regional Detention
- Channel modifications only in the Reach E1 to protect against the 1/500 ACE.
- Stream Crossings –One stream crossing was built for the railroad and one for vehicles. Another stream crossing was modified to accommodate a wider channel.

The estimates of Equivalent Annual Damages for the Plan J as provided by FDA are displayed in Table 30.

Table 30: EAD, Plan J

Reach	EAD $	Infrastructure EAD $	Total EAD $
E1	21,154	351	21,505
E2	240,857	8,727	249,585
E3	717,055	23,068	740,123
E4	49,363	2,571	51,934
E5	6,106	484	6,590
E6	520,865	31,252	552,117
Total	**1,555,400**	**66,454**	**1,621,854**

Plan J estimates of single-event damages in each of the reaches in the study area for specified frequency events are provided in Table 31; the damages shown are at October 2012 price levels.

Table 31: Single Event Damages, Plan J

	Annual Chance Exceedence (Recurrence Interval) Damages							
	0.99 (1- yr)	0.5 (2-yr)	0.2 (5-yr)	0.1 (10-yr)	0.04 (25-yr)	0.02 (50-yr)	0.01 (100-yr)	0.002 (500-yr)
Reach E1								
Damage ($)	-	-	-	-	-	-	300	99,300
Structures (#)	0	0	0	0	0	0	1	6
Reach E2								
Damage ($)	3,000	68,500	361,500	580,200	882,700	1,241,000	1,701,300	2,537,600
Structures (#)	2	4	13	15	17	22	26	34
Reach E3								
Damage ($)	-	77,200	437,200	1,607,500	3,699,100	4,757,200	6,590,900	14,997,500
Structures (#)	0	5	17	25	35	41	43	49
Reach E4								
Damage ($)	-	1,500	25,400	69,800	238,600	360,300	604,900	1,314,700
Structures (#)	0	2	3	4	5	6	6	9
Reach E5								
Damage ($)	-	1,500	5,300	13,300	25,100	33,200	39,900	65,400
Structures (#)	0	2	2	5	6	8	11	16
Reach E6								
Damage ($)	-	12,500	393,400	844,600	2,386,900	4,702,500	6,739,300	11,765,900
Structures (#)	0	1	13	20	26	31	34	37
Total Damage ($)	3,000	161,200	1,222,800	3,115,400	7,232,400	11,094,100	15,676,500	30,780,500
Total Structures (#)	2	14	48	69	89	108	121	151
Damages per Structure ($)	1,514	11,513	25,474	45,151	81,263	102,723	129,558	203,844
Damage Reduced %	46.71%	59.53%	37.86%	80.06%	76.69%	71.43%	67.11%	54.98%

4.3 FLOOD DAMAGE REDUCTION TO RESIDENTIAL AND NONRESIDENTIAL PROPERTIES

4.3.1 Detention Basins

The estimated benefits of the Detention Basins were calculated as the difference between Total EAD for the without project condition less the Total EAD for the Detention Basins. The benefits for Detention Basins are shown in Table 32.

Table 32: Benefits of Detention Basins

Reach	Without: Total EAD $	Detention Basins: Total EAD $	Benefit of Detention Basins $
E1	2,270,088	2,245,246	24,842
E2	289,010	249,585	39,426
E3	1,070,309	740,123	330,186
E4	75,594	51,934	23,660
E5	10,247	6,590	3,658
E6	936,167	552,117	384,050
Total	**4,651,417**	**3,845,595**	**805,822**

4.3.2 Plan G2

The estimated benefits of Plan G2 were calculated as the difference between Total EAD for the without project condition less the Total EAD for Plan G2. The benefits of Plan G2 are displayed in Table 33.

Table 33: Benefits of Plan G2

Reach	Without: Total EAD $	Plan G2: Total EAD $	Benefit of Plan G2 $
E1	2,270,088	21,505	2,248,583
E2	289,010	251,146	37,865
E3	1,070,309	60,473	1,009,836
E4	75,594	45,809	29,785
E5	10,248	6,497	3,751
E6	936,167	113,306	822,861
Total	**4,651,417**	**498,736**	**4,152,681**

4.3.3 Plan J

The estimated benefits of Plan J were calculated as the difference between Total EAD for the without project condition less the Total EAD for Plan J. The benefits of Plan J are displayed in Table 34.

Table 34: Benefits of Plan J

Reach	Without: Total EAD $	Plan J: Total EAD $	Benefit of Plan J $
E1	2,270,088	21,505	2,248,583
E2	289,010	249,585	39,426
E3	1,069,093	740,123	330,186
E4	75,594	51,934	23,660
E5	10,248	6,590	3,698
E6	936,167	552,117	384,050
Total	**4,651,417**	**1,621,854**	**3,029,603**

4.4 INDUCED DAMAGES

Through FDA output, there was no expected inducement of damages in the Jordan Creek Watershed for Detention Basins, Plan G2, or Plan J.

4.5 SUMMARY OF BENEFITS

Benefits for the Jordan Creek watershed were measured by Equivalent Annual Damages reduced as measured by FDA. Benefits for Detention Basins, Plan G2, and Plan J are shown in Table 35.

Table 35: Benefits Compared

Reach	Benefit of Detention Basins $	Benefit of Plan G2 $	Benefit of Plan J $
E1	24,842	2,248,583	2,248,583
E2	39,426	37,865	39,426
E3	330,186	1,009,836	330,186
E4	23,660	29,785	23,660
E5	3,658	3,751	3,698
E6	384,050	822,861	384,050
Total	**805,821**	**4,152,681**	**3,029,603**

4.6 RISK AND UNCERTAINTY ANALYSIS

The analysis followed guidance described in ER 1105-2-101: Risk Analysis for Flood Damage Reduction Studies. As stated in the ER, “A variety of planning and design variables may be incorporated into risk analysis in a flood damage reduction study. Economic Variables in an urban situation may include, but are not limited to, depth-damage curves, structure values, content values, structure first-floor elevations, structure types, flood warning times, and flood evacuation effectiveness. The uncertainty of these variables may be due to sampling, measurement, estimation, and forecasting.”

4.6.1 First Floor Elevations

The first floor elevations (FFE) for each structure indentified from the maps, as well as structures requested to be examined by the City of Springfield, were obtained by a professional survey team. FFE, as defined by the surveyors, is the lowest point of the lowest, non-basement floor. Error associated with the professional survey was entered as a normal distribution with 0.02 feet standard deviation.

4.6.2 Structure Value

Most commercial, industrial, and residential property values were obtained from the Greene 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, were derived by taking the structure's replacement cost less its depreciation. Error associated with the structure values were entered as a normal distribution with 2.5 percent standard deviation.

4.6.3 Content Value

Content values for non-residential properties were estimated using ARW (as referenced in section 3.3.2.1.2). Error associated with the non-residential content values was entered as a normal distribution with 5 percent standard deviation. Content values for residential properties were based on a Content-to-Structure ratio as given in EGM 04-01.

4.6.4 Vehicle Value

Vehicle values were derived with the methodology from the Fort Worth District's Lower Colorado River Basin study, with no uncertainty on values (given the uncertainty in structure values on which the vehicle values are based).

4.6.5 H&H Exceedance Probability Functions

Functions were derived by using the "Analytical from WSP" function using Log Pearson III statistics with a 20 year equivalent record length within FDA program for each reach along each stream. From EM 1110-2-1619 Table 4-5, "Estimated with rainfall-runoff-routing model calibrated to several events recorded at short-interval event gauge in watershed: 20 to 30 years" was chosen given the information from the H&H Appendix in section 2.3. The H&H model used USGS gages at Scenic Avenue and Bennett Street for the 2000 flood to calibrate the model.

4.6.6 H&H Stage-Discharge Function

Functions were derived by using the "Retrieve from WSP" function using Normal Distribution. Defined uncertainty was calculated within FDA using a normal distribution with "stage where stage becomes constant" and the "standard deviation of error for entered stage" defined by the H&H engineer for each reach along each stream.

4.6.7 Depth-Percent Damage Functions

Depth-percent damage functions were entered for all structures, contents, and vehicles based on the source of the original values. Residential functions were obtained from EGM 04-01. Commercial (as well as industrial and public) functions were entered for all businesses and public structures. Those functions, as well as vehicle functions obtained from ARW.

4.7 CONSEQUENCE OF PROJECT EXCEEDANCE AND RESIDUAL RISK

As stated in ER 1105-2-101, "The flood protection performance will be presented. The risk analysis will quantify the performance of all scales of all alternatives considered for final recommendation. The analysis will evaluate and report residual risk, which includes consequence of project capacity exceedance." In accordance with the policy, several figures (FDA output tables) are presented which depict long-term residual risk by original H&H delineated reaches.

Figure 10: Project Performance, Without Project

Project Performance

File Help

Jordan Creek Study; Springfield Project Performance
by Damage Reaches for the Without
(Without project condition) plan for Analysis Year 2020
(Stages in ft.)
Plan was calculated with Uncertainty

Without Project Base Year Performance Target Criteria:
Event Exceedance Probability = 0.01
Residual Damage = 5.00 %

Stream Name	Stream Description	Damage Reach Name	Damage Reach Description	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
					Median	Expected	10	30	50	10%	4%	2%	1%	.4%	.2%
Lower	Lower Branch c	L1 L		1222.39	0.0714	0.0858	0.5924	0.9323	0.9887	0.6623	0.1806	0.0474	0.0106	0.0012	0.0002
		L1 R		levee	0.0996	0.1151	0.7057	0.9745	0.9978	0.4462	0.0736	0.0138	0.0023	0.0001	0.0000
		L1 B		1223.09	0.0941	0.1060	0.6737	0.9653	0.9963	0.5139	0.1110	0.0268	0.0058	0.0007	0.0001
		L2		1218.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		L3		1232.87	0.2044	0.2196	0.9162	0.9994	1.0000	0.1367	0.0209	0.0048	0.0011	0.0001	0.0000
		L4		1238.84	0.4302	0.4328	0.9966	1.0000	1.0000	0.0068	0.0006	0.0001	0.0000	0.0000	0.0000
		L5		1241.50	0.3743	0.3821	0.9919	1.0000	1.0000	0.0141	0.0013	0.0002	0.0000	0.0000	0.0000
		L6		1246.70	0.4180	0.4012	0.9941	1.0000	1.0000	0.0377	0.0047	0.0010	0.0002	0.0000	0.0000
		L7		1248.32	0.7257	0.7136	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		L8		1262.51	0.0115	0.0226	0.2040	0.4957	0.6805	0.9793	0.8224	0.6130	0.3993	0.1954	0.1049
		L9		1265.17	0.0619	0.0862	0.5941	0.9331	0.9890	0.6667	0.2755	0.1130	0.0421	0.0106	0.0038
		L10		1271.22	0.3141	0.3230	0.9798	1.0000	1.0000	0.0064	0.0001	0.0000	0.0000	0.0000	0.0000
North	North Branch o	N1		1274.61	0.3027	0.3162	0.9777	1.0000	1.0000	0.0145	0.0007	0.0000	0.0000	0.0000	0.0000
		N2		1277.23	0.1186	0.1383	0.7743	0.9885	0.9994	0.3738	0.0924	0.0275	0.0077	0.0013	0.0003
		N3		1269.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N4		1282.90	0.2554	0.2755	0.9602	0.9999	1.0000	0.0446	0.0029	0.0004	0.0000	0.0000	0.0000
		N5		1283.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N6		1289.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N7		1301.21	0.3684	0.3817	0.9918	1.0000	1.0000	0.0130	0.0007	0.0001	0.0000	0.0000	0.0000
		N8		1317.48	0.6096	0.6015	0.9999	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N9		1321.65	0.1877	0.1971	0.8887	0.9986	1.0000	0.1283	0.0132	0.0022	0.0004	0.0000	0.0000
		N10		1324.50	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N11		1338.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N12		1342.40	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N13		1345.50	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N14		1361.20	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N15		1365.60	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
South	South Branch c	S1		1275.84	0.1895	0.2054	0.8996	0.9990	1.0000	0.2133	0.0430	0.0105	0.0023	0.0002	0.0000
		S2		1279.23	0.4364	0.4277	0.9962	1.0000	1.0000	0.0052	0.0003	0.0000	0.0000	0.0000	0.0000
		S3		1280.22	0.5963	0.5917	0.9999	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		S4		1281.79	0.4016	0.4069	0.9946	1.0000	1.0000	0.0016	0.0000	0.0000	0.0000	0.0000	0.0000
		S5		1290.30	0.1618	0.1811	0.8644	0.9975	1.0000	0.2403	0.0525	0.0154	0.0045	0.0008	0.0002
		S6		1293.50	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		S7		1303.57	0.0303	0.0437	0.3605	0.7385	0.8930	0.9214	0.5643	0.2914	0.1253	0.0353	0.0124
		S8		1309.23	0.3214	0.3431	0.9850	1.0000	1.0000	0.0515	0.0078	0.0018	0.0004	0.0000	0.0000
		S9		1314.07	0.0695	0.0829	0.5792	0.9255	0.9868	0.6850	0.1837	0.0458	0.0094	0.0009	0.0001
		S10		1311.50	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		S11		1323.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		S12		1331.60	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Figure 11: Project Performance, Detention Basins

Project Performance

File Help

Jordan Creek Study; Springfield Project Performance
by Damage Reaches for the Det All
(All 5 Detention Ponds Alternative) plan for Analysis Year 2020
(Stages in ft.)
Plan was calculated with Uncertainty

Without Project Base Year Performance Target Criteria:
Event Exceedance Probablility = 0.01
Residual Damage = 5.00 %

Stream Name	Stream Description	Damage Reach Name	Damage Reach Description	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
					Median	Expected	10	30	50	10%	4%	2%	1%	.4%	.2%
Lower	Lower Branch c	L1 L		1222.39	0.0715	0.0855	0.5910	0.8930	0.9886	0.6646	0.1768	0.0449	0.0096	0.0011	0.0001
		L1 R		levee	0.0958	0.1118	0.6945	0.9484	0.9973	0.4673	0.0786	0.0147	0.0024	0.0002	0.0000
		L1 B		1223.09	0.0858	0.0998	0.6504	0.9277	0.9948	0.5575	0.1269	0.0311	0.0066	0.0008	0.0001
		L2		1218.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		L3		1232.87	0.1797	0.1958	0.8868	0.9957	1.0000	0.1889	0.0344	0.0088	0.0022	0.0003	0.0001
		L4		1238.84	0.3702	0.3807	0.9917	1.0000	1.0000	0.0148	0.0016	0.0003	0.0000	0.0000	0.0000
		L5		1241.50	0.3209	0.3340	0.9828	1.0000	1.0000	0.0274	0.0029	0.0005	0.0001	0.0000	0.0000
		L6		1246.70	0.3528	0.3618	0.9888	1.0000	1.0000	0.0492	0.0082	0.0021	0.0005	0.0001	0.0000
		L7		1248.32	0.6826	0.6723	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		L8		1262.51	0.0083	0.0169	0.1569	0.3474	0.5741	0.9913	0.8863	0.7065	0.4959	0.2672	0.1565
		L9		1265.17	0.0418	0.0647	0.4875	0.8120	0.9647	0.7952	0.4037	0.1871	0.0764	0.0212	0.0079
		L10		1271.22	0.2175	0.2317	0.9283	0.9986	1.0000	0.0617	0.0037	0.0004	0.0000	0.0000	0.0000
North	North Branch o	N1		1274.61	0.2320	0.2396	0.9354	0.9989	1.0000	0.0551	0.0040	0.0006	0.0001	0.0000	0.0000
		N2		1277.23	0.0798	0.0979	0.6430	0.9239	0.9942	0.5833	0.2061	0.0790	0.0274	0.0062	0.0018
		N3		1269.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N4		1282.90	0.1808	0.2060	0.9004	0.9969	1.0000	0.1458	0.0164	0.0027	0.0004	0.0000	0.0000
		N5		1283.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N6		1289.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N7		1301.21	0.5925	0.5886	0.9999	1.0000	1.0000	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000
		N8		1317.48	0.4841	0.4818	0.9986	1.0000	1.0000	0.0024	0.0001	0.0000	0.0000	0.0000	0.0000
		N9		1321.65	0.1070	0.1214	0.7259	0.9606	0.9985	0.4323	0.0981	0.0269	0.0071	0.0011	0.0003
		N10		1324.50	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N11		1338.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N12		1342.40	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N13		1345.50	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N14		1361.20	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N15		1365.60	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
South	South Branch c	S1		1275.84	0.1161	0.1295	0.7502	0.9688	0.9990	0.4301	0.1587	0.0656	0.0241	0.0056	0.0017
		S2		1279.23	0.2797	0.2993	0.9715	0.9999	1.0000	0.0464	0.0050	0.0009	0.0001	0.0000	0.0000
		S3		1280.22	0.4650	0.4572	0.9978	1.0000	1.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000
		S4		1281.79	0.2143	0.2213	0.9180	0.9981	1.0000	0.0627	0.0035	0.0003	0.0000	0.0000	0.0000
		S5		1290.30	0.0615	0.0831	0.5800	0.8857	0.9869	0.6784	0.2846	0.1215	0.0475	0.0127	0.0045
		S6		1293.50	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		S7		1303.57	0.0127	0.0215	0.1952	0.4190	0.6624	0.9897	0.8418	0.6074	0.3705	0.1580	0.0744
		S8		1309.23	0.2071	0.2303	0.9270	0.9986	1.0000	0.1657	0.0357	0.0107	0.0032	0.0006	0.0002
		S9		1314.07	0.0570	0.0701	0.5163	0.8373	0.9735	0.7815	0.2721	0.0815	0.0205	0.0027	0.0005
		S10		1311.50	0.9990	0.9965	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		S11		1323.00	0.9098	0.8907	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		S12		1331.60	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Figure 12: Project Performance, Plan G2

Project Performance

File Help

Jordan Creek Study; Springfield Project Performance
by Damage Reaches for the Alt G
(Alternative G NED plan) plan for Analysis Year 2020
(Stages in ft.)
Plan was calculated with Uncertainty

Without Project Base Year Performance Target Criteria:
Event Exceedance Probablility = 0.01
Residual Damage = 5.00 %

Stream Name	Stream Description	Damage Reach Name	Damage Reach Description	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
					Median	Expected	10	30	50	10%	4%	2%	1%	.4%	.2%
Lower	Lower Branch c	L1 L		1222.39	0.0001	0.0007	0.0071	0.0177	0.0350	1.0000	0.9992	0.9961	0.9893	0.9779	0.9697
		L1 R		levee	0.0001	0.0016	0.0156	0.0386	0.0757	1.0000	0.9956	0.9787	0.9457	0.8887	0.8499
		L1 B		1223.09	0.0059	0.0111	0.1055	0.2433	0.4274	0.9994	0.9532	0.8217	0.6149	0.3409	0.1931
		L2		1218.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		L3		1232.87	0.1674	0.1847	0.8703	0.9939	1.0000	0.2041	0.0359	0.0092	0.0022	0.0003	0.0001
		L4		1238.84	0.3702	0.3807	0.9917	1.0000	1.0000	0.0148	0.0016	0.0003	0.0000	0.0000	0.0000
		L5		1241.50	0.3209	0.3340	0.9828	1.0000	1.0000	0.0274	0.0029	0.0005	0.0001	0.0000	0.0000
		L6		1246.70	0.3783	0.3814	0.9918	1.0000	1.0000	0.0362	0.0072	0.0019	0.0005	0.0001	0.0000
		L7		1248.32	0.6818	0.6714	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		L8		1262.51	0.0033	0.0073	0.0708	0.1678	0.3074	0.9982	0.9619	0.8788	0.7579	0.5940	0.4986
		L9		1265.17	0.0001	0.0042	0.0411	0.0996	0.1894	0.9994	0.9825	0.9387	0.8689	0.7686	0.7079
		L10		1271.22	0.0077	0.0138	0.1294	0.2927	0.4998	0.9986	0.9303	0.7639	0.5342	0.2695	0.1415
North	North Branch o	N1		1274.61	0.0067	0.0126	0.1186	0.2707	0.4682	0.9985	0.9399	0.7894	0.5705	0.3025	0.1646
		N2		1277.23	0.0762	0.0959	0.6351	0.9196	0.9935	0.5969	0.2184	0.0851	0.0301	0.0071	0.0023
		N3		1269.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N4		1282.90	0.2197	0.2274	0.9243	0.9984	1.0000	0.1068	0.0131	0.0022	0.0004	0.0000	0.0000
		N5		1283.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N6		1289.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N7		1301.21	0.2293	0.2615	0.9517	0.9995	1.0000	0.1131	0.0160	0.0032	0.0007	0.0000	0.0000
		N8		1317.48	0.4841	0.4818	0.9986	1.0000	1.0000	0.0024	0.0001	0.0000	0.0000	0.0000	0.0000
		N9		1321.65	0.1070	0.1214	0.7259	0.9606	0.9985	0.4323	0.0981	0.0269	0.0071	0.0011	0.0003
		N10		1324.50	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N11		1338.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N12		1342.40	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N13		1345.50	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N14		1361.20	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N15		1365.60	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
South	South Branch c	S1		1275.84	0.0092	0.0166	0.1545	0.3427	0.5679	0.9961	0.8977	0.7021	0.4661	0.2222	0.1123
		S2		1279.23	0.0152	0.0250	0.2234	0.4686	0.7176	0.9847	0.7980	0.5409	0.3073	0.1195	0.0526
		S3		1280.22	0.0199	0.0267	0.2373	0.4919	0.7418	0.9803	0.7739	0.5141	0.2954	0.1205	0.0567
		S4		1281.79	0.0057	0.0112	0.1069	0.2463	0.4319	0.9989	0.9474	0.8152	0.6211	0.3692	0.2312
		S5		1290.30	0.0001	0.0004	0.0043	0.0107	0.0212	1.0000	0.9999	0.9999	0.9998	0.9996	0.9995
		S6		1293.50	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		S7		1303.57	0.0142	0.0238	0.2143	0.4528	0.7005	0.9854	0.8115	0.5659	0.3347	0.1373	0.0638
		S8		1309.23	0.2340	0.2457	0.9404	0.9991	1.0000	0.1491	0.0345	0.0107	0.0031	0.0006	0.0002
		S9		1314.07	0.0570	0.0701	0.5163	0.8373	0.9735	0.7815	0.2721	0.0815	0.0205	0.0027	0.0005
		S10		1311.50	0.9990	0.9965	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		S11		1323.00	0.8972	0.8571	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		S12		1331.60	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Figure 13: Project Performance, Plan J

Without Project Base Year Performance Target Criteria:
Event Exceedance Probablility = 0.01
Residual Damage = 5.00 %

					Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
Stream Name	Stream Description	Damage Reach Name	Damage Reach Description	Target Stage	Median	Expected	10	30	50	10%	4%	2%	1%	.4%	.2%
Lower	Lower Branch c	L1 L		1222.39	0.0001	0.0007	0.0071	0.0177	0.0350	1.0000	0.9992	0.9961	0.9893	0.9779	0.9697
		L1 R		levee	0.0001	0.0016	0.0156	0.0386	0.0757	1.0000	0.9956	0.9787	0.9457	0.8887	0.8499
		L1 B		1223.09	0.0059	0.0111	0.1055	0.2433	0.4274	0.9994	0.9532	0.8217	0.6149	0.3409	0.1931
		L2		1218.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		L3		1232.87	0.1797	0.1958	0.8868	0.9957	1.0000	0.1889	0.0344	0.0088	0.0022	0.0003	0.0001
		L4		1238.84	0.3702	0.3807	0.9917	1.0000	1.0000	0.0148	0.0016	0.0003	0.0000	0.0000	0.0000
		L5		1241.50	0.3209	0.3340	0.9828	1.0000	1.0000	0.0274	0.0029	0.0005	0.0001	0.0000	0.0000
		L6		1246.70	0.3528	0.3618	0.9888	1.0000	1.0000	0.0492	0.0082	0.0021	0.0005	0.0001	0.0000
		L7		1248.32	0.6826	0.6723	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		L8		1262.51	0.0083	0.0169	0.1569	0.3474	0.5741	0.9913	0.8863	0.7065	0.4959	0.2672	0.1565
		L9		1265.17	0.0418	0.0647	0.4875	0.8120	0.9647	0.7952	0.4037	0.1871	0.0764	0.0212	0.0079
		L10		1271.22	0.2175	0.2317	0.9283	0.9986	1.0000	0.0617	0.0037	0.0004	0.0000	0.0000	0.0000
North	North Branch o	N1		1274.61	0.2320	0.2396	0.9354	0.9989	1.0000	0.0551	0.0040	0.0006	0.0001	0.0000	0.0000
		N2		1277.23	0.0798	0.0979	0.6430	0.9239	0.9942	0.5833	0.2061	0.0790	0.0274	0.0062	0.0018
		N3		1269.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N4		1282.90	0.1808	0.2060	0.9004	0.9969	1.0000	0.1458	0.0164	0.0027	0.0004	0.0000	0.0000
		N5		1283.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N6		1289.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N7		1301.21	0.5925	0.5886	0.9999	1.0000	1.0000	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000
		N8		1317.48	0.4841	0.4818	0.9986	1.0000	1.0000	0.0024	0.0001	0.0000	0.0000	0.0000	0.0000
		N9		1321.65	0.1070	0.1214	0.7259	0.9606	0.9985	0.4323	0.0981	0.0269	0.0071	0.0011	0.0003
		N10		1324.50	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N11		1338.00	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N12		1342.40	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N13		1345.50	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N14		1361.20	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		N15		1365.60	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
South	South Branch c	S1		1275.84	0.1161	0.1295	0.7502	0.9688	0.9990	0.4301	0.1587	0.0656	0.0241	0.0056	0.0017
		S2		1279.23	0.2797	0.2993	0.9715	0.9999	1.0000	0.0464	0.0050	0.0009	0.0001	0.0000	0.0000
		S3		1280.22	0.4650	0.4572	0.9978	1.0000	1.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000
		S4		1281.79	0.2143	0.2213	0.9180	0.9981	1.0000	0.0627	0.0035	0.0003	0.0000	0.0000	0.0000
		S5		1290.30	0.0615	0.0831	0.5800	0.8857	0.9869	0.6784	0.2846	0.1215	0.0475	0.0127	0.0045
		S6		1293.50	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		S7		1303.57	0.0127	0.0215	0.1952	0.4190	0.6624	0.9897	0.8418	0.6074	0.3705	0.1580	0.0744
		S8		1309.23	0.2071	0.2303	0.9270	0.9986	1.0000	0.1657	0.0357	0.0107	0.0032	0.0006	0.0002
		S9		1314.07	0.0570	0.0701	0.5163	0.8373	0.9735	0.7815	0.2721	0.0815	0.0205	0.0027	0.0005
		S10		1311.50	0.9990	0.9965	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		S11		1323.00	0.9098	0.8907	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		S12		1331.60	0.9990	0.9967	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

It is also important to relay the residual risk human health and safety risk in such a way that people can easily understand the risk of residual flooding. Given the Tentatively Selected Plan is Plan J, the single event damages for that Plan, as reported as FDA output in Table 36, shows remaining damages by reach and frequency.

Table 36: Residual Flooding, Plan J

	Annual Chance Exceedence (Recurrence Interval) Damages							
	0.99 (1- yr)	0.5 (2-yr)	0.2 (5-yr)	0.1 (10-yr)	0.04 (25-yr)	0.02 (50-yr)	0.01 (100-yr)	0.002 (500-yr)
Reach E1								
Damage ($)	-	-	-	-	-	-	300	99,300
Structures (#)	0	0	0	0	0	0	1	6
Reach E2								
Damage ($)	3,000	68,500	361,500	580,200	882,700	1,241,000	1,701,300	2,537,600
Structures (#)	2	4	13	15	17	22	26	34
Reach E3								
Damage ($)	-	77,200	437,200	1,607,500	3,699,100	4,757,200	6,590,900	14,997,500
Structures (#)	0	5	17	25	35	41	43	49
Reach E4								
Damage ($)	-	1,500	25,400	69,800	238,600	360,300	604,900	1,314,700
Structures (#)	0	2	3	4	5	6	6	9
Reach E5								
Damage ($)	-	1,500	5,300	13,300	25,100	33,200	39,900	65,400
Structures (#)	0	2	2	5	6	8	11	16
Reach E6								
Damage ($)	-	12,500	393,400	844,600	2,386,900	4,702,500	6,739,300	11,765,900
Structures (#)	0	1	13	20	26	31	34	37
Total Damage ($)	3,000	161,200	1,222,800	3,115,400	7,232,400	11,094,100	15,676,500	30,780,500
Total Structures (#)	2	14	48	69	89	108	121	151
Damages per Structure ($)	1,514	11,513	25,474	45,151	81,263	102,723	129,558	203,844

5 COST ANALYSIS

5.1 CONSTRUCTION COST

Cost estimates for Detention Basins, G2, and J are presented in the following two figures. In plans G2 and J, the detention pond costs were allocated across reaches by the percentage of benefits provided to each reach. Tables as presented in the following figures do not match exactly to costs in Table 39 and Table 41 due to the allocation of detention pond costs across the reaches.

Flood Risk Management Feasibility Study, Springfield, Missouri (354082)

Preliminary (Class 3) Project Cost Estimate

Plan G2 (without Main and Boonville Street Bridges and channel side trails)

Reach	01 - Lands & Damages (includes 20% contingency)	02 - Relocations	09 - Channels & Canals	15 - Floodway Control and Diversion Structures	Construction Cost (02+09+15)	06 Wildlife Facilities and Sanctuaries[2]	Escalation	Total Contract Cost	Contingency on Construction, percent	Contingency	Planning Engineering & Design	Corps Contra Supervision ar Administratio
								percentages -			8.1	7.7
E1	$1,058,184	$225,233	$4,360,737		$4,585,970	$0		$4,585,970	25	$1,146,493	$371,464	$441,4
E2	$0	$0	$0		$0	$0		$0	30	$0	$0	
E3	$3,182,112	$3,558,062	$7,568,228		$11,126,291	$0		$11,126,291	30	$3,337,887	$901,230	$1,113,7
E4	$0	$0	$0		$0	$0		$0	30	$0	$0	
E5	$0	$0	$0		$0	$0		$0	30	$0	$0	
E6	$5,796,874	$2,373,494	$5,319,193		$7,692,687	$0		$7,692,687	30	$2,307,806	$623,108	$770,0
Total	$10,037,170	$6,156,789	$17,248,158	$0	$23,404,947	$0	$0	$23,404,947		$6,792,186	$1,895,801	$2,325,1

Prepared: 12/18/2012, revised March 2013

[2] - Includes 25% contingency, 8.5 percent PED and 8 percent SIOH.

Detention Basins

Reach & Basin	01 - Lands & Damages (includes 20% contingency)	02 - Relocations	09 - Channels & Canals	15 - Floodway Control and Diversion Structures	Construction Cost (02+09+15)	06 Wildlife Facilities and Sanctuaries[2]	Escalation	Total Contract Cost		Contingency	Planning Engineering & Design includes 23 percent contingency (Feature 30)	Corps Contra Supervision ar Administratio includes 23 percent contingency (Feature 30)
								percentages -		22		
E0N - 11	$1,055,400	$0		$600,003	$600,003	$0		$600,003		$132,001	$59,549	$58,9
E0N - 11c	$608,160	$0		$398,929	$398,929	$0		$398,929		$87,764	$39,593	$39,2
			Reach Subtotal									
E0S - 6	$705,600	$0		$568,624	$568,624	$0		$568,624		$125,097	$56,435	$55,8
E0S - 7	$828,000	$1,232,630		$2,032,995	$3,265,625	$0		$3,265,625		$718,438	$324,106	$320,9
E0S - 9B	$666,000	$0		$386,086	$386,086	$0		$386,086		$84,939	$38,318	$37,9
			Reach Subtotal									
Total	$3,863,160	$1,232,630	$0	$3,986,636	$5,219,267	$0	$0	$5,219,267		$1,148,239	$518,000	$513,0

Figure 14: Cost Estimate for Plan G2 and Detention Basins

Flood Risk Management Feasibility Study, Springfield, Missouri (354082)

(Class 4) Feasibility Study Project Cost Estimate

Plan J

Reach	01 - Lands & Damages (includes 20% contingency)	02 - Relocations	09 - Channels & Canals	15 - Floodway Control and Diversion Structures	Construction Cost (02+09+15)	06 Wildlife Facilities and Sanctuaries	Escalation	Total Contract Cost	Contingency on Construction, percent	Contingency	Planning Engineering & Design includes 23 percent contingency (Feature 30)	Corps Supervi Admin inclu per conti (Feat
								percentages -				
E1	$537,600	$292,301	$5,846,434		$6,138,735	$0		$6,138,735	22	$1,350,522	$610,000	
E2	$0	$0	$0		$0	$0		$0	22	$0	$0	
E3	$0	$0	$0		$0	$0		$0	22	$0	$0	
E4	$0	$0	$0		$0	$0		$0	22	$0	$0	
E5	$0	$0	$0		$0	$0		$0	22	$0	$0	
E6	$0	$0	$0		$0	$0		$0	22	$0	$0	
Total	$537,600	$292,301	$5,846,434	$0	$6,138,735	$0	$0	$6,138,735		$1,350,522	$610,000	
Prepared:	18 Dec 2012, Revised Apr 4, 2013											

Detention Basins

Reach & Basin	01 - Lands & Damages (includes 20% contingency)	02 - Relocations	09 - Channels & Canals	15 - Floodway Control and Diversion Structures	Construction Cost (02+09+15)	06 Wildlife Facilities and Sanctuaries[2]	Escalation	Total Contract Cost		Contingency	Planning Engineering & Design includes 23 percent contingency (Feature 30)	Corps Supervi Admini incluc per contir (Featu
								percentages -		22		
E0N - 11	$1,055,400	$0		$600,003	$600,003	$0		$600,003		$132,001	$59,549	
E0N - 11c	$608,160	$0		$398,929	$398,929	$0		$398,929		$87,764	$39,593	
			Reach Subtotal									
E0S - 6	$705,600	$0		$568,624	$568,624	$0		$568,624		$125,097	$56,435	
E0S - 7	$828,000	$1,232,630		$2,032,995	$3,265,625	$0		$3,265,625		$718,438	$324,106	
E0S - 9B	$666,000	$0		$386,086	$386,086	$0		$386,086		$84,939	$38,318	
			Reach Subtotal									
Total	$3,863,160	$1,232,630	$0	$3,986,636	$5,219,267	$0	$0	$5,219,267		$1,148,239	$518,000	

Figure 15: Cost Estimate for Plan J and Detention Basins

5.2 OPERATIONS AND MAINTENANCE

Operations, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R) cost estimates for Detention Basins, G2, and J are presented in the following estimates (Figure 16 and Figure 17). As the construction costs were allocated, the costs for detention ponds were allocated across the six reaches by the same percentages.

OPERATION, MAINTENANCE, REPAIR, REPLACEMENT AND REHABILITATION

Date Prepared: January 18, 2013

Jordan Creek Flood Risk Management Feasibility Study, Springfield, Missouri

Life Cycle: 50 years

Rate of Return: 3.75 percent

Plan G without Main Street Bridge and Boonville Culvert

Code	Item Description	Estimate O&M Cycle, years	Quantity Factor	Project Quantity	O&M Quantity	Unit	Project Unit Price	O&M Amount	Present Value O&M	Present Value Major Replacement	Annual Cost	Comments
	Jordan Creek Flood Risk Management Feasibility Study, Springfield, Missouri		O&M and Major Replacement Costs						Equivalent Average Annual O&M/Major Replacement Value			
									$1,228,266	$9,905,099	$642,542	
Reach E1 - Wilson's Creek and South Branch 0+00 to 37+92												
00	Periodic Inspections	1	1	1	1	Job	$281.00	$281	$6,304	0	$281	
	Automobile Bridge Inspections	2	1	1	1	Job	$271.00	$271	$4,348	0	$271	Every 2 years
02	No added OMM&R											
09	Mowings	1	3	4.726	14.2	Acres	$85.58	$1,213	$27,221	0	$1,213	3 times per year
	Woody Vegetation Control	4	0.25	4.726	1.2	Acres	$760.97	$899	$8,843	0	$394	Every four years
	Sediment Removal	1	1		5	CY	$63.68	$318	$7,143	0	$318	Annually
	Trash/Debris Removal	1	1		1	Job	$591.46	$591	$13,269	0	$591	Annually
	Scour Repair	5	0.20		5	CY	$774.72	$592	$4,805	0	$214	Once every 5 years
	Riprap Repair	10	0.10		9	CY	$229.24	$593	$2,642	0	$118	Once every 10 years
	Railway Bridges - Wilson Crk Station 322+92	10	0.01	1	0.1	LS	$648,544.00	$6,485	$29,076	$559,714	$26,245	
	Roadway Bridges - Scenic	10	0.01	1	0.1	LS	$458,473.00	$4,585	$20,555	$395,677	$18,553	Monitor Foundation Shoring
	Subtotal										$48,199	
Reach E2 - Jordan Creek 37+93 to 109+99												
	No Work											
	Subtotal											
Reach E3 - Jordan Creek 110+00 to 166+70												
00	Periodic Inspections	1	1	1	1	Job	$281.00	$281	$6,304	$0	$281	
	Automobile Bridge Inspections	2	1	1	1	Job	$271.00	$271	$4,348	$0	$194	Every 2 years
02		10	0.01	1	0.10	LS	$0.00	$0	$0	$0	$0	
	Roadway Bridges - Campbell Street	10	0.01	1	0.10	LS	$1,172,767.00	$11,728	$52,578	$1,012,135	$47,459	
	Railway Tracks Relocation	10	0.01	1	0.10	LS	$0.00	$0	$0	$0	$0	As was originally. No extra OMM&R
09	Mowings	1	3	4.726	14.2	Acres	$85.58	$1,213	$27,221	$0	$1,213	3 times per year
	Woody Vegetation Control	4	0.25	4.726	1.2	Acres	$760.97	$899	$8,843	$0	$394	Every four years
	Sediment Removal	1	1		5	CY	$63.68	$318	$7,143	$0	$318	Annually
	Trash/Debris Removal	1	1		1	Job	$591.46	$591	$13,269	$0	$591	Annually
	Scour Repair	5	0.20		5	CY	$774.72	$592	$2,656	$0	$118	Once every 5 years
	Riprap Repair	10	0.10		9	CY	$229.24	$593	$2,661	$0	$119	Once every 10 years
	Roadway Bridges - Main Street	10	0.01	1	0.1	LS	$0.00	$0	$0	$0	$0	
	Roadway Bridges - Boonville Street	10	0.01	1	0.1	LS	$0.00	$0	$0	$0	$0	
	Roadway Culvert - Phelps Street 1st Segment	10	0.01	1	0.10	LS	$4,388,718.00	$43,887	$196,758	$3,787,601	$177,600	Once every 10 years
	Roadway Culvert - Phelps Street 2nd Segment	10	0.01	1	0.10	LS	$3,567,448.00	$35,674	$159,938	$3,078,819	$144,365	Once every 10 years
	Subtotal										$372,653	

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Figure 16: OMRR&R for G2 and Detention

OPERATION, MAINTENANCE, REPAIR, REPLACEMENT AND REHABILITATION

Date Prepared: January 18, 2013

Jordan Creek Flood Risk Management Feasibility Study, Springfield, Missouri

Life Cycle: 50 years

Rate of Return: 3.75 percent

Plan G without Main Street Bridge and Boonville Culvert

Jordan Creek Flood Risk Management Feasibility Study, Springfield, Missouri			O&M and Major Replacement Costs						Equivalent Average Annual O&M/Major Replacement Value			
									Present Value			
Code	Item Description	Estimate O&M Cycle, years	Quantity Factor	Project Quantity	O&M Quantity	Unit	Project Unit Price	O&M Amount	O&M	Major Replacement	Annual Cost	Comments
Reach E4 - Jordan Creek North Branch 0+00 to 24+75												
	No Work											
	Subtotal											
Reach E5 - Jordan Creek North Branch 24+76 to 81+21												
	No Work											
	Subtotal											
Reach E6 - Jordan Creek South Branch 0+00 to 91+78												
00	Periodic Inspections	1	1	1	1	Job	$281.00	$281	$6,304	$0	$281	
	Automobile Bridge Inspections	2	1	1	1	Job	$271.00	$271	$4,348	$0	$194	Every 2 years
02	No added OMM&R											
09	Mowings	1	3	4.726	14.2	Acres	$85.58	$1,213	$27,221	$0	$1,213	3 times per year
	Woody Vegetation Control	4	0.25	4.726	1.2	Acres	$760.97	$899	$8,843	$0	$394	Every four years
	Sediment Removal	1	1		5	CY	$63.68	$318	$7,143	$0	$318	Annually
	Trash/Debris Removal	1	1		1	Job	$591.46	$591	$13,269	$0	$591	Annually
	Scour Repair	5	0.2		5	CY	$774.72	$592	$2,656	$0	$118	Once every 5 years
	Riprap Repair	10	0.1		9	CY	$229.24	$593	$2,661	$0	$119	Once every 10 years
	National Culvert	10	0.01	1	0.1	LS	$1,207,388.00	$12,074	$54,130	$0	$2,413	
	Railroad Near Sherman	10	0.01	1	0.1	LS	$441,096.00	$4,411	$19,775	$380,680	$17,850	
	Sherman Street Culvert	10	0.01	1	0.1	LS	$298,056.00	$2,981	$13,363	$257,232	$12,062	
	Subtotal										$35,553	
Reach EON - Detention Ponds on North Branch of Jordan Creek												
00	Periodic Inspections	1	1	1	1	Job	$914.00	$914	$20,505	$0	$914	
15	Mowings	1	3	10.7	32.1	Acres	$85.58	$2,747	$61,630	$0	$2,747	3 times per year
	Woody Vegetation Control	4	0.25	10.7	2.7	Acres	$760.97	$2,036	$20,021	$0	$892	Every four years
	Washout Repair	10	0.1		31	CY	$56.50	$1,752	$7,852	$0	$350	Once every 10 years
	Outlet Structure Detention Basin 11	10	0.01	1	0.1	LS	$70,729.29	$7,073	$31,710	$61,042	$24,734	
	Outlet Structure Detention Basin 11c	10	0.01	1	0.1	LS	$95,461.84	$9,546	$42,798	$82,387	$33,383	
	Subtotal										$63,020	
Reach EOS - Detention Ponds on South Branch of Jordan Creek												
00	Periodic Inspections	1	1	1	1	Job	$914.00	$914	$20,505	$0	$914	
15	Mowings	1	3	13	39.0	Acres	$85.58	$3,338	$74,878	$0	$3,338	3 times per year

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OPERATION, MAINTENANCE, REPAIR, REPLACEMENT AND REHABILITATION

Date Prepared: January 18, 2013

Jordan Creek Flood Risk Management Feasibility Study, Springfield, Missouri

Life Cycle: 50 years

Rate of Return: 3.75 percent

Plan G without Main Street Bridge and Boonville Culvert

Jordan Creek Flood Risk Management Feasibility Study, Springfield, Missouri			O&M and Major Replacement Costs						Equivalent Average Annual O&M/Major Replacement Value			
									Present Value			
Code	Item Description	Estimate O&M Cycle, years	Quantity Factor	Project Quantity	O&M Quantity	Unit	Project Unit Price	O&M Amount	O&M	Major Replacement	Annual Cost	Comments
	Woody Vegetation Control	4	0.25	13	3.3	Acres	$760.97	$2,473	$24,324	$0	$1,084	Every four years
	Washout Repair	10	0.1		31	CY	$56.50	$1,752	$7,852	$0	$350	Once every 10 years
	Outlet Structure Detention Basin 6	10	0.01	1	0.1	LS	$133,988.00	$13,399	$60,070	$115,636	$46,855	
	Outlet Structure Detention Basin 7	10	0.01	1	0.1	LS	$133,988.00	$13,399	$60,070	$115,636	$46,855	
	Outlet Structure Detention Basin 9B	10	0.01	1	0.1	LS	$67,834.00	$6,783	$30,412	$58,543	$23,721	
	Subtotal										$123,117	

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OPERATION, MAINTENANCE, REPAIR, REHABILITATION AND REPLACEMENT

Date Prepared: January 18, 2013

Jordan Creek Flood Risk Management Feasibility Study, Springfield, Missouri

Life Cycle: 50 years
Rate of Return: 3.75 percent

Plan J

Jordan Creek Flood Risk Management Feasibility Study, Springfield, Missouri			O&M and Major Replacement Costs						Equivalent Average Annual O&M/Major Replacement Value			
									Present Value			
Code	Item Description	Estimate O&M Cycle, years	Quantity Factor	Project Quantity	O&M Quantity	Unit	Project Unit Price	O&M Amount	O&M	Major Replacement	Annual Cost	Comments
									$590,029	$1,388,633	$234,479	
Reach E1 - Wilson's Creek and South Branch 0+00 to 37+92												
00	Periodic Inspections	1	1	1	1	Job	$281.00	$281	$6,304	0	$281	
	Automobile Bridge Inspections	2	1	1	1	Job	$271.00	$271	$4,348	0	$271	Every 2 years
02	No added OMM&R											
09	Mowings	1	3	4.726	14.2	Acres	$85.58	$1,213	$27,221	0	$1,213	3 times per year
	Woody Vegetation Control	4	0.25	4.726	1.2	Acres	$760.97	$899	$8,843	0	$394	Every four years
	Sediment Removal	1	1		5	CY	$63.68	$318	$7,143	0	$318	Annually
	Trash/Debris Removal	1	1		1	Job	$591.46	$591	$13,269	0	$591	Annually
	Scour Repair	5	0.20		5	CY	$774.72	$592	$4,805	0	$214	Once every 5 years
	Riprap Repair	10	0.10		9	CY	$229.24	$593	$5,837	0	$260	Once every 10 years
	Railway Bridges - Wilson Crk Station 322+92	10	0.01	1	0.01	LS	$648,544.00	$6,485	$29,076	$559,714	$26,245	
	Roadway Bridges - Scenic	10	0.01	1	0.01	LS	$458,473.00	$4,585	$20,555	$395,677	$18,553	Monitor Foundation Shoring
	Subtotal										$48,342	
Reach E2 - Jordan Creek 37+93 to 109+99												
	No Work											
	Subtotal											
Reach E3 - Jordan Creek 110+00 to 166+70												
	Subtotal										$0	
Reach E4 - Jordan Creek North Branch 0+00 to 24+75												
	No Work											
	Subtotal											
Reach E5 - Jordan Creek North Branch 24+76 to 81+21												
	No Work											
	Subtotal											
Reach E6 - Jordan Creek South Branch 0+00 to 91+78												
00	Periodic Inspections	1	1	1	1	Job			$0	$0	$0	
	Automobile Bridge Inspections	2	1	1	1	Job			$0	$0	$0	Every 2 years
02	No added OMM&R											
09	Mowings	1	3	4.726	14.2	Acres			$0	$0	$0	3 times per year

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Figure 17: OMRR&R for J and Detention

OPERATION, MAINTENANCE, REPAIR, REHABILITATION AND REPLACEMENT

Date Prepared: January 18, 2013

Jordan Creek Flood Risk Management Feasibility Study, Springfield, Missouri

Life Cycle: 50 years

Rate of Return: 3.75 percent

Plan J

Jordan Creek Flood Risk Management Feasibility Study, Springfield, Missouri			O&M and Major Replacement Costs						Equivalent Average Annual O&M/Major Replacement Value			
									Present Value			
Code	Item Description	Estimate O&M Cycle, years	Quantity Factor	Project Quantity	O&M Quantity	Unit	Project Unit Price	O&M Amount	O&M	Major Replacement	Annual Cost	Comments
	Woody Vegetation Control	4	0.25	4.726	1.2	Acres			$0	$0	$0	Every four years
	Sediment Removal	1	1		5	CY			$0	$0	$0	Annually
	Trash/Debris Removal	1	1		1	Job			$0	$0	$0	Annually
	Scour Repair	5	0.2		5	CY			$0	$0	$0	Once every 5 years
	Riprap Repair	10	0.1		9	CY			$0	$0	$0	Once every 10 years
	National Culvert	10	0.01	1	0.1	LS			$0	$0	$0	
	Railroad Near Sherman	10	0.01	1	0.1	LS			$0	$0	$0	
	Sherman Street Culvert	10	0.01	1	0.1	LS			$0	$0	$0	
	Subtotal										$0	
Reach EON - Detention Ponds on North Branch of Jordan Creek												
00	Periodic Inspections	1	1	1	1	Job	$914.00	$914	$20,505	$0	$914	
15	Mowings	1	3	10.7	32.1	Acres	$85.58	$2,747	$61,630	$0	$2,747	3 times per year
	Woody Vegetation Control	4	0.25	10.7	2.7	Acres	$760.97	$2,036	$20,021	$0	$892	Every four years
	Washout Repair	10	0.1		31	CY	$56.50	$1,752	$7,852	$0	$350	Once every 10 years
	Outlet Structure Detention Basin 11	10	0.01	1	0.1	LS	$70,729.29	$7,073	$31,710	$61,042	$24,734	
	Outlet Structure Detention Basin 11c	10	0.01	1	0.1	LS	$95,461.84	$9,546	$42,798	$82,387	$33,383	
	Subtotal										$63,020	
Reach EOS - Detention Ponds on South Branch of Jordan Creek												
00	Periodic Inspections	1	1	1	1	Job	$914.00	$914	$20,505	$0	$914	
15	Mowings	1	3	13	39.0	Acres	$85.58	$3,338	$74,878	$0	$3,338	3 times per year
	Woody Vegetation Control	4	0.25	13	3.3	Acres	$760.97	$2,473	$24,324	$0	$1,084	Every four years
	Washout Repair	10	0.1		31	CY	$56.50	$1,752	$7,852	$0	$350	Once every 10 years
	Outlet Structure Detention Basin 6	10	0.01	1	0.1	LS	$133,988.00	$13,399	$60,070	$115,636	$46,855	
	Outlet Structure Detention Basin 7	10	0.01	1	0.1	LS	$133,988.00	$13,399	$60,070	$115,636	$46,855	
	Outlet Structure Detention Basin 9B	10	0.01	1	0.1	LS	$67,834.00	$6,783	$30,412	$58,543	$23,721	
	Subtotal										$123,117	

5.3 INTEREST DURING CONSTRUCTION

Interest during construction was calculated with the following formula:

IDC = (((1+r)^(n*12)-1)/(r))*(p/(n*12))-p; where r=monthly interest rate, n=construction period in years, and p=total project cost. Construction duration was provided by the cost estimator.

6 BENEFIT/COST EVALUATION OF PLANS

6.1.1 Detention Basins

Given cost estimates, interest rates, construction period, and the period of analysis, the annual benefits were compared to the average annual cost of the Detention Basins. Average annual benefits and costs, as well as the benefit-to-cost ratio and the net benefits for Detention Basins are displayed in Table 37.

Table 37: Detention Basin Benefits and Costs

Item	Amount
Interest Rate,%	3.750%
Interest Rate, Monthly	0.307%
Construction Period, Years	1.25
Period of Analysis, Years	50
Total Project Cost	$11,261,700
Interest During Construction ($)	245,500
Investment Cost ($)	11,507,200
Annual Cost	
Amortized Cost ($)	512,900
OMRR&R ($)	186,100
Total Annual Cost ($)	699,000
Annual Benefits	
Structures, Contents, Other ($)	770,800
Infrastructure ($)	35,100
Total Annual Benefits ($)	805,900
Benefit-to-Cost Ratio	**1.15**
Net Benefits ($)	**106,900**

6.1.2 Plan G2

Given cost estimates, interest rates, construction period, and the period of analysis, the annual benefits were compared to the average annual cost of the Plan G2. Average annual benefits and costs, as well as the benefit-to-cost ratio and the net benefits for Plan G2 at 3.75 percent and 7 percent are displayed Table 38.

Table 38: Plan G2 Benefits and Costs

Item	Amount	Amount
Interest Rate,%	3.750%	7%
Interest Rate, Monthly	0.307%	0.565%
Construction Period, Years	3.0	3.0
Period of Analysis, Years	50	50
Total Project Cost	$59,358,500	$59,358,500
Interest During Construction ($)	2,540,800	4,787,600
Investment Cost ($)	61,899,300	64,146,100
Annual Cost		
Amortized Cost ($)	2,759,100	4,648,000
OMRR&R ($)	642,600	642,600
Total Annual Cost ($)	3,401,700	5,290,600
Annual Benefits		
Structures, Contents, Other ($)	4,041,400	4,041,400
Infrastructure ($)	111,200	111,200
Total Annual Benefits ($)	4,152,600	4,152,600
Benefit-to-Cost Ratio	**1.22**	**0.78**
Net Benefits($)	**750,900**	**(1,138,000)**

Looking at G2 by reach, as in Table 38, it was evident that the channel plan in Reach E1 enabled the economic justification of the channels in Reaches E3 and E6.

Table 39: Plan G2, Benefits and Costs for All Reaches

	Reach E1	Reach E2	Reach E3	Reach E4	Reach E5	Reach E6
Interest Rate,%	3.750%	3.750%	3.750%	3.750%	3.750%	3.750%
Construction Period, Years	2.00	1.25	2.75	1.25	1.25	2.00
Period of Analysis, Years	50	50	50	50	50	50
Total Project Cost	$7,958,000	$557,200	$27,982,000	$331,900	$50,100	$22,479,300
Interest During Construction ($)	287,600	12,100	1,420,300	7,200	1,100	812,500
Investment Cost ($)	8,245,600	569,300	29,402,300	339,100	51,200	23,291,800
Annual Cost						
Amortized Cost ($)	367,500	25,400	1,310,600	15,100	2,300	1,038,200
OMRR&R ($)	54,100	9,200	450,000	5,500	800	123,000
Total Annual Cost ($)	421,600	34,600	1,760,600	20,600	3,100	1,161,200
Annual Benefits						
Structures, Contents, Other ($)	2,221,500	36,500	978,500	28,800	3,500	772,600
Infrastructure ($)	27,100	1,300	31,300	1,000	300	50,200
Total Annual Benefits ($)	2,248,600	37,800	1,009,800	29,800	3,800	822,800
BC Ratio	5.3	1.09	0.57	1.4	1.2	0.71
Net Benefits	$1,827,000	$3,200	($750,800)	$9,200	$700	($338,400)

6.1.3 Plan J

Given cost estimates, interest rates, construction period, and the period of analysis, the annual benefits were compared to the average annual cost of the Plan J. Average annual benefits and costs, as well as the benefit-to-cost ratios and the net benefits for Plan J at 3.75 percent and at 7 percent are displayed in Table 40. With $1,831,300 in net benefits, Plan J is the National Economic Development (NED) Plan. Plan J is the alternative plan that reasonably maximizes the net economic benefits consistent with protecting the Nation’s environment.

Table 40: Plan J Benefits and Costs

Item	Amount	Amount
Interest Rate,%	3.750%	7.0%
Interest Rate, Monthly	0.307%	0.565%
Construction Period, Years	3.0	3.0
Period of Analysis, Years	50	50
Total Project Cost	$20,479,600	$20,479,600
Interest During Construction ($)	1,140,500	2,162,500
Investment Cost ($)	21,620,100	22,642,100
Annual Cost		
Amortized Cost ($)	963,700	1,640,600
OMRR&R ($)	234,400	234,400
Total Annual Cost ($)	1,198,100	1,875,000
Annual Benefits		
Structures, Contents, Other ($)	2,967,800	2,967,800
Infrastructure ($)	61,600	61,600
Total Annual Benefits ($)	3,029,400	3,029,400
Benefit-to-Cost Ratio	2.5	1.6
Net Benefits ($)	1,831,300	1,154,400

The benefits and cost by reach are presented in Table 41. All reaches have positive net benefits.

Table 41: Plan J, Benefits and Costs for All Reaches

	Reach E1	Reach E2	Reach E3	Reach E4	Reach E5	Reach E6
Interest Rate,%	3.750%	3.750%	3.750%	3.750%	3.750%	3.750%
Construction Period, Years	1.25	1.25	1.25	1.25	1.25	1.25
Period of Analysis, Years	50	50	50	50	50	50
Total Project Cost	$9,572,300	$557,200	$4,679,300	$331,900	$50,100	$5,288,800
Interest During Construction ($)	346,000	12,100	102,000	7,200	1,100	115,300
Investment Cost ($)	9,918,300	569,300	4,781,300	339,100	51,200	5,404,100
Annual Cost						
Amortized Cost ($)	442,100	25,400	213,100	15,100	2,300	240,900
OMRR&R ($)	48,300	0	0	0	0	0
Total Annual Cost ($)	490,400	25,400	213,100	15,100	2,300	240,900
Annual Benefits						
Structures, Contents, Other ($)	2,221,500	38,100	320,200	22,700	3,400	361,900
Infrastructure ($)	27,100	1,300	10,000	900	200	22,100
Total Annual Benefits ($)	2,248,600	39,400	330,200	23,600	3,600	384,000
BC Ratio	4.6	1.6	1.6	1.6	1.6	1.6
Net Benefits	$1,758,200	$14,000	$117,100	$8,500	$1,300	$143,100

7 BENEFITS OUTSIDE OF FEDERAL INTEREST

In evaluating benefits for FRM projects in urban areas, the Corps participates in projects that address discharges that represent a serious threat to life and property. The threshold for determining flows that fall within this category is outlined in 33 CFR Part 238 (ER 1165-2-21, Water Resources Policies and Authorities: Flood Damage Reduction Measures in Urban Areas). This law states that urban water damage associated with a natural stream or modified natural waterway may be addressed by the Corps only downstream from the point where the discharge for the 10 percent chance, or 10 year, flood is greater than 800 cfs, unless an exemption is granted. The analysis to this point has only included structures which were stationed below the points on North Branch and South Branch where the discharge for the 10 percent chance event was greater than 800 cfs.

There are other structures in the Jordan Creek watershed that are affected by flood risk. These structures are located above the point that meets the 800 cfs – 1.5 square mile criteria as discussed in ER 1165-2-21, Paragraph 7.a.(1) and were initially considered to be out of the scope of this project. However, the detention measures are located upstream of the criteria point and upstream of a number of these structures. ER 1165-2-21, Paragraph 7.a.(4) states "Flood reduction measures, such as dams or diversions, may be located upstream of the particular point where the hydrologic criteria (and area criterion, if appropriate) are met, if economically justified by benefits derived within the stream reach which does qualify for flood control improvement." The detention measures are economically justified by benefits derived below the criteria point with a BCR of 1.27 as presented in Table 37. The location of the detention measure essentially re-sets the upper limit of the project scope and the limit of Federal interest. The structures that were initially considered outside of Federal interest will subsequently be included in the total benefits as derived below the detention measures and above initial criteria point.

For Jordan Creek, two additional reaches were delineated for areas outside of the 800 cfs urban limit. E0-North and E0-South are displayed in Figure 18.

Figure 18: Economic Reaches

There were 253 additional structures in the area outside Federal interest. E0-N contained 130 structures. E0-South contained 123 structures. The number and type of structures that fell within the maximum projected floodplain are shown in Table 42.

Table 42: Structure Inventory, Including E0-N AND E0-S

Reach	Number of structures in reach	Structures by type				Structure values ($)
		Residential	Commercial	Industrial	Public	
E1	32	0	5	27	0	5,438,000
E2	54	15	22	17	0	5,068,800
E3	66	2	33	31	0	33,215,800
E4	12	0	4	6	2	1,930,800
E5	50	43	5	0	2	2,447,600
E6	56	0	23	33	0	27,759,800
E0-N	130	97	19	14	0	15,098,400
E0-S	123	117	3	3	0	12,458,000
Total	523	274	114	131	4	103,417,200

Equivalent Annual Damages were calculated for damages to structures, contents, and vehicles by the FDA program. Table 43 provides the without project estimates of EAD as provided by FDA.

Table 43: EAD, Without Project, Including E0-N AND E0-S

Reach	EAD: Without Project $
E1	2,242,650
E2	278,992
E3	1,037,289
E4	72,076
E5	9,533
E6	882,811
E0-N	58,302
E0-S	143,284
Total	**4,724,937**

The “infrastructure” model was run to calculate EAD for structural damages. Expected annual infrastructure damage in the Without Project condition was $142,041 as shown in Table 44.

Table 44: EAD, Infrastructure Damages, Without Project, Including E0-N AND E0-S

Reach	Structural EAD: Without Project $	Percentage of Damage	Infrastructure EAD: Without Project $
E1	175,888	15.6%	27,438
E2	64,222	15.6%	10,019
E3	211,667	15.6%	33,020
E4	22,552	15.6%	3,518
E5	4,588	15.6%	716
E6	342,024	15.6%	53,356
E0-N	14,349	15.6%	2,238
E0-S	74,972	15.6%	11,696
Total	**910,261**		**142,001**

The estimates of Equivalent Annual Damages for the Plan J as provided by FDA are displayed in Table 44.

Table 45: EAD, Plan J, Including E0-N and E0-S

Reach	EAD $	Infrastructure EAD $	Total EAD $
E1	21,154	351	21,505
E2	240,857	8,727	249,585
E3	717,055	23,068	740,123
E4	49,363	2,571	51,934
E5	6,106	484	6,590
E6	520,865	31,252	552,117
E0-N	56,808	2,176	58,984
E0-S	47,793	3,780	51,572
Total	**1,660,000**	**72,410**	**1,732,410**

The estimated benefits of Plan J, calculated as the difference between Total EAD for the without project condition less the Total EAD for Plan J, are displayed in Table 46.

Table 46: Benefits of Plan J, Including E0-N and E0-S

Reach	Without: Total EAD $	Plan G: Total EAD $	Benefit of Plan G $	Plan J: Total EAD $	Benefit of Plan J $
E1	2,270,088	21,505	2,248,583	21,505	2,248,583
E2	289,010	251,146	37,865	249,585	39,426
E3	1,070,309	60,473	1,009,836	740,123	330,186
E4	75,594	45,809	29,785	51,934	23,660
E5	10,247	6,497	3,750	6,590	3,658
E6	936,167	113,306	822,861	552,117	384,050
E0-N	60,541	58,984	1,556	58,984	1,556
E0-S	154,980	51,572	103,408	51,572	103,408
Total	**4,866,937**	**609,292**	**4,257,645**	**1,732,410**	**3,134,527**

Given cost estimates, interest rates, construction period, and the period of analysis, the annual benefits were compared to the average annual cost of the Plan J. Average annual benefits and costs, benefit-to-cost ratios and the net benefits for Plan G and Plan J at 3.75% and at 7% are displayed in Table 47. With $1,936,300 in net benefits, Plan J remains the NED plan.

Table 47: Plan G2 and Plan J Benefits and Costs, Including E0-N and E0-S

Item	G2	G2	J	J
Interest Rate,%	3.750%	7.0%	3.750%	7.0%
Interest Rate, Monthly	0.307%	0.565%	0.307%	0.565%
Construction Period, Years	3.0	3.0	3.0	3.0
Period of Analysis, Years	50	50	50	50
Total Project Cost	$59,358,500	$59,358,500	$20,479,600	$20,479,600
Interest During Construction ($)	2,540,800	4,787,600	1,140,500	2,162,500
Investment Cost ($)	61,899,300	64,146,100	21,620,100	22,642,100
Annual Cost				
Amortized Cost ($)	2,759,100	4,648,000	963,700	1,640,600
OMRR&R ($)	642,600	642,600	234,400	234,400
Total Annual Cost ($)	3,401,700	5,290,600	1,198,100	1,875,000
Annual Benefits				
Structures, Contents, Other ($)	4,138,400	4,138,400	3,064,800	3,064,800
Infrastructure ($)	119,200	119,200	69,600	69,600
Total Annual Benefits ($)	4,257,600	4,257,600	3,134,400	3,134,400
Benefit-to-Cost Ratio	1.3	0.8	2.6	1.7
Net Benefits ($)	855,900	(1,033,000)	1,936,300	1,259,400

8 ANALYSIS OF ECONOMIC VIABILITY

8.1 Sensitivity of Hydrology

As discussed in Section 3.1, the plan formulation and economic analysis were based on the Ultimate Conditions hydrology model. As a sensitivity test, Plan G2 and Plan J were also analyzed with the 2003 hydrology model. As seen in Table 48, Plan G2 is not an economically viable plan under 2003 hydrology. Plan J remains economically viable with 2003 hydrology.

Table 48: Sensitivity Test: Plan G2 and Plan J Benefits and Costs, 2003 Hydrology

Item	G2	G2	J	J
Interest Rate,%	3.750%	7.0%	3.750%	7.0%
Interest Rate, Monthly	0.307%	0.565%	0.307%	0.565%
Construction Period, Years	3.0	3.0	3.0	3.0
Period of Analysis, Years	50	50	50	50
Total Project Cost	$59,358,500	$59,358,500	$20,479,600	$20,479,600
Interest During Construction ($)	2,540,800	4,787,600	1,140,500	2,162,500
Investment Cost ($)	61,899,300	64,146,100	21,620,100	22,642,100
Annual Cost				
Amortized Cost ($)	2,759,100	4,648,000	963,700	1,640,600
OMRR&R ($)	642,600	642,600	234,400	234,400
Total Annual Cost ($)	3,401,700	5,290,600	1,198,100	1,875,000
Annual Benefits				
Structures, Contents, Other ($)	2,628,800	2,628,800	1,872,600	1,872,600
Infrastructure ($)	110,100	110,100	61,300	61,300
Total Annual Benefits ($)	2,738,900	2,738,900	1,933,900	1,933,900
Benefit-to-Cost Ratio	0.81	0.52	1.6	1.03
Net Benefits ($)	(662,800)	(2,551,700)	735,800	58,900

8.2 Monte Carlo Analysis of Viability

The analysis followed guidance described in ER 1105-2-101: Risk Analysis for Flood Damage Reduction Studies. As stated in the ER: “The estimate of net NED benefits and benefit/cost ratio will be reported both as a single expected value and on a probabilistic basis for each planning alternative. The probability that net benefits are positive and that the benefit-to-cost ratio is at or above 1.0 will be presented for each planning alternative.”

To estimate the probability that economic annual net benefits for Plan J (with Ultimate Hydrology and Outside of Federal Interest benefits) are positive, an uncertainty model was created using @Risk. For the benefits, FDA provided amounts that damage reduced exceed for three probabilities: 0.25, 0.5, and 0.75. The probabilities and benefits were entered into a cumulative distribution function with the benefits rounded to the hundred-thousand with a minimum and maximum estimated by a polynomial function. Cost estimating provided three values from the MII cost estimating program: 0 percent contingency, 23 percent contingency, and 30 percent contingency. Without performing a more robust uncertainty cost analysis, a triangular distribution with the most likely value and the 10 and 90 percentiles was used.

Benefits: RiskCumul(1100000,5400000,{1900000,2900000,4100000},{0.25,0.5,0.75})

Costs: =RiskTrigen(15930000,20480000,25000000,10,90)

A simulation was created with the following characteristics: 10,000 iterations, Latin Hypercube Sampling, Mersenne Twister Generator, Fixed Initial Seed of 3259. Expected and probabilistic values of the net benefits and costs are shown in Table 49. Expected and probabilistic values of the benefit/cost ratio are shown in Table 50.

Table 49: Expected and Probabilistic Values of Net Benefits

	Expected Annual Benefit and Cost		**Net Benefits**		**Prob. Net Benefit is > 0**	**Net Benefit that is Exceeded with Specified Probability**		
Plan	Benefit	Cost	Mean	Std. Dev.		0.75	0.5	0.25
Plan J	4,474,900	1,234,500	3,240,300	2,135,100	0.91	1,550,000	3,500,000	5,000,000

Table 50: Expected and Probabilistic Benefit/Cost Ratios

	Expected Benefit/Cost Ratio		**Prob. Net Benefit is > 0**	**B/C Ratio that is Exceeded with Specified Probability**		
Plan	Mean	Std. Dev		0.75	0.5	0.25
Plan J	3.69	1.84	0.91	2.25	3.8	5.1

Given the inputs of the simulation, there is a 91 percent chance that the BC ratio is greater than 1 at the current discount rate as shown in Figure 19 and that net benefits are greater than zero as shown in Figure 20. There is an 83.4 percent chance that the BC ratio is greater than 1 at a discount rate of 7 percent as shown in Figure 21, and that net benefits are greater than zero as shown in Figure 22.

Figure 19: Probability of Economic Viability at 3.75%

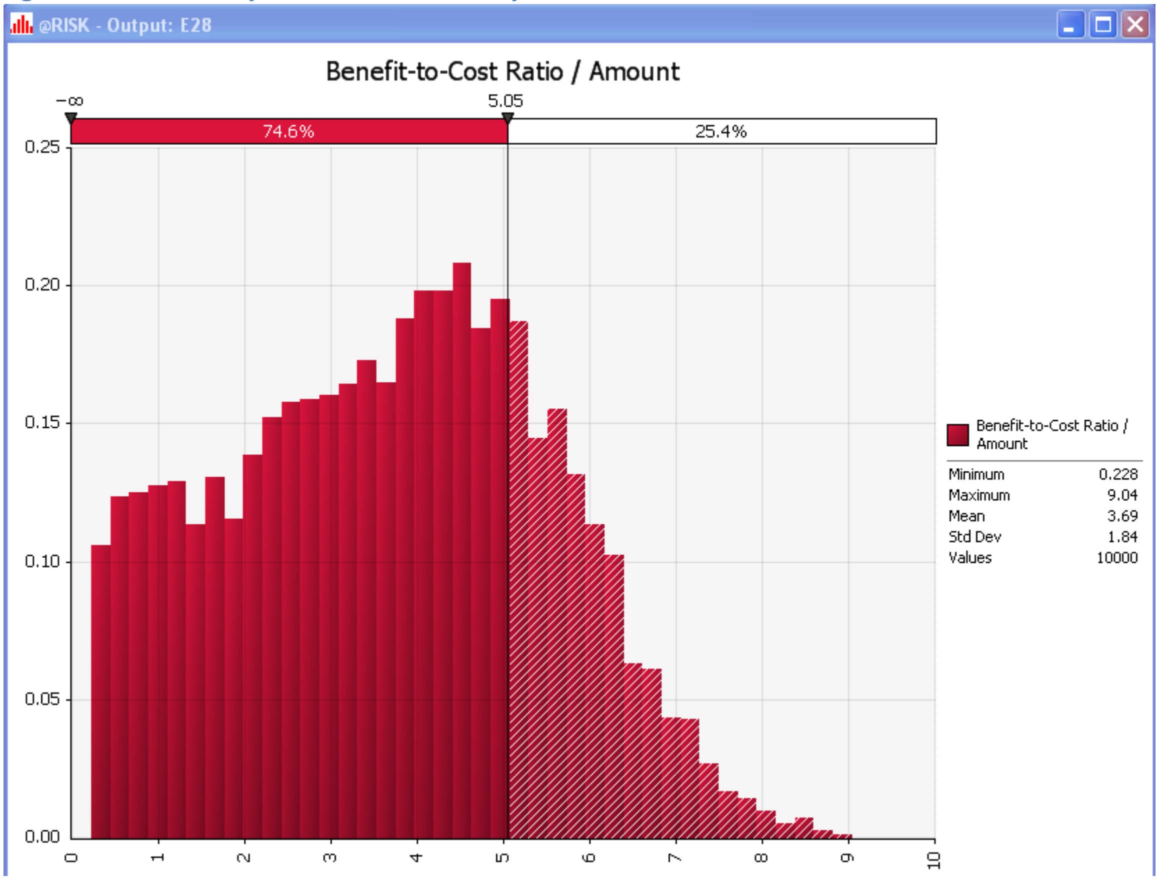


Figure 20: Probability of Positive Net Benefits at 3.75%

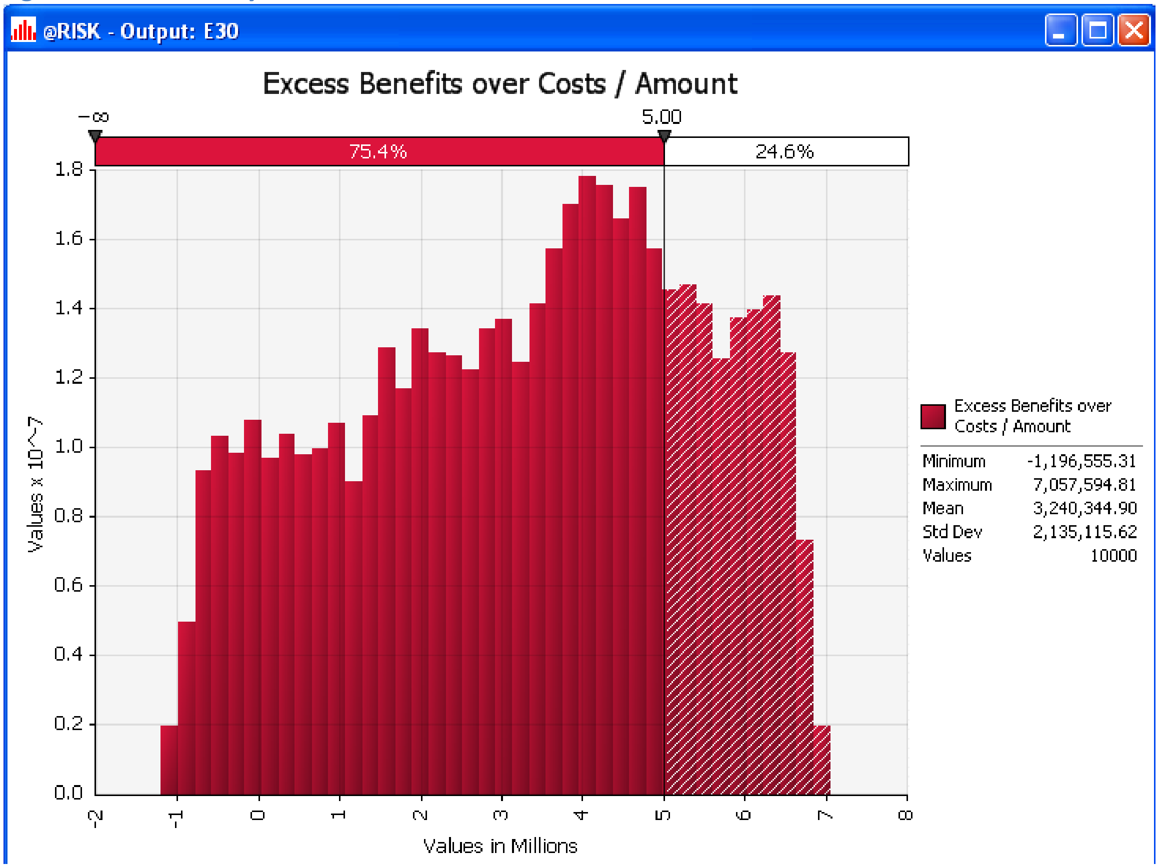


Figure 21: Probability of Economic Viability at 7%

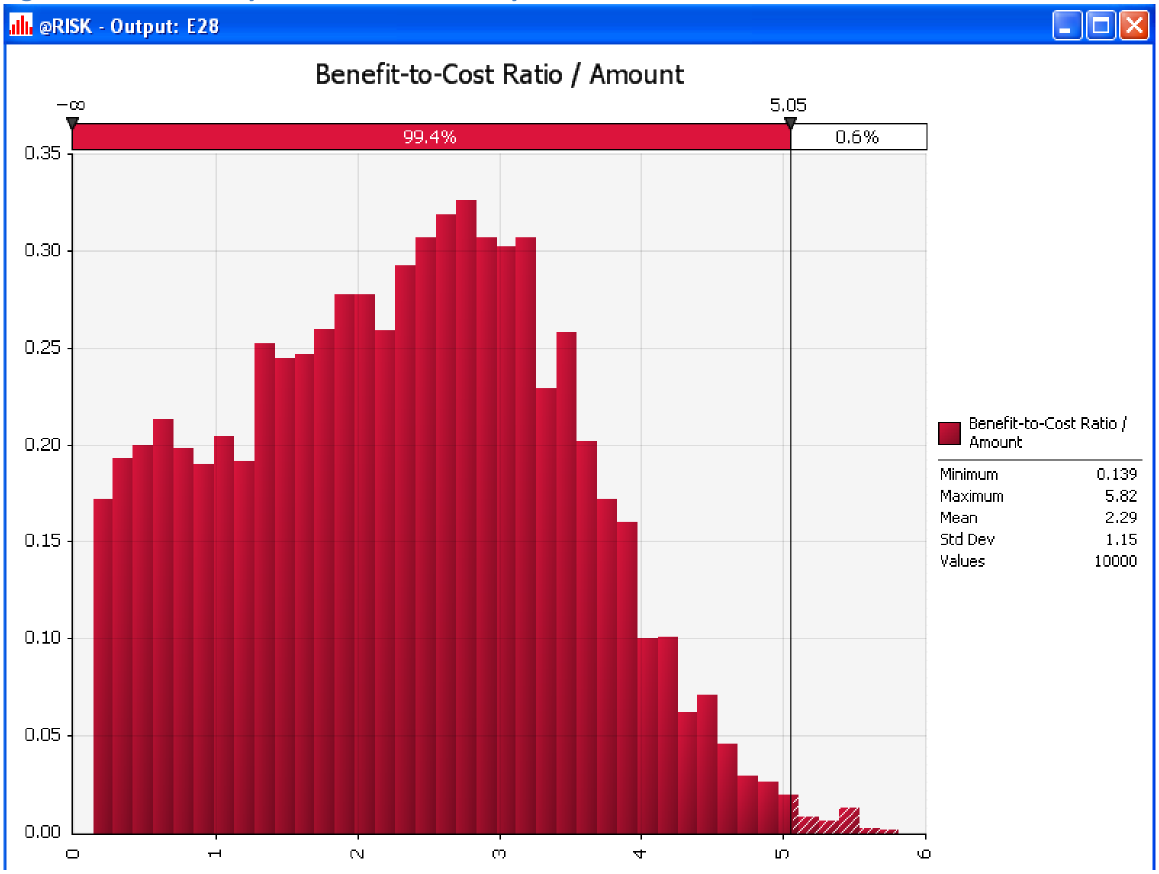
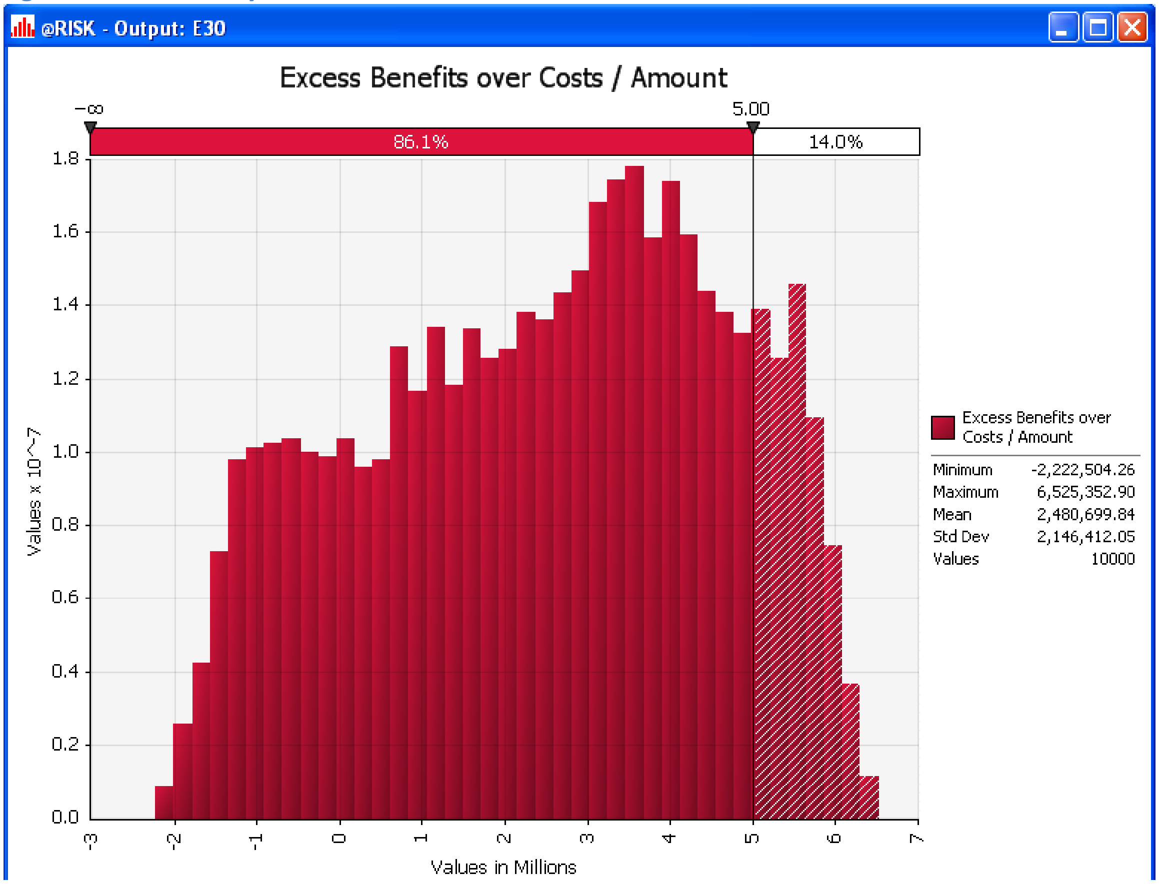


Figure 22: Probability of Positive Net Benefits at 7%



9 FINANCIAL ANALYSIS

9.1 COST APPORTIONMENT

For information on cost apportionment, refer to the main report.

9.2 ABILITY TO PAY

The ability-to-pay test is applied to all flood risk management projects. As a result of the application of the test, some projects may be cost shared at a lower level than the standard non-Federal share, which is the share that would apply to the project before any ability-to-pay consideration. Economic Guidance Memorandum 12-04 is the most current guidance on Ability-to-Pay and provides the procedures and parameters listed within this section. The Ability-to-Pay procedure calculates an Eligibility Factor.

The Eligibility Factor (EF) is: EF= a –b1 x (state income index) –b2 (county income index)

Where: state income index is the average over three years of the state per capita income index (state per capita income divided by the national per capita income) for the state (or states) in which the project is located, and the county income index is the average over three years of the county per capita income index (county per capita income divided by national per capita income) for the county (or counties) in which the project is located.

The parameters a, b1, and b2 were determined using the state and county per capita index data and the condition that a certain fraction of the counties are to have eligibility factors greater than zero. The values of the parameters are: a=19.69; b1=0.083; b2=0.166.

If the EF is one or more, the project is eligible for the full reduction in cost-share to the benefits-based floor. If EF is zero or less, the project is not eligible for a reduction. If EF is between zero and one, the non-Federal cost-share will be reduced proportionately to an amount that is greater than the benefits based floor but less than the standard non-Federal cost share.

EF = 19.69 – (0.083 x 92.66) – (0.166 x 89.05) = -2.78308

For this study, the EF is less than zero; therefore the project is not eligible for a reduction in the standard non-Federal cost share.

9.3 FINANCIAL CAPABILITY

City of Springfield has stated that it is capable and willing to cost share in the project.

10 PLAN FOR ECONOMIC UPDATES

As required by EC 11-2-202 and the Civil Works Policy Memorandum 12-001, the economics of this study will be updated for the development of the Civil Works Budget. As stated in the Memorandum, "It will be limited to reviewing and updating previous assumptions and limited surveying, sampling, and application of other techniques to affirm or develop a reasonable revised estimate of project benefits." Depending on the time which has passed and the verification (or lack of verification) of key benefit assumptions, the scope of work may be limited to reaffirmation, extended to sampling the key data and re-running the FDA model, to fully updating the economic benefits.