ECONOMICS

APPENDIX C

Kansas Citys, Missouri and Kansas
Flood Damage Reduction Project

INTERIM FEASIBLITY REPORT

(Section 216 Feasibility Study – Review of Completed Civil Works Projects)

May 2006

DEPARTMENT OF THE ARMY
Kansas City District, U.S. Army Corps of Engineers
Kansas City, Missouri

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APPENDIX C

KANSAS CITYS, MISSOURI AND KANSAS
SECTION 216 FEASIBILITY STUDY
INTERIM REPORT FOR PHASE 1 UNITS

ECONOMICS
May 2006

1.0 INTRODUCTION
1.1 Purpose and Scope

The purpose of this economic analysis is to assist in updating and verifying data on the project performance of the Kansas Citys, Missouri and Kansas, Local Flood Protection Project. The analysis identifies the extent of the economic impact from flooding with the existing project and, on a comparable basis, evaluates the range of plans to increase project performance considered in the study. The analysis first requires a risk-based analysis of the flood problem under the existing condition (existing levees and floodwalls). The future without project condition is then determined, and finally a risk-based evaluation in terms of benefits, costs, and performance of the various alternatives under the with-project condition is completed. The analysis encompasses all flood-prone properties within the study area. This interim report documents the evaluations accomplished for the Phase 1 Units, the Argentine Unit on the Kansas River and the Fairfax-Jersey Creek, North Kansas City, East Bottoms and Birmingham Units on the Missouri River. The final report will document the evaluations for the Armourdale Unit on the Kansas River and the Central Industrial District (CID) Unit located at the confluence of the Missouri and Kansas Rivers.

1.2 References

The analysis was accomplished under the procedures outlined in the following: Economic and Environmental Principles and Guidelines for Water and Related Resources Implementation Studies (P&G); Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook, dated 22 April 2000; ER 1105-2-101, Planning, Risk Analysis For Flood Damage Reduction Studies, dated 3 January 2006; EM 1110-2-1619, Engineering and Design, Risk-Based Analysis for Flood Damage Reduction Studies, dated 1 August 1996; ETL 1110-2-556, Engineering and Design, Risk-Based analysis in Geotechnical engineering For Support of Planning Studies; EP 1165-2-1, Digest of Water Resources Policies and Authorities.

2.0 STUDY AREA BACKGROUND
2.1 Study Area Location

The Kansas Citys, Missouri and Kansas, Local Flood Protection Project consists of seven separate levee/floodwall units located along both banks of the Missouri and Kansas Rivers. Study area boundaries are Kansas River mile 10 to the confluence with the Missouri River; and Missouri River miles 373.9 to 353.2. The flood control system protects 32 square miles of mostly urban industrial, commercial and residential properties, and some cropland. The units are the Central Industrial District (CID), Argentine, Armourdale, Fairfax-Jersey Creek, North Kansas City, East Bottoms, and Birmingham. The project protects highly developed urban portions of the Kansas City metropolitan area in Jackson and Clay Counties in Missouri, and Wyandotte County in Kansas. Portions of the cities of Kansas City, Missouri, North Kansas City, Missouri, Kansas City, Kansas,

Birmingham, Missouri and Randolph, Missouri are located in the protected areas. Attachment 1 is a map of the project area.

2.2 Study Reaches

For purposes of the study, each levee unit protected area was designated as a separate study reach. The CID Unit, located near the confluence of the Missouri and Kansas Rivers, can be impacted by both Missouri River flooding and Kansas River flooding. Table 1 below lists the study reaches, their river mile boundaries, and the designated index point location for each reach. The reach index point is used to aggregate the stage damage relationships for the different categories of investment in the reach at a common location.

Table 1 Study Reaches

Damage Reach Name	Beginning Station (R.M.)	Ending Station (R.M.)	Bank	Index Location Station (R.M.
Missouri River:				
Fairfax-Jersey Cr.	367.5	373.9	Right	367.7
North Kansas City	362.6	370.7	Left	365.8
East Bottoms	356.6	366.0	Right	357.6
Birmingham	353.2	360.4	Left	355.9
Kansas River:				
Armourdale	0.6	7.7	Left	5.2
Argentine	4.6	10.0	Right	9.6
Missouri and Kansas Rivers:				
CID, MO-KS	Mo. R. 365.8	Mo. R. 367.4	Right	Mo. R. 367.1
	Ks. R. 0.0	Ks. R. 3.0	Right	Ks. R. 1.4

2.3 Study Area Economy and Access

The Kansas City metropolitan area has a diverse and varied economic base. As a centrally located market, it is a major warehouse and distribution center and a leading agribusiness center. It ranks first in the nation as a farm distribution center and as a market for hard wheat. In addition to its agribusiness activities, the metropolitan area has major industrial activities such as auto and truck assembly, steel and metal fabrication, envelope and greeting card production, and food processing. The metropolitan area also fosters a growing non-manufacturing sector. Wholesale and retail industries and service organizations are now chief employers in the area.

The metropolitan area has a major network of interstates and major highways that provides excellent access to each of the levee units. The CID Unit is accessed by means of Interstate 70 on the north, by Interstate 35 on the West, and by Interstate 670, which crosses the center portion of the protected area. U.S. Highway 69 and Interstate 35 provide access to the Argentine Unit, and U.S. 69, U.S. 169, and Interstate 70 serve the Armourdale Unit. Interstate 70 and the Fairfax Bridge/U.S. 69 provide major highway access to the Fairfax-Jersey Creek Unit. Missouri Highway 210, Burlington Avenue, the Paseo and Heart of America Bridges, and Interstates 35 and 435 provide access to the North Kansas City Unit. The East Bottoms Unit is served by Interstates 29, 35, and 435, and the Birmingham Unit has ready access by means of Missouri Highway 210 and Interstates 29, 35 and 435. Kansas City International Airport, less than 20 miles north of the study area, is easily accessible via the interstate system. Major rail service is available to each of the units, and the Charles B. Wheeler (Downtown) Airport is located in the North Kansas City

Unit. The Greater Kansas City Area is generally considered to be the nation's second largest rail center, second only to Chicago. The trunk lines serving Kansas City have main line tracks in the areas protected by the Kansas City Levees. Greater Kansas City is also among the top five trucking centers in the nation.

2.4 Study Area Socioeconomic Characteristics

Census 2000 data for 17 census tracts were compiled to describe the socioeconomic characteristics of each levee unit area as well as for the overall study area. Census 2000 data were also compiled for counties in the study area and for the Kansas City Missouri and Kansas Metropolitan Statistical Area (KC MSA). Although census tracts cover areas that may typically be somewhat larger than the area protected by a levee unit, census tract data are considered to be generally representative of the protected area data and characteristics.

2.4.1 Argentine Unit

2.4.1.1 Land Use and Location

The Argentine Unit is located on the right bank of the Kansas River in Wyandotte County, Kansas. The unit protects the Argentine industrial district in the Kansas City, Kansas metropolitan area that includes major industrial and commercial development. The Argentine rail yard, one of the busiest in the nation, is located in this unit. A residential area is also protected. Census tracts 428 and 438.04 approximate the area protected by the Argentine Unit. These census tracts cover about 4.1 square miles of land area.

2.4.1.2 Population, Income and Employment Characteristics

The Argentine Unit census tracts had a resident population of nearly 3,481 persons in the year 2000, a decline of about 2.5% from the population living in the area in 1990. The median age ranges from 28.3 to 35.0, and the percent of population 65 years of age and over is about 13.2 percent as compared with 11.4 percent for the KC MSA. Approximately 34 percent of the Argentine population is under the age of 18 years. Median household income in 1999 was not available for one census tract. The other census tract had a median household income of $24,740, compared with $33,784 for Wyandotte County and $46,193 for the KC MSA. Approximately 26.4 percent of the Argentine population lives below poverty level, higher than for the KC MSA (8.5%) and Wyandotte County (16.5%). There were 10,700 people working in the Argentine industrial area in 2000 representing a growth of 7.4% in employment over the 1990 level of 9,960. Employment is expected to continue to increase over the next decade in the Argentine Unit area.

2.4.1.3 Housing Characteristics

There are 3,481 housing units in the census tracts that cover the Argentine Unit. These units have a vacancy rate of 7.1 percent, higher than the 6.3 percent rate for the KC MSA, and lower than the 9.4 percent vacancy rate for Wyandotte County. The median value of owner occupied housing units was not available for one census tract and was $67,600 for the other census tract, compared with $54,300 for Wyandotte County and $104,700 for the KC MSA. A lower percentage of housing units were built before 1940 in the Argentine Unit (7.2%) compared with housing units in the KC MSA (12.9%) and in Wyandotte County (18.8%).

2.4.2 Armourdale Unit

2.4.2.1 Land Use and Location

The Armourdale Unit is located on the left bank of the Kansas River in Wyandotte County, Kansas. This unit protects the Armourdale area of the City of Kansas City, Kansas. Facilities of the Kansas City, Kansas Board of Public Utilities are located in this study area as well as major railroad yards and main line tracks. Census tracts 425.01,

425.02, and 426, with a land area of 3.8 square miles, cover the area protected by the Armourdale Unit.

2.4.2.2 Population, Income and Employment Characteristics

Population in the Armourdale Unit decreased from 3,478 in 1990 to 3,213 in 2000 (a 7.6 % decrease). The median age for residents in the census tracts in the Armourdale Unit ranges from 27.6 years to 77.0 years. In comparison, the median age for the KC MSA is 35.2 years and 32.5 years for Wyandotte County. Approximately 7.9 percent of the population is over 65 years old. This is lower than the 65 years and older percentage for the KC MSA and for Wyandotte County (11.4 % and 11.7 % respectively). Approximately 33.2 percent of the total population in the Armourdale Unit is in the under 18 years of age category, compared with 26.6 percent for the KC MSA, and 28.5 percent for Wyandotte County. Median household income in the Armourdale Unit census tracts ranges from $27,524 to $102,264. Median household incomes for Wyandotte County and the KC MSA are $33,784 and $46,193, respectively. A higher percentage of the Armourdale Unit population is below poverty level (35.2 percent) compared with 8.5 percent in the KC MSA and 16.5 percent in Wyandotte County.

About 6,700 persons work in the Armourdale area (2000 estimates), an increase of 1.6 percent over the 1990 employment level. The resident labor force in Armourdale is primarily employed in production/transportation and service occupations.

2.4.2.3 Housing Characteristics

The 1,109 housing units in the Armourdale Unit had a vacancy rate of 11.1 percent, higher than the 9.4 percent vacancy rate for Wyandotte County and the 6.3 percent rate for the KC MSA. The median value of owner occupied housing units ranged from $22,600 to $162,500 compared with a median value of $54,300 for Wyandotte County and $104,700 for the KC MSA. More than 32 percent of the housing units in the Armourdale Levee Unit were built before 1940 compared with 18.8 percent for Wyandotte County and 12.9 percent for the KC MSA.

2.4.3 Fairfax-Jersey Creek Unit

2.4.3.1 Land Use and Location

The Fairfax-Jersey Creek Unit is located on the right bank of the Missouri River in Wyandotte County, Kansas. This unit protects the Fairfax Industrial District in the Kansas City, Kansas metropolitan area. Census tract 400.01 approximates the area protected by the Fairfax-Jersey Creek Unit and covers about 3.8 square miles.

2.4.3.2 Population, Income and Employment Characteristics

Few or no persons currently live in the Fairfax industrial area. There were 11,180 people working in this industrial area in 2000 representing an increase of 6.5 percent over the 1990 employment in this area. Employment in this levee unit is expected to remain fairly stable over the near term.

2.4.3.3 Housing Characteristics

No housing data was provided for census tracts in this levee unit area in the 2000 census.

2.4.4 Central Industrial District Unit, Missouri and Kansas

2.4.4.1 Land Use and Location

The Central Industrial District Unit (CID) is located on the right banks of the Missouri and Kansas Rivers near their confluence. The protected area lies on both sides of the state line between Missouri and Kansas, and includes the central industrial districts of both the City of Kansas City, Missouri and the City of Kansas City, Kansas. The protected area encompasses census tracts 1, 2 and 400.02. These tracts have a land area of 1.8 square

miles. Kemper Arena, the American Royal Building, and world headquarters for a major manufacturing company are located in this protected area.

2.4.4.2 Population, Income and Employment Characteristics

In 2000, the CID had a population of 936 representing a very significant increase (1027.7%) over the 1990 population of 83 persons. This population increase appears to be primarily a result of a popular trend of developing industrial warehouses and commercial buildings in this area for residential use. The CID is currently one of several "loft-living" areas being developed in the Kansas City metropolitan area. Population is expected to continue to increase in the CID area as a result of this trend.

The CID census tracts median age ranges from 29.5 to 32.4, compared with the KC MSA median age of 35.2. The lower median ages for these census tracts may be attributable to the fact that the CID attracts young professionals interested in loft-style living. Residents under the age of 18 years comprise about 1.7 percent of total population in the CID, compared with 26.6 percent for the KC MSA, 28.5 percent for Wyandotte County, and 25.8 percent for Jackson County. The CID percent of population age 65 and over was only 0.8 percent of total population, significantly lower than Wyandotte County (11.7%), Jackson County (12.5%), and the KC MSA (11.4%). Median household income in the census tracts in the CID (1999 dollars) ranged from $34,464 to $36,625. The CID median incomes were lower than the median income for Jackson County Missouri ($39,277) and the Kansas City metropolitan area ($46,193), but higher than for Wyandotte County Kansas ($33,784). The CID had a lower percentage of the population living below poverty level (9.3%) compared with 11.9 percent and 16.5 percent for Jackson and Wyandotte Counties respectively. However, the CID percentage was slightly above the 8.5 percent for the KC MSA.

In the year 2000, there were 7,494 persons working in the CID, representing a 12 percent decline from an employment level of 8,516 in 1990. An increase in employment in the CID would be expected with the increasing resident population and the accompanying small commercial businesses that are required to support the growing resident population. Currently ongoing and planned near-future commercial development in the area will also likely encourage increases in employment in the CID. The resident CID population labor force is predominately employed in management and professional occupations, followed by sales and office occupations.

2.4.4.3 Housing Characteristics

According to the 2000 census there were a total of 517 housing units in the CID with a residential vacancy rate of only 3.7 percent. This housing vacancy rate was lower than the rates for Wyandotte County (9.4 Percent), Jackson County (7.6 percent), Clay County (4.8 percent), and the KC MSA (6.3%). Reflecting the historic nature of the CID area, Census 2000 data indicates that more than 80 percent of the housing units in the CID were built before 1940 compared with 12.9 percent for the KC MSA.

2.4.5 North Kansas City Unit

2.4.5.1 Land Use and Location

The North Kansas City Unit is located on the left bank of the Missouri River in Clay County, Missouri. This unit protects the Charles B. Wheeler Downtown Airport, a portion of the City of North Kansas City, Missouri, major railroad yards, and Kansas City Power and Light Company power plant facilities. Census tracts 200 and 201, with a land area of 6.1 square miles, cover the protected area.

2.4.5.2 Population, Income and Employment Characteristics

In the year 2000, there were 4,882 persons residing in the North Kansas City Unit area. This was an increase of 13.6 percent over the 1990 population of 4,299. The median age range of North Kansas City Levee Unit census tract residents is 27.3 years to 36.9 years. Median age for the KC-MSA is 35.2 years, and 35.0 years for Clay County. Approximately 13.7 percent of the population in this levee unit area is in the 65 years and older age category, higher than the 10.8 percent in this age category for Clay County and the 11.4 percent for the KC MSA. Residents under eighteen years of age in the North Kansas City Unit account for about 7.5 percent of total population compared with 25.8 percent for Clay County and 26.6 percent for the KC MSA. Population is expected to experience some growth over the next decade due to the new higher density housing currently planned and under development in this area. Additionally, since North Kansas City offers many services geared to attract retirees to the area, an increase in the senior population would also be expected. The North Kansas City Unit census tracts had 1999 median household incomes ranging from $22,379 to $29,526, significantly below the median incomes for the KC MSA ($46,193) and for Clay County ($48,347). Approximately 12.2 percent of the North Kansas City Unit population is below poverty level, compared with 8.5 percent for the KC MSA and 5.5 percent for Clay County.

In 2000, approximately 26,703 people worked in the levee unit area. This is an increase of 3.2 percent over the 1990 employment of 25,886. The labor force population residing in this levee unit had higher unemployment rates in 2000 (ranging from 5.4 to 6.2 percent) than Clay County with 3.3 percent, and the KC MSA with a rate of 2.9 percent.

2.4.5.3 Housing Characteristics

In 2000, there were a total of 2,933 housing units in the North Kansas City Unit area. The vacancy rate for these housing units (9.2%) was higher than the 4.8 percent vacancy rate for Clay County and the 6.3 percent rate for the KC MSA. This higher vacancy rate may be due in some part to the anticipated and currently ongoing removal of some lower density units that are being replaced by new higher density units in one area of the North Kansas City Unit. The median value of owner occupied housing ranged from $78,100 to $112,500, compared with the KC MSA median value of $104,700 and the Clay County median value of $104,900. A higher percentage of houses in the North Kansas City Unit (20.3%) were built before 1940 compared with 12.9 percent in the KC MSA and only 6.1 percent in Clay County.

2.4.6 East Bottoms Unit

2.4.6.1 Land Use and Location

The East Bottoms Unit is located on the right bank of the Missouri River in Jackson County and protects an industrialized area of the City of Kansas City, Missouri, and some smaller residential areas. Data for census tracts 3, 4, 5.01 and 5.02 were used to describe the protected area. The land area covered by these census tracts is 10.3 square miles.

2.4.6.2 Population, Income and Employment Characteristics

Approximately 3,277 persons lived in the East Bottoms Unit in the year 2000, a decline of 19.1 percent from the 1990 population of 4,054. The median age of residents in these census tracts ranges from 29.5 to 39.6 years, compared with a median age of 35.2 for both the KC MSA and Jackson County. The percent of population 65 years of age and older (13.7 percent) is higher than for the KC MSA (11.4 percent) and Jackson County (12.5%). The percent of population under the age of 18 years (28.4%) is above the percentages for the KC MSA and Jackson County (26.6% and 25.8% respectively). The 1999 median household incomes for these census tracts range from $21,786 to $36,875,

lower than median household income for the KC MSA ($46,193) and for Jackson County ($39,277).

About 20,147 persons worked in the East Bottoms Unit in 2000, an increase of 8.3 percent over the 1990 employment of 18,601 persons. The resident labor force in the East Bottoms Unit census tracts had higher unemployment rates in 2000 (13.5% to 26.6%) than for the KC MSA (2.9%) and Jackson County (5.7%). The resident labor force is employed primarily in the production/transportation occupations, followed by service occupations.

2.4.6.3 Housing Characteristics

The vacancy rate of 17.5 percent for the 1,534 housing units in the East Bottoms Unit was nearly three times the KC MSA vacancy rate of 6.3 percent and near two and a half times the Jackson County housing vacancy rate of 7.6 percent. Median owner occupied housing value for the census tracts ranged from $15,000 to $92,500, lower than the median value of $104,700 for the KC MSA and $85,000 for Jackson County. Nearly 48 percent of housing units were built prior to 1940, compared with 12.9 percent for the KC MSA and 18.7 percent for Jackson County.

2.4.7. Birmingham Unit

2.4.7.1 Land Use and Location

The Birmingham Unit is located on the left bank of the Missouri River in Clay County, Missouri. This unit protects the village of Birmingham, rural agricultural areas, and a recently developed industrial park. Data for census tracts 207 and 215 are representative of the protected area for this unit. These census tracts have a land area of about 18.9 square miles

2.4.7.2 Population, Income and Employment Characteristics

The 2000 population in the Birmingham Unit was approximately 4,029 persons, a 10.1% decline from the 1990 population of 4,481. The median age for the census tracts in the Birmingham Unit ranged from 35.3 to 36.0 years, slightly higher than the KC MSA median age of 35.2 and the Clay County median age of 35.0. The percent of total population aged 65 years and above (8.6%) is less than for the KC MSA (11.4%) and Clay County (10.8%). In contrast, Birmingham residents under the age of 18 years account for 27.5% of total population, higher than the 26.6 percent for the KC MSA and 25.8 percent for Clay County. The 1999 median household income for these census tracts ranged from $48,333 to $48,463, above the KC MSA median income of $46,193, and comparable to Clay County median income of $48,347. About 6.1 percent of the population is below poverty level, compared with the 8.5 percent for the KC MSA and 5.5 percent for Clay County.

In 2000, approximately 11,112 people worked in the Birmingham Unit. This was a significant increase (more than 102%) over the 5,490 workers in 1990. The resident labor force in the Birmingham Unit area had unemployment rates ranging from 4.2 to 6.5 percent, higher than the KC MSA rate of 2.9 percent and the Clay County rate of 3.3 percent. Primary occupations for Birmingham Unit residents are in the sales/office worker category, followed by management/professional occupations.

2.4.7.3 Housing Characteristics

Birmingham housing units totaled 1,528 in 2000. Housing units had a vacancy rate of 3.3 percent, which is lower than the vacancy rate of 4.8 percent for Clay County and 6.3 percent for the KC MSA. The median value of owner occupied housing units ranged from $69,300 to $80,700, significantly less than the median value of $104,700 for the KC MSA and $104,900 for Clay County. About 4.2 percent of the housing in the Birmingham Unit

was built before 1940, compared with 12.9 percent for the KCMSA and 6.1 percent for Clay County.

Table 2 summarizes population, employment and housing characteristics of the areas protected by the levee units located on the Kansas side of the Kansas City metropolitan area. For comparison purposes, data for Wyandotte County and for the KC MSA are also displayed. Table 3 provides the same characteristics for levee units located on the Missouri side of the Kansas City metropolitan area. In Table 3, data for Jackson and Clay Counties in Missouri and the KC MSA are shown for comparison purposes. The CID unit, located on both sides of the state line, is included in both tables.

Table 2 Population, Employment and Housing Characteristics for Kansas Units 2000

	CID Mo-Ks Unit	Argentine Unit	Armourdale Unit	Fairfax-Jersey Cr Unit	Wyandotte County, KS	Kansas City, MO KS MSA
Population 2000	936	3,481	3,213	NA	157,882	1,776,062
% Chg 1990-2000	1,027.7%	-2.5%	-7.6%	NA	-2.5%	12.2%
Households 2000	483	1,282	986	NA	59,700	694,468
% Chg 1990-2000	1,458.1%	-3.0%	-23.0%	NA	-2.9%	14.1%
Average Number of Persons per Household	1.9	2.7	3.3	NA	2.6	2.5
Median Age— (range for multiple census tracts)	29.5 to 32.4	28.3 to 35.0	27.6 to 77.0	NA	32.5	35.2
% Under Age 18	1.7%	34.0%	33.2%	NA	28.5%	26.6%
% Over Age 65	0.8%	13.2%	7.9 %	NA	11.7%	11.4%
1999 Median Household Income—(range for multiple census tracts)	$34,464 to $36,625	NA to $24,740	$27,524 to $102,264	NA	$33,784	$46,193
% Population Living Below Poverty Level (1999)	9.3%	26.4%	35.2%	NA	16.5%	8.5%
% Unemployed Resident Labor Force— (range for multiple census tracts)	NA	8.3%	NA to 8.3%	NA	8.2%	2.9%
Housing Units 2000	517	1,380	1,109	NA	65,892	740,884
Housing Vacancy Rate	3.7%	7.1%	11.1%	NA	9.4%	6.3%
Median Value of Owner Occupied Housing— (range for multiple census tracts)	NA	NA to $67,600	$22,600 to $162,500	NA	$54,300	$104,700
% Housing Units Built Before 1940	80.6%	7.2%	32.4%	NA	18.8%	12.9%

NA – Information Not Available
Source: Census 2000

Table 3 Population, Employment and Housing Characteristics for Missouri Units 2000

	CID Mo-Ks Unit	North Kansas City Unit	East Bottoms Unit	Birmingham Unit	Jackson County, MO	Clay County, MO	Kansas City, MO KS MSA
Population 2000	936	4,882	3,277	4,029	654,880	184,006	1,776,062
% Chg 1990-2000	1,027.7%	13.6%	-19.1%	-10.1%	3.4%	19.9%	12.2%
Households 2000	483	2,669	1,282	1,478	266,294	72,558	694,468
% Chg 1990-2000	1,458.1%	7.4%	-17.6%	-2.3%	5.6%	23.0%	14.1%
Average Number of Persons Per Household	1.9	1.8	2.6	2.7	2.4	2.5	2.5
Median Age—(range for multiple census tracts)	29.5 to 32.4	27.3 to 36.9	29.5 to 39.6	35.3 to 36.0	35.2	35.0	35.2
% Under Age 18	1.7%	17.5%	28.4%	27.5%	25.8%	25.8%	26.6%
% Over Age 65	0.8%	13.7%	13.7%	8.6%	12.5%	10.8%	11.4%
1999 Median Household Income—(range for multiple census tracts)	$34,464 to $36,625	$22,379 to $29,526	$21,786 to $36,875	$48,333 to $48,463	$39,277	$48,347	$46,193
% Population Living Below Poverty Level (1999)	9.3%	12.2%	27.5%	6.1%	11.9%	5.5%	8.5%
% Unemployed Resident Labor Force— (range for multiple census tracts)	NA	5.4% to 6.2%	13.5% to 26.6%	4.2% to 6.5%	5.7%	3.3%	2.9%
Housing Units 2000	517	2,933	1,534	1,528	288,231	76,230	740,884
Housing Vacancy Rate	3.7%	9.2%	17.5%	3.3%	7.6%	4.8%	6.3%
Median Value of Owner Occupied Housing—(range for multiple census tracts)	NA	$78,100 to $112,500	$15,000 to $92,500	$69,300 to $80,700	$85,000	$104,900	$104,700
% Housing Units Built Before 1940	80.6%	20.3%	47.6%	4.2%	18.7%	6.1%	12.9%

NA—Information not Available
Source: Census 2000

Table 4 below displays estimates of employment in the year 2000 in each levee unit and in the study area as a whole, and the percent change in employment between 1990 and 2000.

Table 4 Estimates of Employment, 2000

Unit	Employment	% Change 1990-2000
Argentine Unit	10,700	7.4%
Armourdale Unit	6,700	1.6%
Birmingham Unit	11,112	88.7%
CID MO-Ks Unit	7,494	-12.0%
East Bottoms Unit	20,147	8.3%
Fairfax-Jersey Creek Unit	11,180	6.5%
North Kansas City Unit	26,703	3.2%
Study Area Total	**94,036**	**9.4%**

Source: Mid America Regional Council

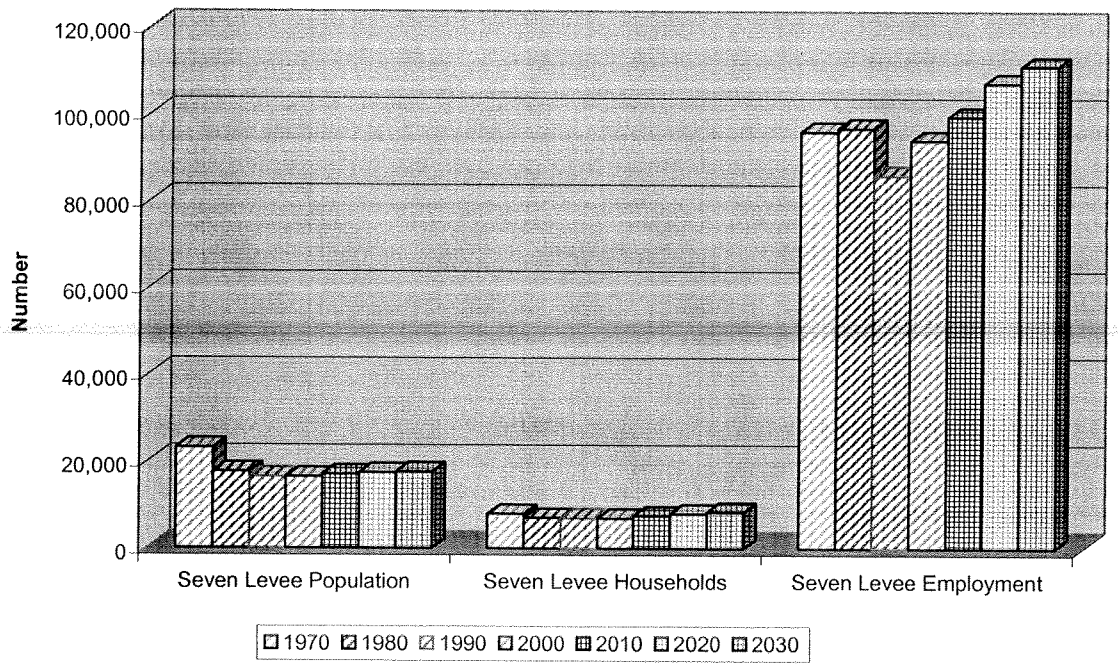
2.4.8 Study Area General Trends in Population, Household and Employment

Census data, 1970 to 2000, and Mid-America Regional Council (MARC) forecasts, 2010 to 2030, for the census tracts in the study area were used to describe general trends in

population, households and employment. MARC is the metropolitan planning organization for the bi-state Kansas City region. MARC also serves as the association of city and county governments and its Board of Directors represents eight counties and 114 cities in the bi-state metropolitan Kansas City region. MARC provides long range planning and public policy coordination services, technical assistance, and seeks to foster understanding and cooperation in the metropolitan area on issues that extend beyond the jurisdiction of a single city, county or state. Figure 2 below displays the general trends in population, households and employment, 1970 to 2030 for the study area as a whole (all seven levee unit areas).

In 1970 the study area levee units had total population of 23,124 persons and 7,952 households. Between 1970 and 1990, the total population and number of households in the study area declined. This trend in the study area was reflective of the national trend that occurred in the 1970's and 1980's when there were population shifts to areas outside of central city areas. After 1990 the population and number of households began to stabilize and by 2000 had increased to 19,818 persons and 8,180 households in the study area. Fluctuations also occurred in study area employment, with an overall decline from a 1970 level of 96,069 to 85,949 by 1990 and then increasing in the year 2000 to a level of 94,035. Based on MARC forecast data for the period 2000 to 2030, total employment in the seven levee unit study area is expected to increase steadily. Population and number of households in the area are expected to experience steady but modest growth.

Figure 2
Seven Levee Area Population, Household, and Employment Trends
1970-2030



2.5 Study Area Investment

Total investment in the seven levee unit study area subject to flooding is estimated to be nearly $16.3 billion dollars (Oct 2004 price levels) and includes investment in

structures, contents and equipment for commercial, industrial, residential, and public categories of investment. More than 5,300 structures having significant value were identified in a survey of the study area. Depreciated replacement value for buildings and infrastructure in the study area is estimated to be more than $5.5 billion, or about 34 percent of total investment. The study area businesses and residences have nearly $10.8 billion worth of investment in contents and other property (66 percent of total investment) that is subject to flood damage. Business contents include inventory, office equipment, computers, production equipment and machinery, and other miscellaneous property subject to flood damage.

2.5.1 Central Industrial District Unit (CID)

The CID Unit is located on the right banks of the Missouri and Kansas Rivers near their confluence. The protected area lies on both sides of the state line between Missouri and Kansas, and includes most of the central industrial districts of both the City of Kansas City, Missouri (Jackson County portion) and the City of Kansas City, Kansas in Wyandotte County. The CID contains commercial, industrial, and public type development. This is an older, historical area, that was devastated during the 1951 flood, but that has been experiencing recent development, revitalization, and renovation of existing commercial and industrial properties. There has also been high interest in recent years in developing and using some of the large older commercial/industrial buildings as residential loft space. The higher value investment is in two convention centers/entertainment venues (American Royal Building and Kemper Arena), some large warehouse facilities, several industrial sites, a few large commercial businesses, and public works facilities. The American Royal Building and Kemper Arena host national and regional events bringing millions of business and tourist dollars into the area. Butler Manufacturing has recently completed its new world headquarters building in this area, and Faultless Starch has planned expansion and construction. Estimated protected investment totals nearly $763 million.

2.5.2 Argentine Unit

The Argentine Unit is located on the right bank of the Kansas River in Wyandotte County, Kansas. This unit protects the Argentine industrial district in Kansas City, Kansas. Major development types include large industrial, commercial, and residential development. A small area of a very few older residential structures mixed in with auto scrap yards and auto repair garages is located near the eastern side of the unit, and a large residential community including neighborhood commercial and public establishments, is located at the southern end of the unit. Major companies protected include Associated Grocers, Harcros Chemicals, Fairbanks Morse, Ankmar, Smurfit, and several major trucking centers. Burlington Northern Santa Fe railroad also has a major rail yard, mainline track, and a very large rail-intermodal facility in this unit. Protected investment is estimated at nearly $2.5 billion.

2.5.3 Armourdale Unit

The Armourdale Unit is located on the left bank of the Kansas River in Wyandotte County, Kansas. This unit protects the Armourdale area of Kansas City, Kansas, an area of mixed residential, commercial, industrial and public development. There are several very large, complex manufacturing and commercial facilities (e.g.,Proctor and Gamble, Colgate Palmolive), a powerplant facility (Kansas City, Kansas Board of Public Utilities Kaw Power Station/Municipal Plant) and Kansas City Southern and Union Pacific rail yards and main line tracks are located in the study area. Some companies have multiple sites in the area. There are many small retail and commercial businesses typically found in and around

residential neighborhoods, and more than 930 residential units in the area. An estimated investment of nearly $2.2 billion is in the protected area.

2.5.4 Fairfax-Jersey Creek Unit

The Fairfax-Jersey Creek Unit is located on the right bank of the Missouri River in Wyandotte County, Kansas. It protects the Fairfax Industrial District in Kansas City, Kansas. Primary development in the area is comprised of large commercial, industrial and public facilities (e.g., General Motors plant, Owens-Corning, Weyerhauser, Certainteed). There is no residential development. Protected investment is estimated at nearly $3.0 billion.

2.5.5 North Kansas City Unit

The North Kansas City Unit is located on the left bank of the Missouri River in Clay County, Missouri. This unit protects the Kansas City Downtown airport, and a large portion of North Kansas City, Missouri. Burlington Northern and Norfolk Southern railroad yards are also protected. There are approximately 1,080 residential units, and many, retail, and small commercial units in addition to warehouse areas and some industrial sites. Estimated protected investment is nearly $3.0 billion.

2.5.6 East Bottoms Unit

The East Bottoms Unit is located on the right bank of the Missouri River in Jackson County, Missouri. The unit protects an industrialized area of the City of Kansas City, Missouri and residential development. There is a range of business activity including manufacturing, transportation, and major warehouse storage in the area, as well as retail business and a small residential area. Some companies have multiple sites in the leveed area. Major companies in the area include a Sears distribution center, Cargill, Isle of Capri casino, General Mills, and Bayer Corporation. There is also a KCPL powerplant facility and a water treatment plant and nearly 250 residential units. Protected investment totals nearly $4.6 billion.

2.5.7 Birmingham Unit

The Birmingham Unit is located on the left bank of the Missouri River in Clay County. It protects the village of Birmingham, Missouri and rural agricultural areas with scattered residential sites, as well as major industry, business parks, underground storage, and a casino. Major businesses protected include Grainger Regional Distribution Center, Voltz auto distribution, Ameristar Casino, Redi-Cut Foods, and Penske Logistics. More than 150 residential units are protected. Protected investment is more than $386 million.

2.5.8 Summary of Study Area Investment

Table 5 below provides a summary of study area investment currently protected by each levee unit.

Table 5 Study Area Investment (without uncertainties) for Structure and Content

October 2004 prices, ($Million)

Levee Unit	Number of Structures/ Groups of Structures	Structure/Infrastructure Investment	Contents/Other Investment (various)	Levee Unit Totals
Argentine	723	$587.9	$1,898.3	$2,486.2
Armourdale	1,349	$627.8	$1,554.6	$2,182.4
CID	287	$386.1	$376.7	$762.9
Fairfax	348	$656.5	$2,303.1	$2,959.6
North Kansas City	1,658	$1,437.7	$1,519.2	$2,956.9
East Bottoms	751	$1,579.8	$2,981.1	$4,560.9
Birmingham	209	$260.4	$125.8	$386.2
Study Area Totals	5,325	$5,536.4	$10,758.8	$16,295.1

Note: any discrepancies are due to rounding

3.0 WITHOUT-PROJECT CONDITION ANALYSIS

3.1 Economic Survey-General

Electronic mapping data files were obtained from local government sources, and Kansas City District Geographic Information System staff compiled detailed aerial maps of each levee unit with 2-foot contours for Kansas areas and 4-foot contours for Missouri areas. GIS staff also obtained electronic files from local cities and counties that contained structure footprint data and land parcel data (including parcel valuation data) for the land area protected by each levee unit. The parcel data was sorted by value increments to identify the high value parcels. It was anticipated that these efforts would provide a preliminary indication of the number and location of high value businesses/parcels.

Due to the massive extent of the investment in the study area, intense efforts were required to prepare for, closely manage and coordinate, conduct, and complete the economic field survey for the Kansas Citys feasibility study to determine study area investment and its potential damageability. Time and funding constraints and limited availability of contact name and address information had to be considered. The data collection efforts for the commercial, industrial, and public facilities were accomplished by architectural-engineering (AE) contract. Corps in-house economics staff members completed the data collection for residential investment, public investment in streets and highways, and commercial investment in railroad tracks, with contract assistance for research and data input. Attachment 2 provides a summary of methodologies used to develop the required data for the economic analysis.

3.2 Commercial, Industrial and Public Facility Economic Data Collection

Economic data collection efforts for the commercial, industrial and public facilities for the feasibility study were based on a mix of direct interviews of large high value businesses, direct interviews of a representative sample of other typical businesses in the study area, visual field observation and estimates based on similar investment and damages for similar types of businesses, and visual observation and estimates using Marshall and Swift commercial valuation software. Business specific data obtained during the reconnaissance phase were also evaluated for use in the feasibility study. The Economic Field Survey (EFS) of the commercial, industrial and public facilities subject to flood damage was divided into two phases and several sub-tasks that were more easily managed in order to facilitate successful completion of the survey by AE contract.

3.2.1 EFS Phase 1

3.2.1.1 In-House Efforts Prior to Actual Survey

A field survey form for use in the data collection efforts was developed and approval was obtained from Office of Management and Budget for use of the form in the survey. A sample of the survey form is included as Attachment 3.

Drainage district sponsor representatives provided names of the largest companies in their respective areas to the Economics team member. Available reconnaissance study data about protected investment in each levee unit were gathered. At the request of the Kaw Valley Drainage District (a local sponsor representing units along the Kansas River, i.e., Argentine, Armourdale, CID-KS, Jersey Creek), an initial survey mailing was sent to businesses in the Argentine, Armourdale and CID-KS units, based on preliminary name and address information provided by the Kaw Valley Drainage District officials. Response to this initial mailing was limited.

The Kansas Citys Project Manager, Plan Formulation Section Chief, and Product Development Team Economist attended a Central Industrial District Association meeting, and a short presentation about the Kansas Citys study was given. To the extent possible,

survey forms were handed out to attending business owners. The Project Manager also attended a Northeast Industrial Area meeting and made forms available. Some forms were returned based on these efforts and the information was included in the analyses.

3.2.1.2 EFS Phase 1 AE Contract

For Phase 1 of the survey, the survey team leader (an experienced former Corps economist) conducted an initial windshield survey of all development in each levee unit, with extensive identification of individual major businesses. Based on his visual observation, on the lists of major businesses identified by the study sponsor representatives, on available reconnaissance phase data, and on the color coded parcel valuation maps prepared by the GIS staff, the survey team leader identified the largest and/or highest value businesses in each levee unit and a mix of other businesses that would comprise a representative sample of typical businesses in the study area. These businesses (about 563 total) were compiled as a "master list" of commercial, industrial and public properties that would be given priority for data acquisition. From the master list, the survey team leader determined an initial subset of these master list businesses that either would specifically need to be interviewed due to their size and complex nature, (e.g., General Motors Corporation, Bayer Corporation, etc.), or would be included in order to develop and interview a representative sample of the typical business types (by NAICS code) found in the study area. Survey team members were then sent out with survey forms for face-to-face interviews with the specifically identified master list businesses.

Security issues following September 11, 2001 impacted the ability of the survey team members not only in gaining entry to the properties, but also in gaining access to the appropriate company representatives. In many instances, the survey form had to be left with administrative support staff, with reliance on those individuals to ensure that the form was given to the appropriate company official, and that the survey form would be mailed back to the Corps when completed. As possible, the survey team members attempted to get appointments with appropriate individuals for a later visit. In many instances, because of the size of these companies, any data entered on the survey form had to go through corporate and legal department reviews before being returned. Although the 1993 flood event could have been catastrophic if the system had been overtopped, the last major actual Missouri River and/or Kansas River flooding occurred in 1951. Some of these business owners were not even aware that they are located behind a levee.

The survey team made field notes based on their visual observations of entities in the levee unit areas, made follow-up contacts with businesses that had taken survey forms to complete and mail back to the Corps, and continued to try to obtain interview data as possible from the initially identified "master list" businesses. Survey forms were distributed to as many of the remaining "master list" businesses as possible. In three of the levee unit areas, the survey team contacted nearly 100% of all the businesses in the protected area (the Argentine, Fairfax, and Birmingham Units).

3.2.1.3 EFS Phase 1 Sponsor Efforts

During the Phase 1 of the EFS, the study sponsor representatives provided intensive effort and valuable assistance in attempting to obtain good response to our requests for survey data from businesses in their levee unit areas. Lists of the specified "master list" businesses by levee unit were provided periodically to the study sponsor representatives, with an indication of whether or not a survey form had been returned by the business. The Fairfax levee district sponsor representative personally contacted each business owner on more than one occasion by means of letters, personal telephone calls, and faxing of survey forms to try to persuade companies in his district to return survey forms. The Kaw Valley

Drainage District officials (covering Armourdale, Argentine and the KS portion of the CID unit) sent out a mailing on their own, (survey form and instructions included) requesting data from companies in their units. The City of Kansas City sponsor representative, covering the CID-MO, North Kansas City, Birmingham, and East Bottoms units, had no mailing list available, but used his contacts at larger companies and public facilities to obtain important survey data.

3.2.1.4 EFS Phase 1 Survey Results

Survey forms completed and returned provided detailed information about property values, location of damageable investment, and damageability of the investment at various depths of flooding in relation to the first floor. Data included the type of business, depreciated structure investment value, investment values by physical location (basement, first floor, second floor) for inventory, office equipment, production equipment, and other contents. Survey data also included estimates of potential damage to structure, inventory, equipment and other contents with various potential depths of flooding in relation to first floors. Information on historical flood events and historical damages were obtained in some cases. However many respondents indicated that they were not occupants of the area during the last major damage event (1951).

The 137 survey forms completed and returned accounted for about $5.6 billion in total investment in the study area. The following table shows a more detailed breakdown by levee unit of the contacts made and the survey forms returned.

Table 6 Results of EFS Phase 1 Survey Efforts

Levee Unit	Number of Master List Businesses Identified in Phase 1 Visual Survey	Number of Completed Contacts/Forms Delivered	Number of Interview Forms Returned	Returned Forms as a Percent of Phase 1 Completed Contacts
Argentine	70	69	26	37.7%
Armourdale	65	24	16	66.7%
Birmingham	13	13	5	38.5%
CID	76	28	9	32.1%
East Bottoms	132	26	12	46.2%
Fairfax-Jersey Creek	110	108	61	56.5%
North Kansas City	97	26	8	30.8%
Total	563	294	137	46.6%

3.2.2 EFS Phase 2

3.2.2.1 Descriptive and Location Data for Master List Businesses

The AE contractor developed descriptive and location data for each master list business by visual observation during a windshield survey, review of the aerial survey maps, and available EFS Phase 1 field notes. The data items developed included the following: levee unit location and river mile location of structure, structure number, name and address of business occupant as available, number of buildings, ground elevation and first floor above ground height, type of construction material, estimated effective age and condition of the building. Ground elevation for each structure was determined based on the aerial maps with either 2-foot contours and spot elevations (Kansas) or 4-foot contours and spot elevations (Missouri).

3.2.2.2 Determination of Valuation Methodology for Master List Businesses

The AE contractor first compiled a spreadsheet of the "master list" businesses in each levee unit. The master list displayed the names of the approximately 563 businesses identified by levee unit in the Phase 1 visual survey and further identified the subset of approximately 294 "economically significant" and/or typically representative businesses/parcels that were contacted and provided with field survey forms during EFS Phase 1. Each master list entry was then assigned a three-digit code based on the North American Industry Classification System (NAICS) for the purpose of grouping similar business/parcel types. The classification code was assigned using field notes and property descriptions developed during EFS Phase 1, from further field observations, and through professional judgment. Approximately fifty different NAICS codes were utilized to characterize the investment categories represented in the study area.

The completed master list was then evaluated to ascertain the most appropriate means of developing the economic investment estimates for the master list businesses/parcels that did not provide completed field survey forms. A single economic valuation methodology was identified for each master list entry. The three valuation methodologies considered for each master list entry used depreciated replacement values and were as follows:

1. Utilize completed field survey form data (spreadsheet code = "I")
2. Estimate structure and contents values based on square footage of similar business/parcel types within the study area (spreadsheet code = "P")
3. Marshall & Swift coupled with visual site survey, GIS-based square footage data, and County Assessor data (spreadsheet code = "M")

In all cases where the completed field survey form data was available, valuation methodology 1 was used.

The master list entries were sorted by NAICS code in order to group common business/parcel types. For each NAICS code, the number of completed field survey forms were reviewed and compared to the number of businesses/parcels for which field survey form data was not available. In those instances where there appeared to be sufficient field survey form data available for a particular NAICS code, and where there appeared to be similarity between the businesses/parcels with completed form data and the businesses/parcels without form data, valuation methodology 2 was applied. Similarities considered included condition, effective age and construction material of facilities, and content and equipment similarities. For instance, if completed forms were available for three wood product manufacturing businesses, and five similar businesses were identified without completed form data, it was determined that the economic valuation data for the five businesses would be estimated based on square footage values from the three businesses.

In those instances where there did not appear to be sufficient field survey form data or where the businesses/parcels appeared to be dissimilar, valuation methodology 3 was applied.

Table 7 displays the three investment valuation methodologies and the corresponding percent of the total master list business investment valuations developed by each methodology.

Table 7 Distribution (%) of Economic Investment Valuation Methodologies Used for the Master List Businesses

Methodology Code	Valuation Methodology	Percent of Total
I	Field Survey Form Data	30%
P	Estimated based on square footage and values of similar businesses in the study area that returned survey forms	48%
M	Marshall & Swift with visual site survey and/or GIS based property data	22%

3.2.2.3 Investment Valuation Estimates for Master List Businesses

The investment values for structure and contents for the master list businesses were completed and input to HEC-FDA under this task using the methodologies proposed and described above. For methodology 2 determinations, the estimated valuations were based on a unit cost per square foot from similar business types that had returned survey forms, if a sufficient number of completed survey forms were available within the NAICS category for the particular master list business. Effective age, condition, and construction material were also considered. For methodology 3 determinations, the Marshall and Swift Commercial Estimator 7 computer program required certain data for each estimate. The required data input included zip code, stories in building, total building area, occupancy group, occupancy type, occupancy code number, occupancy percentage, story height, construction class and quality. Where required input data was not available, normative values within the NAICS commercial category were applied. (Note: If completed survey forms were later received, any estimates of values based on methodologies 2 or 3 were overwritten by survey form data.)

3.2.2.4 Descriptive and Location Data for the Other Businesses and Public Entities

Descriptive and location data for the remaining businesses and public entities (not on the master list) in the rest of the study area were obtained by windshield survey and from available mapping. As for the master list businesses, each structure was assigned a three-digit NAICS code for the purposes of categorizing similar investments. Where similar structure/investment entity types were located adjacently and at similar elevations, such structures/investments were grouped together and entered into HEC-FDA as a single entry. First floor heights above ground, structure ground elevations and low entry elevations were identified using the aerial maps and visual inspection. Each structure or group of structures was assigned a structure number corresponding to the aerial map structure number for identification purposes. Square footage estimates were calculated by scaling the structure footprint outline shown on the map, combined with descriptive data from the visual survey. Visual observations were important in minimizing square footage calculation errors from roof overhands, multiple structure groupings, or multiple story buildings. Quality control review of such calculations was conducted by comparing the calculated square footages for a sample of the structures to available GIS data on square footage.

3.2.2.5 Investment Valuation Estimates for the Other Business and Public Entities

Valuation estimates were developed either by using Marshall and Swift estimation software, or by estimating based on the Phase 1 and Phase 2 locally-obtained data for similar structures/investment types (NAICS code). Marshall and Swift Commercial Estimator and Commercial Contents and Inventory (CCI) software packages were used to estimate structure value and contents/inventory values respectively. Required input data to

the Marshall and Swift programs were based on data gathered during the windshield survey and using normative values for a typical business in that category. If locally obtained survey form data for similar NAICS code businesses were available, a unit value per square foot developed from survey data was applied to the square footage of these businesses as appropriate to develop estimates of investment values.

3.2.2.6 Other Specific Category Valuation Data

Early in the EFS, warehouse owners in the study area provided considerable economic survey form data. Such locally-obtained data were used to develop a unit value per square foot of typical warehouse development for both structure and contents. These unit costs were then applied to the square footage calculations for similar warehouse development for purposes of developing the rest of the study area warehouse investment valuations for structure and contents in each levee unit area.

The AE contract firm also held on-site meetings with Union Pacific Railroad (UPRR) representatives to identify and quantify the economic investment valuations of UPRR facilities in the study area. UPRR data were used to also develop investment valuation data for similar Burlington Northern & Santa Fe Railway Company (BNSF) facilities within the study area. Mapping was reviewed, facilities were identified, and a windshield survey of the BNSF facilities was conducted. Economic investment information provided by Kansas City Terminal Railway Company was also incorporated into development of the data of BNSF. (Railroad track investment was developed separately by the Corps Team economist and is described later in this document.)

3.2.2.7 Summary of Valuation Methodologies Used in the Study for Commercial and Industrial Businesses and Public Facilities as a Whole

Table 8 below provides the resulting percentage distribution of the valuation methodologies used in developing the entire study area investment for all commercial, industrial and public entities (master list businesses plus remainder of the study area businesses and public entities).

Table 8 Percentage Distribution of Valuation Methodologies Used for All Commercial, Industrial and Public Entities (Master List Businesses Plus Rest of the Study Area)

Methodology	Percent of Total
Estimated values from completed survey forms provided by local business owners	14%
Estimated values developed from locally obtained study area data for similar businesses	24%
Estimated values from Marshall & Swift	62%

3.2.3 Damageability of Commercial, Industrial and Selected Public Investment

3.2.3.1 Depth Damage Relationships

Commercial, Industrial and Public damages consist of physical inundation damages to structures and contents (equipment, inventory, etc.). During an in-progress independent review meeting, Corps experts advised the potential use of available generic depth-damage relationships if survey form data were not available. Curves developed and available from a recent New Orleans District study were specifically suggested for evaluation of suitability for use in this study. The New Orleans District was contacted and it was determined that these curves were appropriate because flooding characteristics were similar (freshwater, several days duration, low velocity, silt and debris), and both study areas covered urbanized areas having a mix of residential, commercial, and industrial development, with similar

types of construction. The New Orleans District functions included measures of error needed in risk-based analysis.

To account for the high depths of flooding in the Kansas Citys study area, depth-damage relationships were extended by means of extrapolation and professional judgment. Depth-damage relationships used in this study were obtained from the following sources:

- Depth-damage relationships provided by business/property owner representatives on completed survey forms, including direct dollar damage functions entered in HEC-FDA.
- "Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Ratios (CSVR) in Support of the Lower Atchafalaya Reevaluation and Morganza to the Gulf, Louisiana Feasibility Studies, Final Report", (May 1997), U. S. Army Corps of Engineers, New Orleans District. Structure depth-damage functions and related uncertainties are presented for three different types of construction: metal frame, masonry bearing, and wood frame wall structures. Content depth-damage functions and related uncertainties are presented for six different business/property categories: eating and recreation, groceries and gas stations, professional businesses, public and semi-public, retail and personal services, and warehouse and contractor services.
- Institute for Water Resources (IWR) Report 96-R-12, "Analysis of Non-Residential Content Value and Depth-Damage Data for Flood Damage Reduction Studies", (May 1996). This report presents both structure and content depth-damage functions based on a 1992 survey of businesses in the Wyoming Valley of Northeastern Pennsylvania. The depth-damage functions were tested for significant differences based on the number of stories in a building.
- Institute for Water Resources and other Corps Districts. IWR and other district offices were contacted for depth-damage data. It was determined that the data provided by sources noted in the first three bullets above represented the most applicable and appropriate data readily available.

Application of the above depth damage relationships depended on the business/property category, its construction characteristics, and the source and quantity of survey data available for the particular type of business/ property. When completed survey form data had been provided, the depth-damage relationships provided by the business/property representatives were used. When survey data were not available, the New Orleans District depth-damage functions were typically applied. For structure depth-damage, each business/property was classified by the three different construction types defined in the New Orleans District data. For content and other depth-damages, the NAICS codes assigned to each business/property were used to classify each structure into the appropriate business/property category as defined by the New Orleans District report. Depth-damage functions for multi-story buildings were developed by combining IWR Report multi-story relationships for content damage with the content depth-damage functions of the New Orleans District data. The IWR Report presents content depth-damage curves for seven different Standard Industrial Classification (SIC) categories under both single and multi-story conditions. The depth-damage curve for SIC 59 was selected as being the most representative of the expected depth-damage functions for multi-story structures within the study area. From the SIC 59 curve, a proportionate relationship was

applied to the New Orleans District data for each of the six different business/property categories to characterize the effects of the number of stories on the content depth-damage curves. (The IWR report indicated no significant differences in the estimated structure depth-damage relationships based on the number of stories.)

For warehouses, survey data were provided by representatives of local warehouse facilities in several levee units in the study area. These warehouse facilities were considered to be representative of the typical warehouses in the study area, and thus the depth-damage relationships provided on the returned survey forms were applied to similar warehouses in the study area.

Table 9 below provides a summary breakdown of the various sources of depth damage relationships used in the study.

Table 9 Summary of Sources of Structure Depth-Damage Relationships for Commercial, Industrial and Public Facilities in the Study Area

Source of Depth-Damage Relationship	Percent of Total
New Orleans District Report (1997)	67%
Modified New Orleans District Data Using Multi-Story Relationships Presented in IWR Report 96-R-12	11%
Direct Depth-Damage Functions Provided by Business/Property Representatives	6%
Application of Locally-Obtained Warehouse Data to Typical Warehouse Facilities	16%

Table 10 displays the distribution of selected study area business and public entities (those with incomplete or no survey data) by the categories represented in the New Orleans District content depth damage relationships.

Table 10 Percent Distribution of Selected Study Area Commercial, Industrial, and Public Investment by Business Content Depth Damage Categories

Category	Percent of Total
Eating & Recreation	6%
Groceries & Gas Stations	2%
Professional Businesses	10%
Public & Semi-Public	11%
Retail & Personal Services	6%
Warehouse & Contractor Services	65%

3.2.3.2 Uncertainties about Economic Data

Economic uncertainties are associated with structure and content values, structure elevations, and depth-percent damage relationships. Uncertainties were developed as described below.

Structure value uncertainties were determined by completing a set of Marshall & Swift valuations for a representative sample of 30 master list businesses/properties that had returned completed survey forms. The Marshall & Swift valuations were compared to the survey values and a standard deviation was computed. The 30 businesses sampled for the uncertainty determinations were selected to be representative of the various types of structures located within the study area, and the process considered such factors as NAICS category, size, levee unit location, building effective age, and construction material. Based on statistical analysis of the sampled data set, a normal distribution was selected with a standard deviation of approximately 40 percent. This standard deviation was used as the depreciated structure value uncertainty for all commercial, industrial, and public structures within the study area that did not provide survey data.

Uncertainties for content and other values were determined by computing a standard deviation of the unit costs ($/square foot) determined from the Marshall & Swift CCI software content valuations. A separate standard deviation was computed for each of the six business categories presented in the New Orleans District data. Based on statistical review of the available data, a normal distribution was selected with standard deviations ranging between 47 percent and 70 percent for the various categories. These standard deviations were applied as the content value uncertainty for the majority of the commercial, industrial, and public investments in the study area. For typical warehouse facilities in the study area, a standard deviation was calculated based on the survey content value estimates, and was applied as the content value uncertainty for typical warehouse facilities.

Ground elevation uncertainties were assigned in accordance with EM 1110-2-1619 dated 1 August 1996. Based on the contour interval of available mapping for each levee unit, the recommended standard deviations and normal distributions were assigned (0.3 feet for Kansas units, and 0.6 feet for Missouri units).

Content and other depth-damage relationship uncertainties were assigned by entering the estimates of minimum, maximum and most likely damages provided by business/property representatives on the completed survey forms in a triangular distribution or as presented in the New Orleans District curves.

3.3 Residential and Infrastructure Economic Data Collection

Corps of Engineers Economics staff conducted a field survey of residential structures in the study area. Residential development is located in the Argentine, Armourdale, North Kansas City, East Bottoms and Birmingham Units. Some minor residential investment in the Argentine protected area were not evaluated separately in the residential category, but have been included in the commercial category because the structures are closely associated and even combined with commercial development in the area.

3.3.1 Residential Field Survey

3.3.1.1 Residential Property Values and Uncertainties

Local realtors in both Kansas and Missouri who sell homes in the levee unit areas with residential development were contacted to obtain for each levee unit the typical sales prices for residences by type of residential structure (one-story with basement, two story without basement, etc.) Realtors also provided typical market values for residential lots in the individual market areas. For comparison purposes, Multiple Listing Service data was also obtained from a real estate appraiser about recent comparable sales for residential units in the levee unit areas. Residential development in both the Armourdale Unit and in the East Bottoms Unit is relatively homogeneous. Homes are typically similar in size, effective age, condition, and market value. The Birmingham Unit has a mix of residential types. In North Kansas City, two separate areas of residential development were investigated and discussed with local realtors. One area is more homogeneous, mostly one story without basement residences, while the other area appears to have somewhat more of a mix of residential structure types. Local realtors in the North Kansas City area did not differentiate between the two areas since the two areas have a differing mix of structure types, and provided typical market values and ranges of values for each type of residential structure found in the North Kansas City area. To verify that the realtor provided market values were reasonable and representative of depreciated replacement values, Marshall & Swift depreciated replacement values were developed for a random sample of residential structures in the two levee units having the majority of residential development (the Armourdale and North Kansas City Units). The realtor-provided market values were

determined to reasonably reflect depreciated replacement value. Based on the values provided by the local realtors, typical residential structure market values (not including the typical market land value) were developed by structure type and by levee unit area, and were input into the HEC-FDA program for residential structures as appropriate for type of structure and levee unit location. Similar structure types at similar elevations and river mile locations were grouped together as possible for input into HEC-FDA. Uncertainties about structure values were determined from the ranges of values provided by the realtors contacted for the different structure types and levee unit areas.

For the Residential Other category in HEC-FDA, each residential unit was assumed to have a vehicle of typical average value and typical landscape investment subject to damage. Most families today own more than one vehicle, and with imminent threat of flooding, it is likely that a family would load belongings into one of the vehicles and evacuate the area. Thus, for purposes of the study, vehicles subject to flood damage were limited to one per residential structure. Most homes in the protected areas have typical shrub plantings, lawns, and gardens that would also be damaged by flooding. The vehicle and typical landscaping investment value in the Residential Other category was assumed to be about 20 percent of structure value, with 5% as one standard deviation of error for uncertainty. For example, for a residence with an estimated value of $50,000, the Residential Other category value (vehicle and landscaping) would be estimated at $10,000. The Residential Other category values range from $3,900 to $19,000, with a study area average of $10,500. A Rock Island District depth percent damage function was used for the Residential Other category, based on the assumed similar nature of flooding.

3.3.1.2 Residential Property Elevations and Uncertainties

Elevations of the lowest openings and first floors relative to the ground were noted by visual observation of structures during the field survey. Ground elevations for residential structures were determined from the available mapping and uncertainties about structure elevation were determined based on data in Table 6-5, EM 1110-2-1619, Risk Based Analysis for Flood Damage Reduction Studies (August 1996). Although a vehicle parked on the street or in a driveway would likely be at a lower elevation than the residence it is associated with, for purposes of the analysis a vehicle was assumed to have the same ground elevation as its associated structure.

3.3.1.3 Residential Damageability and Uncertainties

Structure depth percent damage curves obtained from IWR (Economic Guidance Memorandum (EGM) 01-03, Generic Depth-Damage Relationships, 4 Dec 2000) for homes without basements were selected and used as appropriate for the type of structure (e.g. 1 story without basement, 2 story without basement, etc.). Because IWR "with basement" depth percent damage curves were not available for use in the existing condition analyses (May 2003), depth-percent damage relationships and uncertainties for residential structures with basements were obtained from flood damage reduction studies completed by Rock Island District. These curves were generic and were determined to be appropriate for use in the Kansas Citys study based on similar typical Midwest residential structure types and construction, and on the similar nature of flooding. Content to structure value ratios were chosen based on the particular structure depth percent damage curve used for the structure. For no basement residential structures, where the IWR curves were used, the ratio was set at 100% of structure value. For with basement residential structures, where Rock Island District curves were used, ratios and standard deviations in Table 6-4, EM 1110-2-1619, were also used as appropriate for the type of residential structure. When IWR with basement curves later became available, a comparison of the Rock Island

District with basement curves and the IWR with basement curves was completed. The comparison indicated that use of the IWR with basement curves would result in somewhat higher primary damages at each flood depth for the residential structures with basements. However, it was decided to retain the set of with basement curves already entered in HEC-FDA and used in the analyses because study results and conclusions would not be expected to differ based on the choice of curves.

3.3.2 Investment in Roads and Railroads; Elevations; Damageability

Roads are perhaps the most commonly damaged infrastructure facility in a flood event. Damage to roads and other paved surfaces may be caused by floodwaters overtopping, eroding and scouring road surfaces, shoulders, and embankment slopes. In addition to obvious washout areas, as the ground begins to dry out after flooding, pavement buckling and other problem areas can become apparent. Curbs, gutters and sidewalks along the streets and roads can be damaged by uprooted trees and by heavy equipment during cleanup. Also associated with road damage would be damage to traffic signs and stoplights. For purposes of this study, damages to roads and paved parking lots were estimated for Units in the study area. Damages to traffic signs and traffic signals were not included. Miles of roads by type and elevation for each levee unit were determined during the reconnaissance phase of the study. Estimates of the investment per mile for the various types of roads were developed from road construction cost estimates obtained from the Missouri Department of Transportation and from representatives of Kansas City highway engineering firms, and were applied to the estimated miles of roadways by type in each levee unit area subject to flooding. Uncertainties in investment value were determined based on the ranges of values provided for the different types of roads. The analysis uses a 20 percent maximum or minimum variation for interstates and heavy-duty concrete roads, and 35 percent variation for arterial and local/collector streets. Depth-percent damage relationships for roads in the study area were based on previously developed Kansas City District curves used in other approved studies. Omaha District curves were obtained for comparison and to develop estimated uncertainties in the depth-damage relationship. Large paved parking lots associated with commercial and industrial structures in the study area were measured from aerial maps to determine square footage, and a value per square foot representing the cost to resurface the lot (obtained from Kansas City District Cost Engineering and Specifications Section staff) was applied to the square footage to determine investment value. Road depth percent damage relationships were used for the large paved parking lots identified. Damages to roads in each levee unit area are included in the public category of damage. Damages to parking lots in each levee unit area are included in the commercial damage category.

Data for railroad tracks were developed in a similar manner. Miles of track were determined by elevation and by levee unit area during the reconnaissance phase of the study. Estimates of investment value per mile for different types of track were obtained during interviews with study area railroad representatives. Investment per mile was estimated to range from $1,000,000 to more than $2,500,000, depending on the number of electric time locking switches in the track. Since the study area encompasses heavily urbanized areas, and major rail yards, it is reasonable to assume that track with electronic switching would be more prevalent than track without electronic switching. Based on values per mile and the miles of track with the different levels of electronic switching provided by railroad representatives interviewed, an average value per mile of $1,750,000 was developed and applied to the total miles of railroad tracks in the levee unit areas. On average, approximately 42% of this value represents the value of main line tracks, and

about 57% represents the value of electronic switching and other equipment. Uncertainties were based on the range of values obtained from the railroad representatives interviewed. Previously developed Kansas City District depth-percent damage curves were used, and compared with Omaha District curves to determine estimated uncertainties. Separate depth damage relationships for railroad tracks and electronic equipment were used. Estimated damages to railroad tracks are included in the commercial category of damage in each levee unit area.

The Kansas Citys study area contains major significant rail yards and main line track. The Argentine yard is one of the busiest rail yards in the nation. An average of 6,200 cars per day is handled through the Argentine yard, and the total working trackage can accommodate nearly 15,000 cars. On any given day, an estimated 3,500 cars could be sitting in the yard waiting processing (information from interview with railroad representative). For Kansas River flooding, there is not as much advance warning time as for Missouri River flooding. However, in either case, if the call went out to evacuate the study area, railroad representatives from the different rail companies stated independently, in separate discussions with Kansas City District staff, that it would be nearly impossible to move the cars out of the study area rail yards because there is not enough locomotive power available to move them in a short timeframe. The majority of cars and their commodities would be left on the track and would be subject to flood damage. For purposes of this analysis we estimated that approximately 25% of the boxcars would be moved out of harm's way, and that all locomotives would be moved out, except for locomotives in the repair facilities. Railroad car damage would mainly be damage to wheel assemblies once they get wet, along with some other more minor damage to the cars themselves. The railroad representative interviewed estimated the cost for replacement of flooded wheel assemblies at $80,000 per car. Information obtained for the Argentine yard was applied to rail yards in other levee units. Estimated numbers of rail cars in each yard were determined from examination of aerial photos and comparison with the Argentine Yard. Boxcar commodities would also be damaged with a major flood event. To estimate boxcar commodities damage, the top inbound and outbound commodities by rail carload (2000 data) were researched for the Kansas City area, and a weighted value per rail car of $21,700 was developed. The top commodities included Motor Vehicles and Motor Vehicle Parts (30%), Grain and Grain Products (14%), Bituminous Coal, Miscellaneous Coal and Petroleum, Mineral Products (40%), Portland Cement (2%), Other Food Products (8%), Other Products (6%). The Kansas City rail yards are also major containerized shipping centers. Containers waiting processing were estimated by field observation, examining aerial photos, and counting stacks of containers. It was also assumed that, with evacuation in the face of a major flood event, approximately 25 percent of these would be moved out of the floodplain. A typical depreciated value per container was obtained from a company that sells containers and was estimated at $2,300 per container. The company representative indicated that the containers are not too damageable, but that contents would be destroyed in a major flood event. Container unit damage in a major flood event was estimated at about 5 percent of total investment in containers for purposes of the analysis. Container commodity damage was assumed to be similar to boxcar damage; container content values and damages are for finished goods and would likely be much higher than for raw materials.

3.3.3 Crop Acres

Only the Birmingham Unit has agricultural land use, with an estimated 2,300 protected crop acres. Estimates of crop acres by elevation for this levee unit were

determined during the reconnaissance phase from aerial mapping and contours. Typical Missouri River floodplain crop distribution patterns were used to develop a typical composite crop acre. The composite acre is based on the typical mixture of crops for the area (corn, beans, wheat, and milo). The composite acre crop distribution percentage, typical Missouri River floodplain crop yields, current normalized prices, annual variable crop production costs (net of harvest costs), and a weighted monthly probability of flooding (based on historical flood data) were used to develop a weighted average crop primary damage per acre inundated. This value ($150 per acre) was applied to the cumulative acres inundated at each elevation to develop a stage primary crop damage curve that was entered into the HEC-FDA program. The weighted average crop damage per acre was assumed to have a triangular distribution with a minimum estimated value of $140 and a maximum estimated value of $170.

3.4 Historical Flood Events and Damages

Floods in the Missouri and Kansas River Basin carry great quantities of silt and debris, and are of comparatively low velocity and of several days duration. Flow data at the USGS gauge on the Hannibal Bridge in Kansas City is available for the period 1929 to present. Before 1929 the major flood events in the Kansas Citys area occurred in 1844 (17.0 feet above flood stage), 1881 (6.8 feet above), 1903 (14.0 feet above), and 1908 (9.3 feet above). Although the 1844 event is considered the greatest known event in the lower Missouri Basin, there was little development in the area. However, the wharves at the nearby City of Independence, Missouri were destroyed, and Westport Landing (early downtown Kansas City area) thus gained most of the Santa Fe Trail trade. In the 1903 flood, 19 lives were lost in the Kansas Citys area, and an estimated $23,000,000 in property damages (1903 prices) was sustained. The flood of 1903 had an estimated discharge of 543,000 cubic feet per second (c.f.s.).

The 1951 flood, with a Missouri River discharge of 573,000 c.f.s. and 469,000 c.f.s. on the Kansas River, exceeded the other previous events except for the flood of 1844. A two-month period of above-normal precipitation followed by unprecedented intense rains over a 72-hour period in early July caused the flooding. Various news articles and other accounts of the flood indicated that in the early morning hours of Friday, July 13, 1951, the Kansas River poured over the dikes in the Argentine District and about 2000 residents fled to nearby bluffs. Early that morning, too, after the Armourdale district had been officially evacuated, water began to overtop a 4-mile stretch of the levee and inundated the Armourdale area with depths of 15 to 30 feet. On Kansas Avenue, the floodwater was reported to be "waist-high on top of a two story building". About 400-800 people who had decided to stay had to be rescued by boats, out of trees, and from ledges and rooftops. Intense sandbagging efforts to save the West Bottoms failed and later that morning, the Central Industrial District was flooded. In the East and West Bottoms areas, manufacturing and wholesale districts, railroad yards and the Kansas City stockyards were devastated. Packing plants were flooded, and the floodwaters swept away thousands of hogs and cattle. Railroad transportation was halted due to the flooding with severe damage to tracks, rail cars, and rail yards. The American Royal building was inundated by 15 feet of water. Only 2 highway bridges remained in operation in the area, and runaway barges were a threat to these remaining bridges. The flood threat moved on to the Municipal Airport (now the Charles B. Wheeler (Downtown) Airport), the Fairfax District and North Kansas City by Friday night. Planes were evacuated, and North Kansas City residents were ordered to evacuate. Although work to support the dike using bulldozers and trucks continued through the night, the Jersey dike collapsed early on Saturday July 15, and water poured

into the Fairfax District. In an effort to protect the downtown airport and Municipal Air terminal, junked cars were dumped onto levees. Of the five industrial districts, only North Kansas City was completely saved (the Municipal Air Terminal escaped the worst of the damage). Emergency operations also prevented flooding of the Northeast (East Bottoms) and Birmingham Industrial Districts. Water stood for several days in the flooded units and the Kansas River stretched from the Armourdale bluff to the Argentine bluff, with very little to be seen above the floodwater. About 11 square miles were flooded in the Kansas Citys area. Although at least 5 persons died in the Kansas Citys area, about 15,000 people were evacuated. Many of these residents were left homeless and were relocated to trailers and other temporary housing, some for nearly two years. The flood caused a reported $425 to $870 million in damage (1951 price level) ($4.38 to $8.96 billion in 2004 prices) in the study area alone, and July 13, 1951 became known as "Black Friday". As the waters receded, a large amount of debris remained and about 4 feet of mud and silt covered the streets and sidewalks. Norman Rockwell commemorated the 1951 flood and paid tribute to Kansas City residents in his painting, "The Kansas City Spirit". It shows a worker rolling up his sleeves while holding a blueprint, with the Kansas City skyline in the background.

The 1993 flood event crested at 48.9 feet on July 27, 1993, with a Missouri River discharge of 543,000 c.f.s. Although the discharge was less than for the 1951 flood, the 1993 crest of 48.9 feet exceeded the 1951 crest stage of 46.2 feet. All the levees in the Kansas Citys project held, although water levels on several units were encroaching in established freeboard. All of the levees sustained some damage. An estimated $4.57 billion in damages were prevented by the Kansas Citys Federal levee system (The Great Flood of 1993, Post-Flood Report, U.S. Army Corps of Engineers, Sept 1994). Main stem reservoirs on the Missouri above Kansas City prevented an estimated $3.8 billion in damages, much of that in the Kansas Citys area. Just outside the study area in Kansas City, Kansas, several low-lying trailer courts and other homes near Kansas River mile 10 were damaged or destroyed. An estimated 600 mobile homes and 200 other homes were affected. Damages to Kansas City, Kansas utilities reached several million dollars. Kansas City, Missouri reported more than $15 million in damage to public infrastructure. Kemper Arena and the American Royal Building suffered about $2.5 million in water damage to flooring and electrical circuits. The downtown airport sustained damages of nearly $3 million, and pollution control and public works facilities sustained an estimated $8 million in damage. Since the levees in the Kansas Citys project held, these reported damages sustained were likely due to flooding from sources other than the Missouri and Kansas Rivers.

3.5 Physical Damages

Damages for the Kansas Citys study consist of physical inundation damages to the commercial, industrial, residential and public structures and their contents, and damages to roads and railroad tracks in the study area. Early analysis of each levee unit area indicated that if a levee failed, even at the downstream end, all of the protected area could be flooded. The protected areas are relatively "flat" and elevations do not change much. Depending on the location of levee overtopping or failure, the stage interior to the levee may be different than the stage exterior to the levee, and this relationship has been accounted for in the analysis. Early in the analysis, it was also ascertained that structures in the CID Unit would be impacted more by Kansas River flooding than by Missouri River flooding. If a Kansas River headwater flood overtops the CID (KS) Unit at the initial overtopping location, then the water will flow into the Missouri River and outfall over the CID MO floodwall, impacting structures on both sides of the state line. Engineering and

economic data about the Armourdale and CID units will be determined and finalized in the final feasibility report.

3.5.1 Analysis Years

The future with and without project conditions are evaluated over a 50 year period of analysis. The study configuration in the HEC-FDA Flood Damage Reduction Analysis program requires selection of a base year and a future year during the period of analysis to define damage and project performance for specific time periods during the life of a project. The analysis years represent static time periods or years for which the hydrologic engineering and economic data must be developed for the analyses. The existing condition analysis year for the Kansas Citys study is 2002. The future condition analysis years for the Kansas Citys study are 2012 for the base year (assumed to be the first year any proposed project would be implemented and in place) and 2035 for the future year. The future year (selected to be 2035 in this study) is normally a development projection for a specific future year, usually about 20 to 30 years out from the base year. (However, for purposes of this study, no development projections were made for the future year 2035.) The expected annual damage for each year in the analysis period is computed, discounted back to present value and annualized to determine the equivalent value over the analysis period. The expected annual damage is assumed constant in those years of the period of analysis beyond the most likely future condition (future analysis year 2035).

3.5.2 Damage Categories

The predominant land uses and investment in the study area are, as described above, industrial, commercial, public, residential, and crop. Potential flood damages are based on damages to structures and damages to contents, including inventory and equipment for industrial and commercial properties. Additionally, there would be potential damages to public infrastructure (roads).

3.5.3 Damage Calculation Methodologies and Uncertainties

The feasibility phase analyses for the Kansas Citys, MO and KS utilizes the HEC-FDA program (version 1.2, March 2000) developed by the Hydrologic Engineering Center, for incorporation of risk and uncertainty in the analysis of alternatives. Eight water surface profiles were entered into HEC-FDA for the Missouri River and for the Kansas River. The eight profiles included the 0.10, 0.01, 0.005, 0.002, 0.0013, 0.001, 0.0008, and 0.0007 probability events. For successful entry into HEC-FDA, the water surface profiles were "smoothed" by eliminating cross-sections at bridges where "blips" in the profiles occurred. In addition to specific economic data uncertainties discussed in previous sections, the program allows quantification of uncertainties in the discharge-exceedance probability function for each reach, the stage-discharge function for each reach, and the aggregated stage-damage functions by category for each reach, and incorporates those uncertainties in the integration of the hydrologic and hydraulic engineering and economic analysis of the with and without project conditions using Monte Carlo simulation techniques.

Flood damages for various flood events are computed based on the level of investment subject to flooding, the beginning damage elevation, and the estimated damage to that investment with various depths of flooding. Values of investment subject to flooding, structure elevations, and foundation heights (to indicate the elevation at which first floor flood damages would be estimated to occur) along with associated uncertainties were entered into the HEC-FDA program for each structure or groups of structures in the study area. Damage susceptibility functions and associated uncertainties for the various types of structures and contents determined as described in preceding paragraphs were also entered into the HEC-FDA program. The HEC-FDA program references each structure's

first floor elevation or beginning damage elevation to the corresponding frequency event elevation at the reach index point. Individual stage-damage relationships at each structure for each investment category are then computed with risk and aggregated to the reach index location in the HEC-FDA program for integration of the economic and hydrologic engineering data. Use of the HEC-FDA program for the analysis facilitates the assessment of the tradeoff between risks and costs.

An example of a depth-percent damage function, with error limits, for the content investment category is displayed in Table 11 below. An example stage primary damage report (at the reach index point) is provided in Table 12 on the following page.

Table 11 Example Depth-Percent Damage Function Report for 1 ½ NB - Content

Depth (ft.)	Damage (Percent)	Error Limit Curves (Normal) Damage (Percent)			
		-2 SD	-1 SD	+1 SD	+2 SD
-2.00	0.00	0.00	0.00	0.0	0.0
-1.00	2.2	0.00	0.0	4.4	6.6
0.00	2.9	0.00	1.4	4.4	5.9
1.00	4.7	2.3	3.5	5.9	7.1
2.00	7.5	4.9	6.2	8.8	10.1
3.00	11.1	8.3	9.7	12.5	13.9
4.00	15.3	12.3	13.8	16.8	18.3
5.00	20.1	16.9	18.5	21.7	23.3
6.00	25.2	21.6	23.4	27.0	28.8
7.00	30.5	26.3	28.4	32.6	34.7
8.00	35.7	30.7	33.2	38.2	40.7
9.00	40.9	34.9	37.9	43.9	46.9
10.00	45.8	38.8	42.3	49.3	52.8
11.00	50.2	42.0	46.1	54.3	58.4
12.00	54.1	44.9	49.5	58.7	63.3
13.00	57.2	47.2	52.2	62.2	67.2
14.00	59.4	48.6	54.0	64.8	70.2
15.00	60.5	49.1	54.8	66.2	71.9
20.00	65.0	51.0	58.0	72.0	79.0
25.00	70.0	54.0	62.0	78.0	86.0
30.00	75.0	57.0	66.0	84.0	93.0
35.00	80.0	60.0	70.0	90.0	100.0

3.5.4 Results of Damage Analysis for Without Project Condition

3.5.4.1 Beginning Damage Elevations

Stage damage curves developed with risk and uncertainty at the reach index point indicate that physical damages to structures in the Argentine Unit on the Kansas River could occur with an event with a 0.01 probability of occurrence in any given year under existing conditions. The .01 event corresponds to a nominal water surface elevation of 769.61 at the Argentine index point location. On the Missouri River, physical damages to structures in East Bottoms could occur with an event with a 0.002 probability of occurrence in any given year under existing conditions. The North Kansas City and Fairfax-Jersey Creek Units could incur damages beginning with a 0.004 probability event under existing conditions. Corresponding index point nominal water surface elevations for these frequency events are 742.63 for the East Bottoms Unit, 753.04 for North Kansas City, and 756.09 for Fairfax-Jersey Creek. Birmingham Unit physical damages could occur with an event having a frequency of 0.001 and a corresponding river elevation of 742.90 at the reach index point.

Table 12 Stage-Damage Report Without Project, Industrial Damage Category

Plan Name: Without
Analysis Year: 2002
Stream Name: Missouri River
Damage Reach Name: East Bottoms
Damage Category Name: Industrial

Stage (ft.)	Damage ($1,000's)	Error Limit Curves (Normal) Damage ($1,000's)			
		-2 SD	-1 SD	+1 SD	+2 SD
692.00	0.00	0.00	0.00	0.0	0.0
694.00	0.00	0.00	0.00	0.0	0.0
696.00	0.00	0.00	0.00	0.0	0.0
698.00	0.00	0.00	0.00	0.0	0.0
700.00	0.00	0.00	0.00	0.0	0.0
702.00	0.00	0.00	0.00	0.0	0.0
704.00	0.00	0.00	0.00	0.0	0.0
706.00	0.00	0.00	0.00	0.0	0.0
708.00	0.00	0.00	0.00	0.0	0.0
710.00	0.00	0.00	0.00	0.0	0.0
712.00	0.00	0.00	0.00	0.0	0.0
714.00	0.00	0.00	0.00	0.0	0.0
716.00	0.00	0.00	0.00	0.0	0.0
718.00	0.00	0.00	0.00	0.0	0.0
720.00	0.00	0.00	0.00	0.0	0.0
722.00	0.00	0.00	0.00	0.0	0.0
724.00	0.00	0.00	0.00	0.0	0.0
726.00	11.11	0.00	0.00	99.76	188.45
728.00	6111.98	0.00	1896.10	10327.86	14545.31
730.00	60575.78	1414.94	31000.86	90150.70	119736.63
732.00	429700.81	246947.81	338341.31	521060.31	612453.81
734.00	780984.31	602313.63	691665.56	870303.06	959655.00
736.00	1145962.50	908545.63	1027276.13	1264648.88	1383379.38
738.00	1348010.88	1090016.50	1219037.63	1476984.13	1606005.25
740.00	1503760.63	1225778.88	1364795.63	1642725.63	1781742.38
742.00	1631133.38	1337838.50	1484513.25	1777753.50	1924428.38
744.00	1727229.63	1421424.50	1574355.50	1880103.75	2033034.75
746.00	1781085.13	1475539.50	1628340.75	1933829.50	2086630.75
748.00	1794792.13	1489270.25	1642059.63	1947524.63	2100314.00
750.00	1803266.38	1497742.13	1650532.63	1956000.13	2108790.75

Table 13 below provides a summary by levee unit of the frequency events and corresponding elevations at which physical damages are estimated to begin to occur based on evaluation of the existing physical condition of the levee system units.

Table 13 Beginning Damage Events and Elevations

Unit	Elevation at reach index point	Frequency of event
Argentine	769.61	.010
Armourdale	TBD in Phase 2	TBD in Phase 2
CID (KS. R. flooding)	TBD in Phase 2	TBD in Phase 2
CID (MO. R. flooding)	TBD in Phase 2	TBD in Phase 2
East Bottoms	742.63	.002
North Kansas City	751.92	.004
Fairfax-Jersey Cr.	755.20	.004
Birmingham	742.90	.001

3.5.4.2 Integration of Stage-Damage and Stage-Discharge-Frequency Relationships

Hydrologic and hydraulic uncertainties include uncertainties about the stage-discharge-exceedance probability relationships. Uncertainties in the discharge-exceedance probability functions were developed in the HEC-FDA program by the graphical exceedance probability method using the water surface profiles and a 70-year period of record. Uncertainty in stage-discharge functions was based on a locally developed standard deviation of error (1.5 feet). Tables 14 and 15 below, and Table 16 on the following page, display examples of discharge-exceedance probability, stage-discharge, and exceedance probability-damage functions (including risk and uncertainty). The functions were generated in the HEC-FDA program after specification and input of the above-described uncertainties. Integration of the depth damage relationships with the stage-frequency data in the HEC-FDA program provided estimates of total damages for flood events with various chances of occurrence for the existing without project conditions.

Table14 Exceedance Probability-Discharge Function Report for Damage Reach North Kansas City

Plan Name: Without, Without Project Condition
Analysis Year: 2002
Stream Name: Missouri River

		Confidence Limit Curves (standard error)			
		Discharge (cfs)			
Exceedance Probability	Discharge (ft.)	- 2 SD	-1 SD	+1 SD	+2 SD
0.9990	50000	40174	44818	55781	62230
0.9900	62900	52322	57368	68966	75617
0.9500	78100	66935	72302	84363	91128
0.9000	88300	76820	82360	94668	101495
0.8000	103000	71016	96823	109571	116562
0.7000	116252	103239	109552	123361	130906
0.5000	142000	126278	133908	150581	159680
0.3000	176326	154983	165310	188076	200609
0.2000	201000	173641	186820	216256	232670
0.1000	245000	203057	223045	269116	295606
0.0400	305665	243909	273047	342181	383058
0.0200	352626	273807	310728	400174	454134
0.0100	401000	303440	348826	460977	529926
0.0040	472071	345291	403734	551973	645400
0.0020	530000	378198	447711	627414	742733
0.0010	590000	411334	492632	706612	846272

Table 15 Stage-Discharge Report for Damage Reach North Kansas City

Plan Name: Without, Without Project Condition
Analysis Year: 2002
Stream Name: Missouri River
Damage Reach Name: North Kansas City

		Error Limit Curves Stage (ft.)			
Discharge (c.f.s.)	Stage (ft.)	- 2 SD	-1 SD	+1SD	+2 SD
0	696.17	696.17	696.17	697.67	699.17
245000	739.76	736.76	738.26	741.26	742.76
401000	748.81	745.81	747.31	750.31	751.81
454000	751.21	748.21	749.71	752.71	754.21
530000	754.45	751.45	752.95	755.95	757.45
565000	755.75	752.75	754.25	757.25	758.75
590000	756.72	753.72	755.22	758.22	759.72
610000	757.48	754.48	755.98	758.98	760.48
625000	758.03	755.03	756.53	759.53	761.03

Table 16 Exceedance Probability-Physical Damage Function Report for Damage Reach North Kansas City (physical damages) (Oct 2002 prices)

Plan Name: Without, Without Project Condition
Analysis Year: 2002
Stream Name: Missouri River

Exceedance Probability	Damage ($1000's) by Damage Categories					Total Physical Damage
	Commercial	Crop	Industrial	Public	Residential	
0.9990	0.0	0.0	0.0	0.0	0.0	0.0
0.9900	0.0	0.0	0.0	0.0	0.0	0.0
0.9500	0.0	0.0	0.0	0.0	0.0	0.0
0.9000	0.0	0.0	0.0	0.0	0.0	0.0
0.8000	0.0	0.0	0.0	0.0	0.0	0.0
0.7000	0.0	0.0	0.0	0.0	0.0	0.0
0.6000	0.0	0.0	0.0	0.0	0.0	0.0
0.5000	0.0	0.0	0.0	0.0	0.0	0.0
0.4750	0.0	0.0	0.0	0.0	0.0	0.0
0.4500	0.0	0.0	0.0	0.0	0.0	0.0
0.4250	0.0	0.0	0.0	0.0	0.0	0.0
0.4000	0.0	0.0	0.0	0.0	0.0	0.0
0.3750	0.0	0.0	0.0	0.0	0.0	0.0
0.3500	0.0	0.0	0.0	0.0	0.0	0.0
0.3250	0.0	0.0	0.0	0.0	0.0	0.0
0.3000	0.0	0.0	0.0	0.0	0.0	0.0
0.2750	0.0	0.0	0.0	0.0	0.0	0.0
0.2500	0.0	0.0	0.0	0.0	0.0	0.0
0.2250	0.0	0.0	0.0	0.0	0.0	0.0
0.2000	0.0	0.0	0.0	0.0	0.0	0.0
0.1750	0.0	0.0	0.0	0.0	0.0	0.0
0.1500	0.0	0.0	0.0	0.0	0.0	0.0
0.1250	0.0	0.0	0.0	0.0	0.0	0.0
0.1000	0.0	0.0	0.0	0.0	0.0	0.0
0.0750	0.0	0.0	0.0	0.0	0.0	0.0
0.0500	0.0	0.0	0.0	0.0	0.0	0.0
0.0400	0.0	0.0	0.0	0.0	0.0	0.0
0.0250	0.0	0.0	0.0	0.0	0.0	0.0
0.0200	0.0	0.0	0.0	0.0	0.0	0.0
0.0150	0.0	0.0	0.0	0.0	0.0	0.0
0.0100	0.0	0.0	0.0	0.0	0.0	0.0
0.0075	0.0	0.0	0.0	0.0	0.0	0.0
0.0040	433553.19	0.0	735593.13	124471.79	87012.73	1380630.90
0.0020	509021.75	0.0	863637.81	146138.58	102159.02	1620957.16
0.0010	509021.75	0.0	863637.81	146138.58	102159.02	1620957.16

3.5.4.3 Exceedance Probability-Damage (including risk and uncertainty) for the Interim Feasibility Report Units

.01 Exceedance Probability Event. The .01 exceedance probability event would impact the Argentine Unit on the Kansas River and is estimated to cause physical damages of nearly $1.2 billion. Flood depths in the Argentine Unit could reach more than 15 feet on the lowest structure and average 6.3 feet in depth (average depth on all Argentine structures). Approximately 682 structures would be flooded.

.004 Exceedance Probability Event. A flood event of this magnitude and frequency would impact the Argentine Unit on the Kansas River, and two units on the Missouri River (North Kansas City and Fairfax-Jersey Creek). This event is expected to cause physical damages of more than $5.17 billion in the Units addressed by this interim report. More

than $1.6 billion would occur in the Argentine Unit, with flood depths up to nearly 19 feet. The North Kansas City Unit could incur more than $1.5 billion in physical damages, and Fairfax-Jersey Creek could incur nearly $2.0 billion in physical damages. Nearly 2,700 structures in the Phase 1 units would be affected.

.002 Exceedance Probability Event. This event would impact all Phase 1 units, Argentine, East Bottoms, North Kansas City and Fairfax-Jersey Creek Units. Maximum flood depths in the six impacted units could range from about 16 feet in the East Bottoms Unit to nearly 24 feet in the Argentine and North Kansas City Units. Physical damages with an event of this magnitude are estimated to total more than $7.6 billion in the interim report Units, ranging from more than $1.69 billion in the Argentine Unit to more than $2.3 billion in the Fairfax-Jersey Creek Unit. More than 3,400 structures in the interim report Units would be affected.

.001 Exceedance Probability Event. A flood event of this frequency and magnitude would impact all interim report Units including the Birmingham Unit. Nearly 3,700 structures in the five units could be affected and physical damages would total more than $9.1 billion. Physical damages are estimated to range from about $256.3 million in the Birmingham Unit to more than $3.0 billion in the East Bottoms Unit. Maximum flood depths could range from slightly more than 18 feet in the East Bottoms Unit to about 28.5 feet in the Argentine Unit.

Table 17 on the following page displays the existing condition physical damages by flood frequency event for each levee unit in the study area. Damages in the CID Unit are based on Kansas River flooding. The next table, Table 18, displays the existing condition physical damages by category, by flood frequency event, and by levee unit. Table 19 shows the number of structures/groups of structures affected by each flood event by reach and by damage category.

Table 17 Existing Condition Physical Damage by Exceedance Probability Event

			EXISTING CONDITION			
Levee Unit	**Exceedance Probability Event**	**2002 Discharge (cfs)**	**2002 Stage (ft)**	**Max Struc Depth***	**Avg Depth All Structures**	**Physical Damage (Oct 2004 Prices, $000)**
Argentine	0.010	241,000	769.61	15.1	6.3	$1,095,946.6
	0.008	259,541	771.21	16.6	7.8	$1,342,244.7
	0.004	296,623	774.41	18.7	9.9	$1,676,702.5
	0.002	341,000	778.24	23.7	14.9	$1,693,190.0
	0.001	388,000	782.86	28.5	19.7	$1,693,190.0
Armourdale**	0.010	241,000	765.0	TBD	TBD	TBD
	0.008	259,541	766.6	TBD	TBD	TBD
	0.004	296,623	769.8	TBD	TBD	TBD
	0.002	341,000	773.63	TBD	TBD	TBD
	0.001	388,000	778.45	TBD	TBD	TBD
CID (KS R. Flooding)**	0.010	241,000	755.52	TBD	TBD	TBD
	0.008	259,541	756.63	TBD	TBD	TBD
	0.004	296,623	758.86	TBD	TBD	TBD
	0.002	341,000	761.53	TBD	TBD	TBD
	0.001	369,000	764.96	TBD	TBD	TBD
Birmingham	0.010	405,000	736.72	-	-	$0.0
	0.008	429,177	737.7	-	-	$0.0
	0.004	477,531	739.67	-	-	$0.0
	0.002	537,000	741.18	-	-	$0.0
	0.001	600,000	742.9	22.1	12.4	$256,589.0
East Bottoms	0.010	401,000	738.26	-	-	$0.0
	0.008	424,690	739.06	-	-	$0.0
	0.004	472,071	740.67	-	-	$0.0
	0.002	530,000	742.63	16.0	9.6	$1,824,605.1
	0.001	590,000	744.37	18.1	11.6	$3,055,464.9
North Kansas City	0.010	401,000	748.81	-	-	$0.0
	0.008	424,690	749.85	-	-	$0.0
	0.004	472,071	751.92	20.2	12.3	$1,508,634.0
	0.002	530,000	754.45	23.7	15.7	$1,771,241.8
	0.001	590,000	756.72	26.2	18.1	$1,771,241.8
Fairfax-Jersey Cr.	0.010	287,000	751.53	-	-	$0.0
	0.008	299,260	752.75	-	-	$0.0
	0.004	323,781	755.20	18.9	10.4	$1,991,027.2
	0.002	348,000	757.61	22.4	13.9	$2,353,429.9
	0.001	390,000	760.09	24.8	16.5	$2,353,429.9
Total for Phase 1 Units	0.010					$1,095,946.61
	0.008					$1,342,244.7
	0.004					$5,176,363.7
	0.002					$7,642,466.8
	0.001					$9,129,915.6

* Based on lowest structure
** Data to be finalized in Phase 2
Some data is truncated by HEC-FDA.

Table 18 Physical Damages by Category for Selected Exceedance Probability Events

Damage Category	Existing Condition (2002) Physical Damages (Oct 2004 prices, $000)				
	.01 exceedance probability	.008 exxceedance probability	.004 exceedance probability	.002 exceedance probability	.001 exceedance probability
Argentine					
Commercial	$507,133.3	$621,104.2	$775,869.8	$783,498.9	$783,498.9
Crop	$0.0	$0.0	$0.0	$0.0	$0.0
Industrial	$488,534.6	$598,325.7	$747,415.2	$754,764.7	$754,764.7
Public	$78,342.7	$95,949.1	$119,857.6	$121,036.1	$121,036.1
Residential	$21,936.0	$26,865.8	$33,560.1	$33,890.1	$33,890.1
Total	$1,095,946.61	$1,342,244.7	$1,676,702.5	$1,693,190.0	$1,693,190.0
Armourdale*					
Commercial	TBD	TBD	TBD	TBD	TBD
Crop	0	0	0	0	0
Industrial	TBD	TBD	TBD	TBD	TBD
Public	TBD	TBD	TBD	TBD	TBD
Residential	TBD	TBD	TBD	TBD	TBD
Total	TBD	TBD	TBD	TBD	TBD
CID (KS R flooding)*					
Commercial	TBD	TBD	TBD	TBD	TBD
Crop	0	0	0	0	0
Industrial	TBD	TBD	TBD	TBD	TBD
Public	TBD	TBD	TBD	TBD	TBD
Residential	TBD	TBD	TBD	TBD	TBD
Total	TBD	TBD	TBD	TBD	TBD
Birmingham					
Commercial	$0	$0	$0.0	$0.0	$175,707.7
Crop	$0	$0	$0.0	$0.0	$417.4
Industrial	$0	$0	$0.0	$0.0	$27,852.6
Public	$0	$0	$0.0	$0.0	$16,027.0
Residential	$0	$0	$0.0	$0.0	$36,584.2
Total	$0	$0	$0.0	$0.0	$256,589.0
East Bottoms					
Commercial	$0	$0	$0.0	$422.079.1	$706,809.3
Crop	$0	$0	$0.0	$0.0	$0.0
Industrial	$0	$0	$0.0	$1,228,416.6	$2,057,093.8
Public	$0	$0	$0.0	$169,800.9	$284,.346.8
Residential	$0	$0	$0.0	$4,308.5	$7,215.0
Total	$0	$0	$0.0	$1,824,605.1	$3,055,464.9
North Kansas City					
Commercial	$0	$0	$473,749.4	$556,214.9	$556,214.9
Crop	$0	$0	$0.0	$0.0	$0.0
Industrial	$0	$0	$803,792.6	$943,708.7	$943,708.7
Public	$0	$0	$136,012.0	$159,687.6	$159,687.6
Residential	$0	$0	$95,080.0	$111,630.5	$111,630.5
Total	$0	$0	$1,508,634.0	$1,771,241.8	$1,771,241.8
Fairfax-Jersey Cr.					
Commercial	$0	$0	$79,758.2	$94,275.6	$94,275.6
Crop	$0	$0	$0.0	$0.0	$0.0
Industrial	$0	$0	$1,854,074.1	$2,191,548.9	$2,191,548.9.6
Public	$0	$0	$57,194.9	$67,605.4	$67,605.4
Residential	$0	$0	$0.0	$0.0	$0.0
Total	$0	$0	$1,991,027.2	$2,353,429.9	$2,353,429.9
Total for Phase 1 Units					
Commercial	$507,133.3	$621,104.2	$1,329,377.2	$1,856,068.6	$2,316,506.5
Crop	$0.0	$0.0	$0.0	$0.0	$369.7
Industrial	$488,534.6	$598,325.7	$3,405,281.9	$5,118,439.0	$5,974,968.8
Public	$78,342.7	$95,949.1	$313,064.5	$518,130.1	$648,703.0
Residential	$21,936.0	$26,865.8	$128,640.1	$149,829.28	$189,319.9
Total	$1,095,946.61	$1,342,244.7	$5,176,363.7	$7,642,466.8	$9,129,915.6

*Data for these units will be provided in the final report.
Any discrepancies due to rounding
Some data is truncated by HEC-FDA.

Table 19 Number of Structures/Groups of Structures Affected by Selected Events

Damage Category	Existing Condition (2002)			
	.01 exceedance probability	.004 exceedance probability	.002 exceedance probability	.001 exceedance probability
Argentine				
Commercial	206	207	207	207
Industrial	61	62	62	62
Public	38	38	38	38
Residential	377	386	405	413
Total	682	693	712	720
Armourdale *				
Commercial	TBD	TBD	TBD	TBD
Industrial	TBD	TBD	TBD	TBD
Public	TBD	TBD	TBD	TBD
Residential	TBD	TBD	TBD	TBD
Total	TBD	TBD	TBD	TBD
CID (KS R flooding) *				
Commercial	TBD	TBD	TBD	TBD
Industrial	TBD	TBD	TBD	TBD
Public	TBD	TBD	TBD	TBD
Residential	TBD	TBD	TBD	TBD
Total	TBD	TBD	TBD	TBD
Birmingham				
Commercial	0	0	0	21
Industrial	0	0	0	25
Public	0	0	0	1
Residential	0	0	0	155
Total	0	0	0	202
East Bottoms				
Commercial	0	0	256	257
Industrial	0	0	209	209
Public	0	0	21	24
Residential	0	0	247	247
Total	0	0	733	737
North Kansas City				
Commercial	0	194	195	195
Industrial	0	279	279	279
Public	0	105	105	105
Residential	0	1,078	1,078	1,078
Total	0	1,656	1,657	1,657
Fairfax-Jersey Cr.				
Commercial	0	30	31	31
Industrial	0	236	240	256
Public	0	51	53	53
Residential	0	0	0	0
Total	0	317	324	340
Total for Phase 1 Units				
Commercial	206	431	689	711
Industrial	61	577	790	831
Public	38	194	217	221
Residential	377	1,464	1,730	1,893
Total	682	2,666	3,426	3,656

* Data to be determined during Phase 2

3.5.4.4 Expected Annual Physical Damages for the Existing Condition

The HEC-FDA program was used to calculate (with risk and uncertainty) the expected annual physical damages for the existing condition. Table 20 provides a detailed breakdown of the existing condition expected annual physical damages by category for each levee unit and for the total study area.

Table 20 Existing Condition Expected Annual Physical Damages

	Existing Condition Expected Annual Physical Damages (Oct 2004 Prices, $000)					
Levee Unit	Commercial	Industrial	Public	Residential	Crop	Total
Argentine	$8600.8	$8,284.5	$1,328.5	$372.0	$0.00	$18,585.0
Armourdale*	TBD	TBD	TBD	TBD	TBD	TBD
CID (KS R. flooding) *	TBD	TBD	TBD	TBD	TBD	TBD
Birmingham	$315.1	$49.9	$28.7	$65.6	$0.7	$460.1
East Bottoms	$1,421.6	$4,137.4	$571.9	$14.5	$0.00	$6,145.4
North Kansas City	$2,882.9	$4,981.8	$816.9	$926.7	$0.00	$9.608.3
Fairfax	$559.8	$13,013.1	$401.4	$0.0	$0.00	$13,974.3
Total, Phase 1 Units	$13,799.3	$30,466.9	$3,147.5	$1,378.8	$0.7	$48,773.2

*To be determined for the final report.

3.6 Non-Physical Costs of Flooding

Reduction of the physical damages described above would be the basis for the benefits of a project in each levee unit in the study area. Although not included in the damages shown in the above table, benefits of providing additional flood protection in the study area would also include avoidance of other costs, such as emergency costs, floodplain relocation and reoccupation costs, and clean-up costs. When compared with the actual physical flood damages prevented, these may be more minor benefit categories. However, for purposes of the study, we estimated costs and benefits for emergency, relocation and reoccupation, clean-up, and traffic disruption categories.

3.6.1 Assumptions and Methodologies

3.6.1.1 Cleanup Costs

Based on data obtained from studies and approved reports by other Corps Districts, cleanup costs, with levee overtopping and approximately a 0.2% event in each of the Kansas Citys levee units, were estimated at 2 percent of total investment in structures and contents. Estimated cleanup costs for each levee unit were entered into the HEC-FDA study file, along with an appropriate depth-damage relationship, for integration with the hydrologic data and to determine annual cleanup costs incurred in each unit over the period of analysis.

3.6.1.2 Emergency Costs and Floodplain Relocation/Reoccupation Costs

These other costs of flooding are much more difficult to determine and estimate than physical flood damages. In the Kansas Citys study area, actual study area historical data about these types of costs are neither readily available nor easily estimated because the last damaging flood event in any of the study area units was in 1951. However, we estimated emergency costs for the study area units based on an evaluation of actual data collected about the 1993 flood along the Missouri and Mississippi Rivers. Several Corps published reports about the 1993 flood were researched in detail to obtain estimates of typical emergency costs in Missouri. These reports included the *1993 Interagency Floodplain Management Review Committee Report* (Galloway Report); *Impacts of the Great Flood of 1993*, U.S. Army Corps of Engineers Lower Mississippi Valley Division, May 1996; and the *Flood Plain Management Assessment of the Upper Mississippi River and Lower Missouri Rivers and Tributaries,* U. S. Army Corps of Engineers June 1995. We specifically compared 1993 flood damages with 1993 agency emergency costs as reported in these documents. The 1993 emergency cost category data included the following: Federal Emergency Management Agency disaster administrative costs (costs of temporary disaster field offices and temporary hires, but not including costs for permanent administrative staff or permanent office and equipment costs), Department of Health and

Human Services 1993 flood disaster costs, Corps flood emergency and emergency operations costs, and Environmental Protection Agency 1993 flood costs relative to underground storage tanks, oil spill response, and Abatement, Control, Compliance program operations. Based on the data provided in the reports, emergency costs, as a percent of total physical flood damages, ranged from a low of 12.4% to a high of 15%, with an average of 13.4% for all States impacted by the 1993 flood. We assumed that the 1993 flood data were typical for a flood event of that magnitude (approximately a 0.2% probability event) and that the data provided an historical basis for estimating these types of costs that could be incurred in the Kansas Citys highly developed urban study area for a flood event of similar magnitude. For the Kansas Citys feasibility study, emergency costs were estimated at 13 percent of primary damages for a 0.2% event. This percentage is similar to the average percentage described above for all States impacted in the 1993 flood and is also similar to the percentage used to estimate these costs in the Corps Pearl River Study. We did not obtain or include data about emergency costs for local police and emergency services. Estimated emergency costs for a 0.2% event were entered into the HEC-FDA study file for each levee unit area as the maximum emergency costs that could be incurred, and a depth percent damage relationship was applied in the HEC-FDA model to estimate emergency costs for other probability events. The equivalent annual emergency costs incurred over the period of analysis were computed in HEC-FDA. The depth percent damage relationship was developed as follows. First study area primary damages resulting from various probability events were computed as a percentage of the estimated 0.2% probability event primary damages in the study area. Each resulting percentage was then paired with the average flood depth in the study area flooded units for each probability event in order to develop a depth-percent damage relationship. Thus emergency costs estimated to be incurred for any exceedance probability event would be approximately 13% of the primary physical damages for that specific exceedance probability event.

Based on our research, the 1993 emergency costs described above included hazardous and toxic waste type clean-up costs, but in our opinion, did not include normal business and residential cleanup costs or relocation and reoccupation costs for floodplain residents. Relocation and reoccupation costs (and cleanup costs to a certain extent) were included in a different category identified as "disaster relief" in the 1993 flood data published in the three reports cited above. This disaster relief category reported all government human resource disaster relief payments. However, in our evaluation of the 1993 data, we determined that the 1993 disaster relief category data overlapped somewhat with actual physical flood damages and use of that data would result in the potential for double counting. Thus, estimates of costs for relocation and reoccupation of floodplains were instead obtained from extensive interviews with Federal Emergency Management Agency (FEMA) officials and published FEMA data for recent Missouri declared disasters, including the 1993 flood in Missouri. FEMA estimates were based on monies provided for disaster housing assistance and individual and family grant assistance. Estimated FEMA assistance per disaster per housing unit ranged from a low of $5,500 to a high of nearly $16,000, and an estimated average of $7,500 per housing unit. The average cost per housing unit was applied to the number of housing units in each of the Kansas Citys levee unit areas for use in this study as an estimate of relocation and reoccupation of floodplain costs that occur with floods of the magnitude of the 1993 event. This average value per housing unit was also comparable to a value computed per vulnerable residence in the floodplain based on information and data for Missouri counties provided in the *1993 Interagency Floodplain Management Review Committee Report* noted above. Relocation

and reoccupation costs for non-residential occupants (commercial, industrial, public) were not estimated and were not included in the analysis.

3.6.1.3 Traffic Disruption Costs

Flooding or even the threat of flooding and public safety concerns may cause road closures and detouring of traffic. Traffic detours can last for the duration of actual flooding plus the time required for road cleanup and road repairs. As described in *National Economic Development Procedures Manual-Urban Flood Damage*, IWR Report 88-R-2, March 1988, the costs of traffic disruption are based on the vehicle operating costs for the additional miles traveled because of the detour, and on traffic delay costs per passenger. Lowest point elevations for major routes in each unit were compared with levee unit overtopping elevations and flood event interior stages with overtopping to determine which roads would be closed and by which flood events. Kansas City District Hydrology and Hydraulics Section staff made estimates of flood durations for various events, and further durations of potential road closures were estimated for cleanup and repair activities. Daily traffic counts for major roads and highways that would likely be closed in the event of levee failure/overtopping were obtained from Missouri and Kansas State Transportation Departments, together with estimates of the number of trucks versus cars in the count. The average number of passengers per vehicle was determined based on an urban weighted average (1.42 persons) provided in a Kansas Department of Transportation study. Detour routes were measured and compared with mileage for the non-disrupted route to determine the additional miles that would be traveled with the detour. Additional operating costs per mile were estimated at $0.375 for cars and $0.625 for trucks. Additional time to travel the detour was computed based on an estimated detour route speed limit and distance compared with the non-disrupted route speed limit and distance. The published average local wage rate for the metropolitan area of $16.56 was used for truck drivers and one-third of the average local wage rate was used for adult car passengers. Estimated traffic disruption costs for each unit were entered into the HEC-FDA study file, and integrated with the hydrologic data, to determine estimated annual traffic disruption costs during the period of analysis.

3.6.2 Summary of Estimated Non-Physical Costs of Flooding

Table 21 summarizes the existing condition estimated annual non-physical costs of flooding.

Table 21 Non-Physical Costs of Flooding

	Existing Condition Expected Annual Non-Physical Costs of Flooding (Oct 2004 Prices, $000)					
Levee Unit	**Clean-up**	**Emergency & Relocation/ Reoccupation**	**Traffic Disruption**	**Total Non-Physical Costs of Flooding**	**As a % of Physical Damages**	**As a % of Total Damages (Physical + Non-Physical)**
Argentine	$465.9	$2,480.6	$9.5	$2,956.0	16%	14%
Armourdale*	TBD	TBD	TBD	TBD	TBD	TBD
CID (KS R. flooding) *	TBD	TBD	TBD	TBD	TBD	TBD
CID (MO R. flooding) *	TBD	TBD	TBD	TBD	TBD	TBD
Birmingham	$10.7	$49.0	$2.7	$62.4	14%	12%
East Bottoms	$133.0	$628.5	$16.8	$778.2	13%	11%
North Kansas City	$292.6	$1,337.6	$31.3	$1,661.5	18%	15%
Fairfax	$297.1	$1,599.3	$4.0	$1,900.4	14%	12%
Totals, Phase 1 Units	$1,199.3	$6,095.0	$64.3	$7,358.5	15%	13%

*Data to be determined in Phase 2.

3.7 Damages to Sewers and Levees

Damages to, and cleaning of, sewer systems ($millions) in each of the levee unit areas and damages to the levees/floodwalls themselves would occur with major flood and storm events. Although significant, these damages have not been accounted for in the analysis due to the difficulty of documenting and relating the damages to various flood events, and also due to the difficulty of determining how an increase in the performance of the Federal system would change the level of damages under the with project condition.

3.8 Existing Condition Engineering Performance

3.8.1 Hydraulic Considerations

How well a Federal flood control project performs is indicated by the probability of the top of the levee/floodwall project being exceeded in a certain number of years. For each levee unit, the elevation at the lowest point on the levee/floodwall was translated to a corresponding elevation at the index point location for each reach based on the water surface profiles in order to derive the "adjusted top of levee elevation" at the index point. (The reach index point is used to aggregate the stage damage relationships for the different categories of investment in the reach at a common location.)

For each levee unit, Table 22 below displays the existing condition adjusted top of levee/floodwall elevation at each reach index point, the water surface elevations associated with selected flood frequency events, and the existing condition reliability against overtopping for the specified events.

Table 22 Comparison of Top of Levee Elevations with Selected Flood Frequency Event Elevations, Existing Condition

Levee Unit	Reach Index Point (River Mile)	Adjusted Top of Levee Elevation at Index Point	Water Surface Profile Elevation		Existing Condition Unit Margin Against Overtopping (TOL minus specified event water surface profile elev.)		Conditional Probability of Design Containing 1% Overtopping Event
			1% Event	0.2% Event	1% Event	0.2% Event	
Kansas River:							
Argentine	9.65	776.0	769.61	778.24	6.4	-2.2	.91
Armourdale*	5.2	772.1*	765.00	773.63	TBD	TBD	TBD
CID*	1.4	760.8*	755.52	761.53	TBD	TBD	TBD
Missouri River:							
CID*	367.10	758.9*	750.96	756.95	TBD	TBD	TBD
Birmingham	355.95	743.0	736.72	741.18	6.3	1.8	.99
East Bottoms	357.63	746.3	738.26	742.63	8.0	3.7	.999
North Kansas City	365.82	755.5	748.81	754.45	6.7	1.0	.98
Fairfax-Jersey Cr.	367.70	760.5	751.53	757.61	9.0	2.9	.99**

* Data for Armourdale and CID are preliminary and subject to change in the final feasibility report.
** Overtopping reliability shown for Fairfax-Jersey Creek Unit assumes a successful flood fight at lower tieback and at JC outlet.

3.8.2 Geotechnical and Structural Considerations

In addition to the top of levee elevation, geotechnical and structural probabilities of failure below the top of levee/floodwall elevation must also be considered. Existing older levees and floodwalls may have deteriorated and can no longer be assumed to hold water to the stage initially intended. Geotechnical and structural engineers determined the most likely expected modes and sites of failure prior to overtopping in each Unit. A full range of conditional probabilities of failure versus river stage elevation encompassing the probable failure point (PFP) and probable non-failure point (PNP) were determined by geotechnical and structural engineer PDT members for each site/mode of failure in each Unit, in accordance with existing guidance. The probability of failure versus exterior stage relationships developed for major features and/or sites that were considered to have high

probability of failure were then translated to the index point of each reach, and each individual potential failure site/mode was determined to be independent. The probabilities of failure for each site/mode were then combined using a formula contained in ETL-1110-2-556, Risk-Based Analyses for Geotechnical Engineering for Support of Planning Studies, to derive a single combined probability of failure versus river stage curve that accounted for all sites or modes of potential failure (Formula: Pr(f)=1-(1-p1)(1-p2) . . .(1-pn)). The resulting combined probability of failure versus river stage curve was entered into the HEC-FDA study file in the "Levee Features" section. Attachment 2 to this appendix contains Reliability Analysis Flowcharts for the Argentine, Fairfax-Jersey Creek, North Kansas City, East Bottoms, and Birmingham Units. The flowcharts depict the probabilities of geotechnical and structural failure by site or feature and how they were incorporated into the analyses. Table 23 displays the existing condition potential failure sites/modes for each Unit addressed in the interim feasibility report and the probable failure point and probable non-failure point for each site/mode of failure.

Table 23 Existing Condition Potential Failure Sites/Modes

		EXISTING CONDITION POTENTIAL FAILURE SITES/MODES			
UNIT/Potential Structural and Geotechnical Failure Site/Mode	**Existing Top of Levee Elevation (ft msl, at index point)**	**Probability of Geotech/Struc Failure at Levee overtopping point**	**PFP (elev, ft msl)**	**PNP (elev, ft msl)**	**Consequences of Potential Structural and Geotechnical Failure**
ARGENTINE	776.0				
Levee Embankment		0.317	776.0 (TOL)	775.2	Unit will flood
Floodwall		0.006	776.0 (TOL)	776.0 (TOL)	Unit will flood
Strong Ave Pump Station		0.919	775.2	767.6	Unit will flood
Argentine Pump Station		0.953	774.8	767.3	Unit will flood
Argentine Unit **Combined** Probability of Failure		0.997	772.75	766.74	Unit will flood
FAIRFAX-JERSEY CREEK	760.5				
JC Sheetpile Wall		0.400	760.5 (TOL)	751.7	Unit will flood
BPU Floodwall		0.961	760.1	758.6	Unit will flood
Lower Tieback (floodfight)		0.329	760.5 (TOL)	759.5	Unit will flood
JC Outlet (floodfight)		0.086	760.5 (TOL)	760.5 (TOL)	Unit will flood
Fairfax-JC Unit **Combined** Probability of Failure		0.986	759.82	751.71	Unit will flood
NORTH KANSAS CITY	755.5				
Harlem Underseepage Site		0.423	755.5 (TOL)	750.7	Unit will flood
National Starch Underseepage Site		0.351	755.5 (TOL)	752.4	Unit will flood
North Kansas City Unit **Combined** Probability of Failure		0.625	755.5 (TOL)	750.0	Unit will flood
EAST BOTTOMS	746.3				
Blue R. Confluence Underseepage Site		0.197	746.3 (TOL)	744.3	Unit will flood
Floodwall Sta 64+48 to 74+56		0.044	746.3 (TOL)	746.3 (TOL)	Unit will flood
East Bottoms Unit **Combined** Probability of Failure		0.232	746.3 (TOL)	744.2	Unit will flood

3.8.3 Annual Overall Performance and Equivalent Long-term Risk of the Existing Project

For each levee unit, Table 24 shows the likelihood of overtopping or failure of the existing levee. The annual probability (probability in any given year) that flooding will occur is shown , as is the long-term risk or probability of the target stage/top of project being exceeded in a 10-, 25-, and 50-year period (including geotechnical and structural failure considerations).

Table 24 Annual Overall Performance and Equivalent Long-Term Risk, Existing Condition 2002

Levee Unit	Top of Levee/ Floodwall Elevation (feet) (at index point)	Annual Performance (Expected Annual Probability of Design Being Exceeded)	Equivalent Long-Term Risk (Probability of Exceedance Over the Indicated Time Period		
			10 Years	25 Years	50 Years
Argentine	776.0	.013	.125	.284	.487
Armourdale*	772.1	TBD	TBD	TBD	TBD
CID (KS R.)*	760.8	TBD	TBD	TBD	TBD
CID (MO R.)* (PRELIMINARY)	758.9	TBD	TBD	TBD	TBD
Birmingham	743.0	.002	.015	.037	.072
East Bottoms	746.3	.002	.024	.059	.115
North Kansas City	755.5	.005	.053	.128	.240
Fairfax-Jersey Cr.	760.5	.007	.064	.152	.281

* Data to be determined in Phase 2.

3.8.4 Alternative Display of Annual Performance and Equivalent Long-Term Risk of the Existing Project

An alternative way of displaying long term risk is presented in Table 25. Both annual performance (flooding in any given year) and long-term risk over several years as specified are stated in terms of the chance of the design being exceeded (flooding).

Table 25 Alternative Display of Annual Performance and Equivalent Long-term Risk, Existing Condition 2002

			Equivalent Long-Term Risk (Chance of Design Being Exceeded Over the Indicated Time Period)		
Levee Unit	**Top of Levee/ Floodwall Elevation (feet) (at index point)**	**Annual Performance (Chance of Exceedance (flooding) in any Given Year)**	**10 Years**	**25 Years**	**50 Years**
Argentine	776.0	1 in 76.9	1 in 8.0	1 in 3.5	1 in 2.1
Armourdale*	772.1	TBD	TBD	TBD	TBD
CID (KS R.)*	760.8	TBD	TBD	TBD	TBD
CID (MO R.)*	758.9	TBD	TBD	TBD	TBD
Birmingham	743.0	1 in 500	1 in 66.7	1 in 27.0	1 in 13.9
East Bottoms	746.3	1 in 500	1 in 41.7	1 in 16.9	1 in 8.7
North Kansas City	755.5	1 in 200	1 in 18.9	1 in 7.8	1 in 4.2
Fairfax-Jersey Cr.	760.5	1 in 142.9	1 in 15.6	1 in 6.6	1 in 3.6

*Data to be determined in Phase 2.

3.8.5 Conditional Probability of Design Non-Exceedance.

Table 26 on the following page describes the performance of each levee unit existing design for the 1% exceedance probability event, one criteria currently used in levee certification. It shows the probability that the target stage associated with each unit

(top of levee elevation) will not be exceeded, given the occurrence of the 1% exceedance probability event.

Table 26 Conditional Probability of Design Non-Exceedance, Existing Condition 2002

Levee Unit	Top of Levee/Floodwall Elevation (at index point)	Conditional Probability of Design Containing 1% Exceedance Probability Event
Argentine	776.0	0.49
Armourdale*	771.2	TBD
CID (KS R.)*	760.8	TBD
CID (MO R.)*	758.9	TBD
Birmingham	743.0	0.99
East Bottoms	746.3	0.96
North Kansas City	755.5	0.85
Fairfax-Jersey Cr.	760.5	0.82

*Preliminary, subject to change in final report

3.9 Future Without-Project Condition

3.9.1 Changes from the Existing Condition

3.9.1.1 Changes in Economic Investment

Future without-project condition damages in the base year (2012) are expected to be greater in certain levee units than for the existing condition because of recent and ongoing changes in investment. In the North Kansas City Unit, substantial changes in investment have taken place since the existing condition analysis was completed. Older, lower value, residential structures have been razed. New, higher value, residential and commercial structures have been and are being constructed in the same area. Specific data about the proposed and newly constructed structures were obtained from local city officials and media coverage. The future without project condition structure inventory was updated to account for the increased levels of development in the levee unit. In the CID Unit, interviews with officers of the CID Association, data from CID Association newsletters, and telephone interviews with business owners, provided data about new development in the CID that has recently occurred or is planned within the next 2-3 years. The City has already accomplished major infrastructure improvements in the CID Unit. Local news articles indicate that this area is anticipated to be the next "artist loft areas". Based on this information, data and values for specific structures in the CID inventory were updated to reflect the specific expansion and growth already in place or proposed for the next 2-3 years. Other than the changes noted above, no further changes in economic investment were projected for the future condition year 2035.

3.9.1.2 Hydraulic Changes

Future condition profiles were determined to be the same as existing condition profiles, with the exception of any impacts from the recently completed Missouri River Levee System L-385 Federal Levee. The L-385 project, on the opposite bank of the Missouri River and just upstream of the Fairfax-Jersey Creek Unit, was determined to have minimal effect on future condition profiles (2012 and 2035) in the Kansas Citys study area. Some very slight variations in profiles occurred in the very far upstream portion of the Kansas Citys study area, and these were accounted for in the Kansas Citys future condition profiles. It should be noted that uncertainties about river stage, however, were increased from 1.5 feet used for the existing and base year future conditions (2002 and 2012) to 1.8 feet in 2035. Based on existing information, it was assumed that any potential for stage

trends would be alleviated by notching of dikes and other work under the ongoing Missouri River Mitigation project.

3.9.2 Future Without-Project Condition Damages

Table 27 provides a comparison of damages for the existing condition and damages for the future without-project condition that include the changes in economic investment and river hydraulics as described above. The primary damages shown in the table were developed in consideration of all uncertainties (economic and engineering). Economic uncertainties are the uncertainties about structure elevation, structure and content values, and depth-percent damage relationships. Engineering uncertainties are the uncertainties about stage-discharge relationships and exceedance probability-discharge relationships.

Table 27 Comparison of Existing and Future Without Project Physical Damages and Other Costs of Flooding By Selected Exceedance Probability Event (risk and uncertainty included) (Oct 2004 Prices).

Levee Unit	Existing Condition 2002			Future Without Project Condition 2012 (base year)			Future Without Project Condition 2035 (future year)		
Exceedance Probability	Discharge (cfs)	Stage (ft)	Damage ($000)	Discharge (cfs)	Stage (ft)	Damage ($000)	Discharge (cfs)	Stage (ft)	Damage ($000)
Argentine									
0.010	241,000	769.61	$1,270,340.0	241,000	769.61	$1,270,340.0	241,000	769.61	$1,285,050.0
0.004	296,623	774.41	$1,943,510.0	296,623	774.41	$1,943,510.0	296,623	774.41	$1,949,340.01
0.002	341,000	778.24	$1,962,620.0	341,000	778.24	$1,962,620.0	341,000	778.24	$1,962,620.0
0.001	388,000	782.86	$1,962,620.0	388,000	782.86	$1,962,620.0	388,000	782.86	$1,962,620.0
Armourdale*									
0.010	241,000	765.00	TBD	241,000	765.00	TBD	241,000	765.00	TBD
0.004	296,623	769.80	TBD	296,623	769.80	TBD	296,623	769.80	TBD
0.002	341,000	773.63	TBD	341,000	773.63	TBD	341,000	773.63	TBD
0.001	388,000	778.45	TBD	388,000	778.45	TBD	388,000	778.45	TBD
CID (KS R. Flooding)*									
0.010	241,000	755.52	TBD	241,000	755.52	TBD	241,000	755.52	TBD
0.004	296,623	758.86	TBD	296,623	758.86	TBD	296,623	758.86	TBD
0.002	341,000	761.53	TBD	341,000	761.53	TBD	341,000	761.53	TBD
0.001	369,000	764.96	TBD	369,000	764.96	TBD	369,000	764.96	TBD
Birmingham									
0.010	405,000	736.72	$0	405,000	736.72	$0	405,000	736.72	$0
0.004	477,531	739.17	$0	477,531	739.17	$0	477,531	739.17	$0
0.002	537,000	741.18	$0	537,000	741.18	$0	537,000	741.18	$0
0.001	600,000	742.90	$291,388.0	600,000	742.90	$291,388.0	600,000	742.90	$291,388.0
East Bottoms									
0.010	401,000	738.26	$0	401,000	738.26	$0	401,000	738.26	$0
0.004	472,071	740.67	$0	472,071	740.67	$0	472,071	740.67	$0
0.002	530,000	742.63	$2,053,860.0	530,000	742.63	$2,053,860.0	530,000	742.63	$2,225,380.0
0.001	590,000	744.37	$3,439,370.0	590,000	744.37	$3,439,370.0	590,000	744.37	$3,439,370.0
North Kansas City									
0.010	401,000	748.81	$0	401,000	748.81	$0	401,000	748.81	$0
0.004	472,071	751.92	$1,786,590.0	472,071	751.92	$1,882,950.0	472,071	751.92	$1,903,850.0
0.002	530,000	754.45	$2,097,580.0	530,000	754.45	$2,203,750.0	530,000	754.45	$2,203,750.0
0.001	590,000	756.72	$2,097,580.0	590,000	756.72	$2,203,750.0	590,000	756.72	$2,203,750.0
Fairfax-Jersey Creek									
0.010	287,000	751.53	$0	287,000	751.53	$0	287,000	751.53	$0
0.004	323,781	755.20	$2,260,170.0	323,781	755.20	$2,260,170.0	323,781	755.20	$2,300,330.0
0.002	348,000	757.61	$2,671,560.0	348,000	757.61	$2,671,560.0	348,000	757.61	$2,671,480.0
0.001	390,000	760.09	$2,671,560.0	390,000	760.09	$2,671,560.0	390,000	760.09	$2,671,480.0

* Data to be determined in Phase 2.

Note: Primary damages have in many instances been truncated by HEC-FDA.

3.9.3 Future Without-Project Condition Annual Damages

Future without-project condition annual damages are summarized in Table 28. Physical damages and other costs of flooding are displayed separately and are also characterized as a percent of total damages.

Table 28 Future Without-Project Condition Annual Damages

(Oct 2004 Prices, 5.375% Interest, $000)

Levee Unit and Analysis Year	Physical Damages	Other Costs of Flooding	Total Annual Damages	Physical Damages as a % of Total	Other Costs of Flooding as a % of Total
ARGENTINE					
Expected Ann Dmg—2012	$18,585.0	$2,956.0	$21,541.1	86%	14%
Expected Ann Dmg—2035	$18,804.6	$2,990.5	$21,795.1	86%	14%
Equivalent Ann Dmg—50 yr pd of analysis	$18,701.9	$2,974.4	$21,676.2	86%	14%
ARMOURDALE					
Expected Ann Dmg—2012	TBD	TBD	TBD	TBD	TBD
Expected Ann Dmg—2035	TBD	TBD	TBD	TBD	TBD
Equivalent Ann Dmg—50 yr pd of analysis	TBD	TBD	TBD	TBD	TBD
CID (KS R. flooding)					
Expected Ann Dmg—2012	TBD	TBD	TBD	TBD	TBD
Expected Ann Dmg—2035	TBD	TBD	TBD	TBD	TBD
Equivalent Ann Dmg—50 yr pd of analysis	TBD	TBD	TBD	TBD	TBD
CID (MO R. flooding)					
Expected Ann Dmg—2012	TBD	TBD	TBD	TBD	TBD
Expected Ann Dmg—2035	TBD	TBD	TBD	TBD	TBD
Equivalent Ann Dmg—50 yr pd of analysis	TBD	TBD	TBD	TBD	TBD
BIRMINGHAM					
Expected Ann Dmg—2012	$460.1	$62.4	$522.5	88%	12%
Expected Ann Dmg—2035	$483.0	$65.7	$548.7	88%	12%
Equivalent Ann Dmg—50 yr pd of analysis	$472.3	$64.1	$536.4	88%	12%
EAST BOTTOMS					
Expected Ann Dmg—2012	$6,145.4	$778.2	$6,923.6	89%	11%
Expected Ann Dmg—2035	$6,484.9	$827.2	$7,312.1	89%	11%
Equivalent Ann Dmg—50 yr pd of analysis	$6,326.1	$804.3	$7,130.4	89%	11%
NORTH KANSAS CITY					
Expected Ann Dmg—2012	$9,608.3	$1,661.5	$11,269.9	85%	15%
Expected Ann Dmg—2035	$9,872.4	$1,707.2	$11,579.6	85%	15%
Equivalent Ann Dmg—50 yr pd of analysis	$9,748.8	$1,685.8	$11,434.7	85%	15%
FAIRFAX-JERSEY CR.					
Expected Ann Dmg—2012	$13,974.3	$1,900.4	$15,874.7	88%	12%
Expected Ann Dmg—2035	$14,318.9	$1,949.1	$16,268.0	88%	12%
Equivalent Ann Dmg—50 yr pd of analysis	$14,157.7	$1,926.3	$16,084.0	88%	12%
Study Area Totals					
Expected Ann Dmg—2012	$48,773.2	$7,358.5	$56,131.7	87%	13%
Expected Ann Dmg—2035	$49,963.9	$7,539.7	$57,503.5	87%	13%
Equivalent Ann Dmg—50 yr pd of analysis	$49,406.7	$7,454.9	$56,861.7	87%	13%

Notes: Data for Armourdale and CID will be determined for the final report.
To avoid double counting, study area totals in the final report will not include damages in CID from Missouri River flooding.

3.9.4 National Economic Development (NED) and Regional Economic Development (RED) Impacts Without Project

The benefit evaluation process involves analysis of the economic losses to the subject study area from flooding, and the potential gains to the study area from the successful prevention of flooding. Some impacts with and without a flood control project

may be of major significance to a metropolitan area or community, but may not have any net impact on the national economy. For example, if a flood interrupts production at a given business in one community, that community suffers a loss. However, if the lost production is replaced by production at another plant elsewhere in the country, the loss to the local community does not represent a net loss to the national economy. These regional (RED) impacts are not included in determining the NED benefits and costs, but do receive consideration in the decision-making process.

In the Kansas Citys study area, some major production facilities are either a sole producer of a certain product or are one of just two or a very few in the nation that produce that product. General Motors Corporation, National Starch, Proctor and Gamble are some prime examples. Loss of production capability in these instances could certainly be an economic loss to the nation unless consumers were able to find a similar product and made the choice to purchase the substitute product. However, these potential NED losses were not quantified for purposes of this study.

4.0 WITH-PROJECT CONDITION ANALYSIS

4.1 NED Analysis of Benefits and Costs

Economic costs and benefits resulting from a project are evaluated in terms of their impacts on national wealth, without regard to where in the United States the impacts may occur. National Economic Development (NED) benefits must result directly from a project and must represent net increases in the economic value of goods and services to the national economy. NED costs represent the costs of diverting resources from other uses in implementing a flood control project, as well as the costs of economic losses resulting from detrimental effects of a project. Such other detrimental effects of a project could include, for example, induced flooding in areas other than the project study area.

4.2 Residual Damages and Benefits of Screening Alternatives for Units Addressed in Interim Feasibility Report

The existing condition evaluation of each of the levee units determined that the Kansas River units (Argentine, Armourdale and CID (Kansas River flooding)) have relatively higher overtopping exceedance probabilities than the Missouri River units. Therefore, it was determined early in the plan formulation process that raise alternatives would be considered for the Kansas River units, and that with a levee/floodwall raise, any geotechnical site or structural feature with a significant probability of failure would also be included as an engineering solution in the raise alternative. Levee raise alternatives are evaluated based on traditional Corps analyses for identification of the NED plan (the plan with the highest net benefits). Since existing condition analyses indicated the Missouri units overall had relatively higher reliabilities against overtopping, it was determined that engineering solutions would be evaluated for geotechnical sites and structural features that had significant probability of failure. For this interim report, engineering solutions were evaluated for the Fairfax-Jersey Creek Unit, North Kansas City Unit and East Bottoms Unit. The Birmingham Unit reliability and performance was deemed adequate in relation to other units in the Kansas Citys flood protection system. The Birmingham unit performance currently meets planning objectives in this feasibility study, and no reliability improvements are recommended under the auspices of this study.

For the initial screening of alternatives, the future condition with- and without-project equivalent annual damages (EAD) were calculated with risk and uncertainty in the HEC-FDA program reflecting October 2004 prices, 2012 levels of investment in the study area levee units, and the FY 2005 Federal interest rate of 5.375 percent. For each Phase 1

Unit, the following sections briefly describe the screening alternatives considered. The accompanying tables display the benefits of each alternative and the with-project equivalent residual annual damages that would be expected to occur if each alternative considered were in place. Equivalent annual damages under the future without-project condition are also shown for comparison purposes.

4.2.1 Argentine Unit Alternatives

4.2.1.1 Initial Alternatives Evaluated

The existing Kansas Citys levees along the Kansas River are the result of a 1962 modification of the original levee designs. That modification was completed due to the 1951 Kansas River flood and the overtopping of the Argentine, Armourdale, and CID Units. Since the 1951 flood, the left and right overbanks and accreted land areas along the reach extending from river mile 3.5 to the upstream end of the Argentine Unit have become overgrown with mature trees. The riparian acreage reduces the conveyance capacity of the Kansas River from the 1962 design. The alternative of removing all of the trees in the Argentine, Armourdale and CID Unit reaches of the Kansas River was investigated early in the study to determine the potential for reducing water surface profiles by restoring the Kansas River channel to a condition similar to that on which the 1962 modifications were based. HEC-RAS computer modeling was used to estimate the effectiveness of tree removal on the hydraulics of the Kansas River. With tree removal, conveyance capacity is improved with about a 0.6 foot reduction in water surface profiles in the Argentine Unit reach, about 0.3 foot reduction in the Armourdale reach, and about a 0.1 foot reduction in the CID Unit reach. A combination of tree removal and channel modification was also considered. This combination would provide more conveyance capacity than just removing trees. Water surface profiles would be reduced by about 1.4 feet, 0.5 feet, and 0.1 feet respectively in the Argentine, Armourdale, and CID Unit reaches. Alternatives based on tree removal and channel modification were screened out early in the study because of the somewhat limited effect on conveyance capacity improvement and because tree removal would adversely impact riparian habitat availability along the Lower Kansas River. Conversely, however, preservation and retention of the riparian habitat necessitates higher structural alternative raises than would be necessary if the trees were not on the foreshore.

Three levee raise alternatives were also evaluated for the Argentine Unit. The existing top of levee/floodwall (TOL) at the Argentine index point is at elevation 776.0. Argentine Alternative 1 is a "nominal 500-year + 0 foot" raise; TOL elevation would increase to 778.24. Argentine Alternative 2 is a "nominal 500-year + 3 feet" raise, with a TOL elevation of 781.24 at the index point. Argentine Alternative 3 is a "nominal 500-year + 5 feet" raise; TOL elevation would increase to 783.24. An alternative with pump station improvements and earthwork, but with no levee raise, was also evaluated for the Argentine Unit (Argentine Alternative 4).

4.2.1.2 Argentine Unit Residual Damages and Benefits

Residual damages and benefits in the Argentine Unit for each of the alternatives evaluated are displayed in Table 29 on the following page.

Table 29 Argentine Unit Equivalent Annual Flood Damage Reduction Benefits and Residual Damages With and Without Project

(October 2004 Prices, 5.375% Interest Rate, 50 year Period of Analysis, $000)

Argentine Unit Alternative	Annual Physical Flood Damages in Argentine Unit With- and Without-Project	Other Costs of Flooding in Argentine Unit With- and Without Project (Annual)	Total Annual Physical Flood Damages and Other Costs of Flooding/Residual Damages in Argentine Unit	Total Benefits in Argentine Unit (Reduction in Annual Physical Flood Damages and Other Costs of Flooding)
Future Without Project	$18,701.9	$2,974.4	$21,676.2	NA
Remove Trees	$17,792.4	$2,809.2	$20,601.6	$1,074.6
Remove Trees and Channel Modification	$15,395.3	$2,396.0	$17,791.3	$3,885.0
Arg Alt 1 Nom 500 yr+0 ft Raise	$5,127.7	$896.0	$6,023.7	$15,652.6
Arg Alt 2 Nom 500 yr+3 ft Raise	$3,428.0	$610.4	$4,038.4	$17,637.8
Arg Alt 3 Nom 500 yr+5 ft Raise	$2,580.3	$460.5	$3,040.8	$18,635.5
Arg Alt 4 No Raise, Pump Sta Remedies & Earthwork	$7,066.2	$1,167.0	$8,233.2	$13,443.0

Note: Any discrepancies due to rounding

4.2.2 Fairfax-Jersey Creek Unit Alternatives, Residual Damages, and Benefits

In the existing condition evaluation for the Fairfax-Jersey Creek Unit, one structural feature (Board of Public Utilities floodwall) in the upper portion of the unit at or near R.M. 373.8 was determined to have a significant probability of structural failure. Additionally, one site, near the Jersey Creek sheetpile wall and wharf area in the lower portion of the unit at approximately R.M. 367.7, was determined to have a significant probability of geotechnical failure. Failure at either of these two sites would cause flooding in the entire Fairfax-Jersey Creek Unit. A flood fight at either of these two sites offers no guarantees of success and necessarily incurs tremendous costs for emergency services and floodplain evacuation. Because of the massive level of industrial, commercial, public and other investment located in the Fairfax-Jersey Creek Unit, the potential for the entire unit to flood if the levee/floodwall were undercut or failed, and the resulting massive damages that would occur in the unit, it was determined early on that a flood fight alternative was not an acceptable or viable alternative.

Two engineering solutions were evaluated for the BPU floodwall. Alternative 1 is a buttressed or "modified" wall alternative that would add an additional row of auger cast piles on the landward side of the pile cap. Alternative 2 is a "combination" wall alternative that consists of a new floodwall landside of the existing floodwall, which would tie into a modified existing wall at locations of utilities.

Three engineering solutions were evaluated for the Jersey Creek sheetpile wall. Alternative 2 is a new channel closed cell sheet pile wall constructed landside of the existing wall. Alternative 3 is a new channel wall using auger cast piles placed on the landside of the existing sheetpile wall, and tiebacks. Alternative 4 is a new channel wall using open cell technology and placed landside of the existing wall. A flood fight alternative (Alternative 1) was also considered and determined not to be practical.

Table 30 displays residual damages and benefits in the Fairfax-Jersey Creek Unit for each alternative considered.

Table 30 Fairfax-Jersey Creek Unit Equivalent Annual Benefits and Residual Damages With and Without Project

(October 2004 Prices, 5.375% Interest Rate, 50 year Period of Analysis, $000)

Fairfax-Jersey Cr Unit Alternative	Annual Physical Flood Damages in Fairfax-Jersey Cr Unit	Other Costs of Flooding in Fairfax-Jersey Cr Unit (Annual)	Total Annual Damages/Residual Damages in Fairfax-Jersey Cr Unit	Total Benefits in Fairfax-Jersey Cr Unit
Future Without Project	$14,157.7	$1,926.3	$16,084.0	NA
BPU Alt 1, Modified Wall (Add'l Row of Piles & Buttresses)*	$13,532.0	$1,832.1	$15,364.1	$719.9
BPU Alt 2, Combo Wall*	$13,532.0	$1,832.1	$15,364.1	$719.9
JC Alt 2, New Closed Cell Sheetpile Wall**	$4,925.9	$746.7	$5,672.6	$10,411.4
JC Alt 3, New Wall, Auger Cast Piles & Tiebacks**	$4,925.9	$746.7	$5,672.6	$10,411.4
JC Alt 4, New Open Cell Sheetpile Wall**	$4,925.9	$746.7	$5,672.6	$10,411.4
FAIRFAX-JC TOTAL PLAN: BPU Floodwall Solution AND JC Sheetpile Wall Solution	$3,836.0	$580.2	$4,416.2	$11,667.8

* With BPU Floodwall alternatives residual risk remains at the Jersey Creek Sheetpile Wall.
** With JC Sheetpile Wall alternatives, residual risk remains at the BPU Floodwall.

4.2.3 North Kansas City Unit Alternatives, Residual Damages, and Benefits

Two sites in the North Kansas City Unit (Harlem and National Starch) were determined, in the existing condition analyses, to have significant probabilities of geotechnical failure due to underseepage. Failure at either of these two sites would cause flooding in the entire North Kansas City Unit. A flood fight at either of these two sites offers no guarantees of success and necessarily incurs tremendous costs for emergency services and floodplain evacuation. Because of the massive level of industrial, commercial, public and residential investment located in the North Kansas City Unit, the potential for the entire unit to flood if the levee/floodwall were undercut or failed, and the resulting massive damages that would occur in the unit, it was determined early on that a flood fight alternative was not an acceptable or viable alternative.

For the Harlem site, three engineered solutions were evaluated. Alternative 2 is construction of a landside seepage berm to control underseepage during flooding. With this alternative, modification or relocation costs for structures and utilities would be high, and this plan would also require relocation of businesses and homes. These costs are not included in the cost estimate for this alternative. Alternative 3 is a buried collector system. Alternative 4 consists of installation of pressure relief wells.

Based on the knowledge gained in the detailed formulation and analyses of the most cost effective engineering solutions for the Harlem site, one engineering solution was developed for the National Starch site, a pressure relief well system. Table 31 on the following page summarizes total residual damages and benefits in the North Kansas City Unit with implementation of the North Kansas City Unit alternatives.

Table 31 North Kansas City Unit Equivalent Annual Benefits and Residual Damages With and Without Project

(October 2004 Prices, 5.375% Interest Rate, 50 year Period of Analysis, $000)

North Kansas City Unit Alternative	Annual Physical Flood Damages in North Kansas City Unit	Other Costs of Flooding in North Kansas City Unit (Annual)	Total Annual Damages/Residual Damages in North Kansas City Unit	Total Benefits in North Kansas City Unit
Future Without Project	$9,748.8	$1,685.8	$11,434.7	NA
Harlem Alt 2, Landside Seepage Berm*	$6,526.0	$1,127.3	$7,653.3	$3,781.4
Harlem Alt 3, Buried Collector System*	$6,526.0	$1,127.3	$7,653.3	$3,781.4
Harlem Alt 4, Pressure Relief Wells*	$6,526.0	$1,127.3	$7,653.3	$3,781.4
National Starch Alt 1, Relief Well System**	$8,336.6	$1,440.4	$9,777.0	$1,657.6
NKC Unit TOTAL PLAN: Harlem Site Solution AND National Starch Site Solution	$4,070.1	$700.7	$4,770.8	$6,663.9

* With Harlem site solutions, residual risk remains at the National Starch site.
** With National Starch site solutions, residual risk remains at the Harlem site.

4.2.4 East Bottoms Unit Alternatives, Residual Damages, and Benefits

Existing condition analysis determined that one site in the East Bottoms Unit, near the Missouri river and Blue River confluence, has a significant probability of geotechnical failure due to underseepage concerns. Four alternatives were considered to control underseepage during flood events at the Bayer site. Alternative 1, flood fight, was considered not practical because of the massive level of industrial, commercial, public and residential investment located in the East Bottoms Unit, the potential for the entire unit to flood if the levee/floodwall were undercut or failed, and the resulting massive damages that would occur in the unit. Alternative 2 is a sheet pile wall, Alternative 3 is a slurry cut-off wall, and Alternative 4 is installation of pressure relief wells. The table below summarizes the residual damages and benefits in the East Bottoms that would result with implementation of each East Bottoms Unit alternative considered.

Table 32 East Bottoms Unit Equivalent Annual Benefits and Residual Damages With and Without Project

(October 2004 Prices, 5.375% Interest Rate, 50 year Period of Analysis, $000)

East Bottoms Unit Alternative	Annual Physical Flood Damages in East Bottoms Unit	Other Costs of Flooding in East Bottoms Unit (Annual)	Total Annual Damages/Residual Damages in East Bottoms Unit	Total Benefits in East Bottoms Unit
Future Without Project	$6,326.1	$804.3	$7,130.4	NA
EB-Blue R. Confluence Site Alt 2, Sheetpile Wall	$2,521.7	$376.0	$2,897.7	$4,232.7
EB-Blue R. Confluence Site, Alt 3, Slurry Cut-Off Wall	$2,521.7	$376.0	$2,897.7	$4,232.7
EB-Blue R. Confluence Site, Alt 4, Pressure Relief Wells	$2,521.7	$376.0	$2,897.7	$4,232.7

4.3 Costs of Screening Alternatives for the Interim Feasibility Report Units

4.3.1 Annual Project Costs

Screening cost estimates (Oct 2004 price level) and estimated construction periods for each of the alternatives were provided by the Cost Engineering and Specifications Section, Design Branch, Kansas City District, with input from other Product Development Team (PDT) members. Interest during construction (IDC) for each alternative was

calculated based on the total first cost for each alternative, the starting and completion dates for each phase, assumed equal monthly expenditures during each phase, and the FY05 Federal interest rate of 5.375 percent. Ongoing Federal funding issues were not considered in the starting and completion dates of the phases; appropriate funding was assumed available for each phase. Total first cost for each alternative includes the estimated construction cost, cost for lands, easements and rights of way, preliminary engineering and design cost, supervision and administration cost, and contingencies. Interest during construction calculated for each alternative was then added to the total first cost to derive the economic cost of each alternative. The economic cost was then annualized based on a 50-year life and a 5.375% interest rate.

4.3.2 Annual OMRR&R Costs

The Costs for operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) were estimated in October 2004 prices for each alternative and are based on a life cycle cost analysis. The analyses include only the new additional OMRR&R costs that the sponsors would be expected to incur based on the new proposed unit modifications. The analyses considered and accounted for the new additional OMRR&R in each year of occurrence, and then computed a present worth value of the future OMRR&R costs. The present worth value was then annualized using a Federal Interest Rate of 5.375% and a 50 year period of analysis.

Following is a description of the assumptions used in determining the new additional OMRR&R costs that the Sponsors would be responsible for with each alternative.

New Relief Wells: Each new well is assumed to be maintained every 4 years at an estimated cost of $5,000 per well. New wells are assumed to be replaced after 40 years; the replacement cost includes 10% E&D and 7% S&A. The Sponsor would continue to incur costs for any existing relief wells but these costs are ongoing for the existing project and are not included in the analysis of the proposed project.

New Buried Collector System: It was assumed that the new buried collector pipe would be flushed every 25 years, and that this would require a 2 man crew and approximately 3 days, plus equipment cost.

New Pump Plant: It was assumed that pumps in a new pump plant will be serviced every 10 years.

The Kansas Citys Units are well-maintained levee and floodwall units and the Sponsors comply with annual inspection requirements. The current OMRR&R costs that the Sponsors currently typically incur for the existing project in each unit will continue.

4.3.3 Other Direct Costs of Implementation

4.3.3.1 Induced Damages

Implementation of the three Argentine raise alternatives would temporarily increase the potential for induced physical flood damages in the Armourdale and CID Units if certain very rare flood events were to occur. These potential damages in the Armourdale and CID Units are deemed temporary in nature because they could occur only in the interim period between completion of the Argentine Unit raise and before construction is completed for similar raises for the Armourdale and CID Units. Evaluation of raise alternatives for the Armourdale and CID units will be completed for the Kansas Citys final report. Potential induced damages in the Armourdale and CID Units result from the rare flood events and flood stages that occur above the existing top of levee elevations in these units, and would be incurred beginning with about a 300 year, or more rare, event. If a 300 year or greater flood event would occur in the interim time period before completion of

any Armourdale and CID Unit raises, the Argentine Unit raise alternatives would increase profiles and flood depths by approximately 6 inches or less in the Armourdale and CID Units. With a 300 year event, structures in the Armourdale and CID Units would already be inundated with maximum flood depths (based on lowest structure elevation) of more than 21 feet and average flood depths (average for all structures) of about 15 feet in the Armourdale Unit and nearly 7 feet in the CID Unit. Induced flooding would add an additional 6 inches or less of flood depth on these structures.

The Argentine raise alternatives, during occurrence of rare flood events, would also induce six inches or less of additional flood depth in low-lying unleveed areas on both sides of the river just upstream of the Argentine and Armourdale Units and in another small unleveed area (approximately 4 residences impacted) near the 7th Street bridge, across from the Armourdale Unit. These areas are unprotected and would already be inundated with high flood depths before any induced flooding resulting from an Argentine Unit raise would begin to occur.

Although the induced damages upstream and downstream of the Argentine Unit are not considered a "taking", nevertheless they are included in the economic analysis of each raise alternative as a direct cost of implementation.

Argentine Alternative 4 (No Raise) does not induce any damages elsewhere, and has no other direct costs of implementation. Implementation of the Argentine Unit raise alternatives does not impact the Missouri River Units (Fairfax-Jersey Creek, North Kansas City, East Bottoms and Birmingham), and residual damages in those Missouri River Units would remain the same as for the future without project condition in those units.

Implementation of the engineering solutions proposed for the Missouri River Units (Fairfax-Jersey Creek, North Kansas City, and East Bottoms) would not induce any damages elsewhere.

4.3.3.2 Impacts to Existing Facilities

Implementing the raise alternatives (Argentine Alternatives 1, 2 and 3) will also necessitate two existing privately owned pump station facilities to incur costs for removing existing discharge piping, replacing with slightly larger pipes in order to maintain existing pumping capacity, and placing the new pipes up and over the new levee. The estimated cost for relocating the discharge piping for these two facilities over the new levee ($156,000 at October 2004 prices) was annualized based on the 50 year period of analysis and 5.375% interest rate.

Solutions identified for the other Phase I units (Missouri River Units) do not affect existing facilities, have negligible potential to impact the operation and maintenance of existing facilities, and no other direct costs of implementation have been identified.

Table 33 on the following page summarizes the other direct costs of implementing each of the Argentine Unit alternatives.

Table 33 Other Direct Costs of Implementing Argentine Unit Alternatives

(October 2004 Prices, 5.375% Interest Rate, 50 year Period of Analysis, $000)

Alternative	Annual Benefits in the Argentine Unit	Annual Induced Physical Damages in Other Areas				Argentine Unit Private Pump Station Facility Costs (Annual)	Total Other Direct Costs of Implementation of Argentine Unit Alternatives (Annual)
		Downstream, Armourdale Unit (Temporary)	Downstream, CID Unit (Temporary)	Upstream Areas, Small Area Across from Armourdale Unit	Total		
Argentine Alt 1, Nominal 500+0 Raise	$15,652.6	$160.6	$24.6	$2.1	$187.3	$9.1	$196.4
Argentine Alt 2, Nominal 500+3 Raise	$17,637.8	$171.7	$27.4	$2.6	$201.7	$9.1	$210.8
Argentine Alt 3, Nominal 500+5 Raise	$18,635.5	$175.2	$27.8	$2.9	$205.9	$9.1	$215.0
Argentine Alt 4, No Raise, Pump Sta Remedies & Earthwork	$13,443.0	$0	$0	$0	$0	$0	$0

4.3.4 Total Annual Costs

The total annual cost of each alternative that will be compared with the benefits of the project is the sum of the annual economic cost, the increase in annual OMRR&R cost, and the other direct costs of the project (induced damages and private pump station facility costs). Table 34 on the following page provides a detailed breakdown of costs for the alternatives considered. Project costs for removing trees and the combination of removing trees with channel modification in the Kansas River reaches were not estimated because it was determined early in the screening process that these alternatives impacted riparian habitat in the Kansas River corridor in exchange for somewhat limited improvements in conveyance capacity.

4.4 Summary of Economic Screening of Alternatives Considered for Units Addressed in the Interim Feasibility Report

Table 35 displays a summary of total annual costs (including increases in OMRR&R costs, induced damages, and other direct implementation costs), annual benefits, residual damages, and net benefits for each of the Phase 1 alternatives evaluated. For the Fairfax-Jersey Creek Unit and the North Kansas City Unit, the data is also presented for the combination of the least cost solutions for each separable site or feature. The benefit/cost ratio which includes consideration of induced damages and other direct costs, and the net benefits for the alternatives considered are also shown.

Table 34 Detailed Cost Breakdown for Screening Alternatives for Units Addressed in Interim Report

(October 2004 Prices, 5.375% Interest, 50-yr Period of Analysis, $000)

Levee Unit Alternative	Project First Cost	Interest During Constr.	Project Economic Cost	Annual Economic Cost	Increase in Annual OMRR&R Cost	Other Annual Direct Costs	Total Annual Cost
ARGENTINE UNIT							
Arg 1, nominal 500+0 Raise	$30,372.0	$3,026.0	$33,398.0	$1,936.4	$12.2	$196.4	$2,145.0
Arg 2, nominal 500+3 Raise	$52,568.0	$5,888.0	$58,456.0	$3,389.3	$12.2	$210.8	$3,612.3
Arg 3, nominal 500+5 Raise	$65,964.0	$7,279.0	$73,243.0	$4,246.7	$49.6	$215.0	$4,511.3
Arg 4, No Raise, Pump Sta Remedies & Earthwork	$15,598.0	$815.0	$16,413.0	$951.6	$12.2	-	$963.8
FAIRFAX-JC UNIT							
BPU Floodwall Solution							
Alt 1, Modified Wall (Add'lRow of Piles)	$ 7,109.0	$ 550.8	$ 7,659.8	$ 444.1	$ 2.0	-	$ 446.1
Alt 2, Combo Wall	$ 7,500.0	$ 583.0	$ 8,083.0	$ 468.7	$ 2.0	-	$ 470.7
JC Sheetpile Wall Solution							
Alt 1, Flood Fight*	(See Note)					-	
Alt 2, New Channel Closed Cell Sheetpile Wall	$ 10,866.0	$ 607.3	$ 11,473.3	$ 665.2	$ 2.0	-	$ 667.2
Alt 3, New Channel Wall, Auger Cast Piles & Tiebacks	$ 9,629.0	$ 538.1	$ 10,167.1	$ 589.5	$ 2.0	-	$ 591.5
Alt 4, New Channel Wall, Open Cell Technology	$ 8,575.0	$ 479.2	$ 9,054.2	$ 525.0	$ 2.0	-	$ 527.0
NORTH KANSAS CITY UNIT							
Harlem Site Solution							
Alt 1, Flood Fight*	(See Note)						
Alt 2, Landside Seepage Berm	$ 5,910.0	$ 616.4	$ 6,526.4	$ 378.4	$ 1.0	-	$ 379.4**
Alt 3, Buried Collector System	$ 1,455.0	$ 68.0	$ 1,523.0	$ 88.3	$ 1.5	-	$ 89.8
Alt 4, Pressure Relief Wells	$ 1,992.0	$ 81.0	$ 2,073.0	$ 120.2	$25.8	-	$ 146.0
National Starch Site Solution							
Alt 1, Relief Well System	$ 7,063.0	$ 479.5	$ 7,542.5	$ 437.3	$31.8	-	$ 469.1
EAST BOTTOMS UNIT							
Blue R Confl. Site Solution							
Alt 1 Flood Fight*	(See Note)						
Alt 2 Sheetpile Wall	$12,849.0	$ 390.0	$13,239.0	$ 767.6	$ 2.0	-	$ 769.6
Alt 3 Slurry Cut-Off Wall	$ 3,416.0	$ 106.8	$ 3,522.8	$ 204.3	$ 2.0	-	$ 206.3
Alt 4 Pressure Relief Wells	$ 1,346.0	$ 50.7	$ 1,396.7	$ 81.0	$24.8	-	$ 105.8

Notes:

* The true costs of a flood fight alternative are difficult to determine. A flood fight offers no guarantees of success and necessarily incurs tremendous costs for emergency services and floodplain evacuation. Because of the massive level of industrial, commercial, public and other investment located in the Kansas Citys levee units, the potential for an entire unit to flood if the levee/floodwall were undercut or failed, and the resulting massive damages that would occur in the unit, it is unlikely that a flood fight alternative would be considered an acceptable and viable alternative to be carried forward for further refinement. Therefore, no efforts at this time have been undertaken to adequately document the true costs of a flood fight alternative.

**Harlem Site Alt 2 Landside Seepage Berm does not include costs for relocating residents or utilities relocations.

Table 35 Screening Summary With-Project Annual Benefits, Costs, and Net Benefits, Interim Report Alternatives

(October 2004 Prices, 5.375% Interest Rate, 50 Year Period of Analysis, $000)

Levee Unit Alternative	Total Annual Costs of Project *	Annual Benefits	Residual Damages	B/C Ratio	Net Benefits
ARGENTINE					
Arg 1, nominal 500+0 Raise	$2,145.0	$15,652.6	$6,023.7	7.3	$13,507.6
Arg 2, nominal 500+3 Raise	$3,612.3	$17,637.8	$4,038.4	4.9	$14,025.5
Arg 3, nominal 500+5 Raise	$4,511.3	$18,635.5	$3,040.8	4.1	$14,124.2
Arg 4, No Raise, Pump Sta Remedies & Earthwork	$963.8	$13,443.0	$8,233.2	13.9	$12,479.2
FAIRFAX-JERSEY CR					
BPU Floodwall Solutions					
Alt 1, Modified Wall (Add'l Row of Piles)	$446.1	$719.9	$15,364.1	1.6	$273.8
Alt 2, Combo Wall	$470.7	$719.9	$15,364.1	1.5	$249.2
JC Sheetpile Wall Solutions					
Alt 2, New Channel Closed Cell Sheetpile Wall	$667.2	$10,411.4	$5,672.6	15.6	$9,744.2
Alt 3, New Channel Wall, Auger Cast Piles & Tiebacks	$591.5	$10,441.4	$5,672.6	17.6	$9,819.9
Alt 4, New Channel Wall, Open Cell Technology	$527.0	$10,441.4	$5,672.6	19.8	$9,884.4
FAIRFAX-JC UNIT TOTAL PROJECT: BPU Floodwall Solution (Alt 1) AND JC Sheetpile Wall Solution (Alt 4) **	$973.1	$11,667.8	$4,416.2	12.0	$10,694.7
NORTH KANSAS CITY					
Harlem Site Solutions					
Alt 2, Landside Seepage Berm	$379.4	$3,781.4	$7,653.3	10.0	$3,402.0
Alt 3, Buried Collector System	$89.8	$3,781.4	$7,653.3	42.1	$3,691.6
Alt 4, Pressure Relief Wells	$146.0	$3,781.4	$7,653.3	25.9	$3,635.4
Nat'l Starch Site Solutions					
Alt 1, Relief Well System	$469.1	$1,657.6	$9,777.0	3.5	$1,188.5
NKC UNIT TOTAL PROJECT: Harlem Site Solution (Alt 3) and Nat'l Starch Site Solution (Alt 1)**	$558.9	$6,663.9	$4,770.8	11.9	$6,105.0
EAST BOTTOMS					
Blue R. Confluence Site Solutions					
Alt 2 Sheetpile Wall	$769.6	$4,232.7	$2,897.7	5.5	$3,463.1
Alt 3 Slurry Cut-Off Wall	$206.3	$4,232.7	$2,897.7	20.5	$4,026.4
Alt 4 Pressure Relief Wells	$105.8	$4,232.7	$2,897.7	40.0	$4,126.9

Notes:

* Includes PED, LERRD, Construction, Interest During Construction, increased OMRR&R cost due to implementation of proposed project, induced damages, and other direct costs due to implementation of the project; assumes appropriate operation and maintenance of the existing project by the local sponsor will continue..

** Total plan for Fairfax-JC and North Kansas City Units is based on least cost engineering solutions for each site/separable feature.

4.5 Economic Performance of Alternatives Considered

The economic performance and effectiveness of the final array of alternatives in each Unit are compared in Table 36 on the following page. The table displays the expected value and probabilistic values of equivalent annual damage (EAD) and EAD reduced, thus showing the impact of uncertainty in evaluation of project benefits. The damages reduced represent the project benefits, and are shown in terms of annualized equivalent values as computed in the HEC-FDA program.

Table 36 Economic Performance of Alternatives

Oct 2004 Prices, 5.375% Interest Rate, 50 Year Period of Analysis, $000

Plan	Top of Levee/ Floodwall Elev (ft)	Expected Value and Probabilistic Values of EAD and EAD Reduced					
		Equivalent Annual Damage			Probability EAD Reduced Exceeds Indicated Amount		
		Without Plan	With Plan	Damage Reduced	.75	.50	.25
ARGENTINE UNIT							
Fut Without Project	776.00	$21,676.2	-	-	-	-	-
Alt 1 Nom 500+0	778.24		$6,023.7	$15,652.6	$6,998.2	$12,846.2	$21,234.1
Alt 2 Nom 500+3	781.24		$4,038.4	$17,637.8	$7,627.3	$14,236.8	$23,924.5
Alt 3 Nom 500+5	783.24		$3,040.8	$18,635.5	$7,986.0	$14,845.3	$25,306.3
Alt 4 No Raise, Pump Sta Remedies & Earthwork	776.00		$8,233.2	$13,443.0	$6,320.6	$11,111.9	$18,174.1
FAIRFAX-JERSEY CREEK UNIT							
Fut Without Project	760.5	$16,084.0	-	-	-	-	-
BPU Floodwall – All Solutions	760.5		$15,364.1	$719.9	$85.1	$377.3	$1,030.5
JC Sheetpile Wall – All Solutions	760.5		$5,672.6	$10,411.4	$3,878.5	$7,757.2	$14,390.9
Total Fairfax-Jersey Cr Unit Plan (BPU Floodwall and JC Sheetpile Wall)	760.5		$4,416.2	$11,667.8	$4,122.1	$8,386.6	$16,052.4
NORTH KANSAS CITY UNIT							
Fut Without Project	755.5	$11,434.7	-	-	-	-	-
Harlem Site –All Solutions	755.5		$7,653.3	$3,781.4	$1,416.0	$3,050.9	$5,212.4
National Starch Site Solution	755.5		$9,777.0	$1,657.6	$587.6	$1,316.4	$2,278.3
Total North Kansas City Unit Plan (Harlem Site and Nat'l Starch Site)	755.5		$4,770.8	$6,663.9	$2,778.7	$5,003.0	$8,519.7
EAST BOTTOMS UNIT							
Fut Without Project	746.3	$7,130.4	-	-	-	-	-
East Bottoms Unit Blue R. Confluence Site — All Solutions	746.3		$2,897.7	$4,232.7	$1,959.7	$2,886.8	$4,991.1

4.6 Engineering Performance of Alternatives Considered

How well a Federal flood control project performs is indicated by the probability of the top of levee/floodwall project being exceeded in a certain number of years.

4.6.1 Annual Performance and Equivalent Long-term Risk for Alternatives Considered

Long-term risk indicates how successfully the project would protect against flooding given the uncertainties and over a long period of time. Table 37 shows for the without-project condition and for each alternative considered the long term risk or probability of the target stage/top of project being exceeded in a 10-, 25-, and 50-year period.

Table 37 Annual Performance and Equivalent Long-term Risk

Plan	Top of Levee/ Floodwall Elevation (ft)	Annual Performance (Expected Annual Probability of Design Being Exceeded) Year 2012	Equivalent Long-term Risk (Probability of Exceedance Over the Indicated Time Period)		
			10 Years	25 Years	50 Years
ARGENTINE UNIT					
Future Without Project	776.00	.013	.125	.284	.487
Remove Trees	776.00	.013	.119	.271	.469
Remove Trees and Channel Modification	776.00	.011	.1026	.237	.418
Alt 1 Nom 500+0	778.24	.003	.030	.074	.142
Alt 2 Nom 500+3	781.24	.002	.019	.048	.093
Alt 3 Nom 500+5	783.24	.001	.013	.033	.064
Alt 4 No Raise, Pump Sta Remedies & Earthwork	776.00	.004	.042	.103	.195
FAIRFAX-JERSEY CREEK UNIT					
Future Without Project	760.50	.007	.064	.152	.281
BPU Floodwall –All Solutions	760.50	.006	.061	.147	.272
JC Sheetpile Wall -- All Solutions	760.50	.002	.018	.044	.086
Total Fairfax-Jersey Cr Unit Plan (BPU Floodwall and JC Sheetpile Wall)	760.50	.001	.013	.032	.062
NORTH KANSAS CITY UNIT					
Future Without Project	755.50	.005	.053	.128	.240
Harlem Site –All Solutions	755.50	.003	.034	.082	.158
National Starch Site Solution	755.50	.005	.045	.109	.206
Total North Kansas City Unit Plan (Harlem Site and Nat'l Starch Site)	755.50	.001	.011	.027	.054
EAST BOTTOMS UNIT					
Future Without Project	746.30	.002	.024	.059	.115
East Bottoms Unit Blue R. Confluence Site —All Solutions	746.30	.0003	.003	.008	.017

4.6.2 Conditional Probability of Design Non-Exceedance for Alternatives Considered

Table 38 on the following page shows the probability that the target stage (levee) associated with each plan will not be exceeded, given the occurrence of the 1% exceedance probability event.

Table 38 Conditional Probability of Design Non-Exceedance

Plan	Top of Levee/ Floodwall Elev (ft)	Conditional Probability of Design Containing 1% Exceedance Probability Event (Yr 2012)
ARGENTINE UNIT		
Future Without Project	776.00	.49
Remove Trees	776.00	.51
Remove Trees and Channel Modification	776.00	.58
Alt 1 Nom 500+0	778.24	.95
Alt 2 Nom 500+3	781.24	.99
Alt 3 Nom 500+5	783.24	.99
Alt 4 No Raise, Pump Sta Remedies & Earthwork	776.00	.90
FAIRFAX-JERSEY CREEK UNIT		
Future Without Project	760.50	.82
BPU Floodwall –All Solutions	760.50	.82
JC Sheetpile Wall -- All Solutions	760.50	.98
Total Fairfax-Jersey Cr Unit Plan (BPU Floodwall and JC Sheetpile Wall)	760.50	.99
NORTH KANSAS CITY UNIT		
Future Without Project	755.50	.85
Harlem Site –All Solutions	755.50	.93
National Starch Site Solution	755.50	.88
Total North Kansas City Unit Plan (Harlem Site and Nat'l Starch Site)	755.50	.98
EAST BOTTOMS UNIT		
Future Without Project	746.30	.96
East Bottoms Unit Blue R. Confluence Site —All Solutions	746.30	1.00

4.7 RED Impacts With Project

Construction of any of the alternatives considered would contribute to the long term stability of each of the Units in which a plan is implemented. Plans considered do not require acquisition or relocation of residents or businesses. There would be no impacts to the local tax bases due to demolition or removal of structures. With increased levee unit reliability and performance, existing businesses would be expected to continue their existing occupancy in each Unit and new businesses and investment would be more easily attracted to the Unit in the future if vacancies occur, resulting in a stronger tax base. With continued industrial and commercial stability enhanced by the increased reliability against flooding, existing neighborhoods and populations would also be expected to remain relatively stable, barring impacts from other sources. Temporary increases in employment would be expected during construction. The temporary presence of construction workers for the project may bring a temporary increase in demand for some services in the local area, but also a temporary increase in business volume, profits, and sales tax receipts at the local retail and service establishments.

5.0 NED PLAN FOR EACH UNIT ADDRESSED IN THE INTERIM FEASIBILITY REPORT

The National Economic Development (NED) plan is the scale of alternative that reasonably maximizes expected net NED benefits. Net NED benefits are the difference between the NED benefits and the NED costs. The plan with the highest net benefits (not necessarily the highest benefit-cost ratio) is considered the NED plan, assuming technical feasibility, environmental soundness, and public acceptability. Per current guidance, if two plans have similar net benefits, the less costly plan is considered to be the NED plan. This guidance is applied to the Argentine Unit raise alternatives, and is the basis for selecting Argentine Alternative 2, Nominal 500+3 Raise, as the Argentine Unit NED alternative. Based on the economic screening of the array of alternatives for each Phase 1 Unit, as

shown in Table 35 above, Table 39 below displays the NED plan annual costs, benefits, net benefits and residual damages by Unit.

Table 39 NED Plan and Summary of Benefits, Costs, and Residual Damages for Each Unit Addressed in the Interim Feasibility Report

October 2004 prices, 5.375% Interest Rate, 50 year Period of Analysis

	ARGENTINE	FAIRFAX-JERSEY CREEK	NORTH KANSAS CITY	EAST BOTTOMS
NED Plan:	Alt. 2 Nominal 500+3 foot Raise	BPU Floodwall Alt 1 Modified Wall and JC Sheetpile Wall Alt 4, New Open Cell Wall	Harlem Site Alt 3, Buried Collector System and National Starch Site Alt 1, Relief Well System	Alt 4, Pressure Relief Wells
New Top of Levee Elevation (at index point)	781.24	No Change	No Change	No Change
Reliability against 1% event	0.99	0.99	0.98	0.998
Project First Cost	$52,568.0	$15,684.0	$8,518.0	$1,346.0
Interest During Construction	$5,888.0	$1,030.0	$547.5	$50.7
Project Economic Cost	$58,456.0	$16,714.0	$9,065.5	$1,396.7
Annualized Project Economic Cost	$3,389.3	$969.1	$525.6	$81.0
Estimated Increase in Annual OMRR&R Cost with Project Implementation	$12.2	$4.0	$33.3	$24.8
Other Direct Costs (Annual)	$210.8	$0	$0	$0
Total Annual Cost	$3,612.3	$973.1	$558.9	$105.8
Annual Benefits	$17,637.8	$11,667.8	$6,663.9	$4,232.7
Benefit/Cost Ratio	4.9	12.0	11.9	40.0
Net Benefits	$14,025.5	$10,694.7	$6,105.0	$4,126.9
Residual Damages	$4,038.4	$4,416.2	$4,770.8	$2,897.7

6.0 INCREMENTAL ANALYSES

In water resources planning, the plan that maximizes net NED benefits is the best plan from an economic perspective. To find the best plan, the economic analysis examines increments of plans or project features to determine their incremental costs and incremental benefits. Increments of plans may be, for example, increments of added levee heights or separate features that are added to the plan. Increments of plans continue to be added and evaluated as long as the incremental benefits exceed the incremental costs.

6.1 Argentine Unit Incremental Analyses

For the Argentine Unit, an incremental analysis of benefits and costs was completed for the No Raise alternative and for the three raise alternatives considered. The analysis indicates that Alternative 4, No Raise, Pump Station Remedies and Earthwork, is economically justified. The analysis also shows that raising the levee in addition to implementing the Alternative 4 pump station remedies and earthwork is justified. Each of the successive raises (Alternatives 1, 2 and 3) is incrementally justified and provides incremental benefits that exceed the incremental cost of each successive raise. Table 40 summarizes the total benefits and costs and the incremental benefits and costs of each alternative considered for the Argentine Unit. Table 41 summarizes the incremental increase in engineering performance over the without-project condition.

Table 40 Incremental Analysis of Argentine Unit Raise Alternatives

(October 2004 Prices, 5.375% Interest Rate, 50 Year Period of Analysis, $000)

	Future Without Project	Arg 4, No Raise, Pump Sta Remedies & Earthwork	Arg 1, Nom 500 + 0 Raise	Arg 2, Nom 500 + 3 Raise	Arg 3, Nom 500 + 5 Raise
Total Annual Cost (including induced damages and other direct costs)	-	$963.8	$2,145.0	$3,612.3	$4,511.3
Total Annual Benefits	-	$13,443.0	$15,652.6	$17,637.8	$18,635.5
B/C Ratio		13.9	7.3	4.9	4.1
Net Benefits	-	$12,479.2	$13,507.6	$14,025.5	$14,124.2
Annual Incremental Cost of each successive alternative	-	$963.8	$1,181.2	$1,467.3	$899.0
Incremental Benefits of each successive alternative	-	$13,443.0	$2,209.6	$1,985.2	$997.7
Incremental Benefits/ Incremental Costs	-	13.9	1.9	1.4	1.1
% Increase in annual costs over previous alternative	-	100%	123%	68%	25%
% Increase in annual benefits over previous alternative	-	100%	16%	13%	6%
% Increase in net benefits over previous alternative	-	100%	8%	4%	1%
Equivalent Annual Damages/Residual Damages	$21,676.2	$8,233.2	$6,023.7	$4,038.4	$3,040.8

Table 41 Incremental Increase in Engineering Performance With Implementation of Each Argentine Unit Alternative

Alternative/Remedy	Top of Levee/Floodwall Elevation (ft msl)	Conditional Probability of Design Containing 1% Event	Incremental Increase in Performance of each Successive Alternative Against 1% Event
Future Without Project Condition		0.49	-
Arg 4, No Raise, Pump Sta Improvements & Earthwork	776.00	0.90	0.41
Arg 1, Nom 500+0 Raise	778.24	0.95	0.05
Arg 2, Nom 500+3 Raise	781.24	0.99	0.04
Arg 3, Nom 500+5 Raise	783.24	0.99	<0.01

6.2 Fairfax-Jersey Creek Unit Incremental Analyses

The Fairfax-Jersey Creek Unit has two significant separable and independent potential failure sites, one near the BPU floodwall in the upper end of the Unit and one near the Jersey Creek sheetpile wall in the lower end of the Unit. For the incremental analyses, based on the NED plan least cost engineering solution, the benefits and costs of implementing only the BPU floodwall site solution (first added site) were determined, with the residual risk remaining at the JC sheetpile wall site. The BPU floodwall solution would provide annual benefits of nearly $720,000 at an annual cost of $446,100, with a benefit cost ratio of 1.6 and net benefits of $273,800. However, residual annual damage would total $15,364,100 because of the remaining risk at the JC sheetpile wall site. Next the incremental benefits and incremental costs (based on the least cost engineering solution) were determined for the addition of the Jersey Creek sheetpile wall solution to the plan. Adding the Jersey Creek sheetpile solution to the plan provides additional benefits of $10,947,900 at an incremental annual cost of $ $527,000, resulting in an incremental benefit-incremental cost ratio of 20.8 and an incremental increase in net benefits of

$10,420,900. Residual annual damages were significantly reduced to $4,416,200. Conversely, using incremental analysis, the benefits and costs of first improving the reliability of only the Jersey Creek sheetpile wall (first added site) were determined, with the residual risk remaining at the BPU floodwall site. This solution provided benefits of $10,411,400 at an annual cost of $527,000, and a benefit cost ratio of 19.8. Net benefits were $9,884,400 and residual damages were $5,672,600. The incremental benefits and incremental costs of adding the BPU floodwall solution to the alternative were then determined on a last added basis. The analysis showed that the incremental benefits of adding the BPU floodwall site solution to the plan ($1,256,400) were greater than the incremental annual cost ($446,100). The incremental benefit-incremental cost ratio was 2.8. Net benefits increased by $810,300 and residual damages were decreased to $4,416,200. Table 42 summarizes the economic performance of the separable feature solutions and the total plan for the Fairfax Jersey Creek Unit. For comparison the annual damages under the Future Without-Project condition are also shown.

Table 42 Economic Performance of Fairfax-Jersey Cr Unit Separable Feature Solutions and Total Plan

(October 2004 Prices, 5.375% Interest Rate, 50 Year Period of Analysis, $000)

Alt	Fairfax-JC Unit Equivalent Annual Damages/ Residual Damages	Proj First Cost	Proj Economic Cost	Total Annual Cost	Total Annual Benefits	Benefit / Cost Ratio	Net Benefits
Future Without Project	$16,084.0	-	-	-	-	-	-
BPU Floodwall Solution Only (residual risk remains at JC sheetpile wall)	$15,364.1	$7,109.0	$7,659.8	$446.1	$719.9	1.6	$273.8
JC Sheetpile Wall Solution Only (residual risk remains at BPU floodwall site)	$5,672.6	$8,575.0	$9,054.2	$527.0	$10,411.4	19.8	$9,884.4
Total Plan: BPU Floodwall Solution AND JC Sheetpile Wall Solution	$4,416.2	$15,684.0	$16,714.0	$973.1	$11,667.8	12.0	$10,694.7

Table 43 on the following page summarizes the incremental economic performance of the two separable feature solutions proposed in the Fairfax-Jersey Creek Unit.

The reliability of the Fairfax-Jersey Creek unit against flooding increases as the separable increments or solutions are added to the plan. Table 44 displays the probabilities that each solution and the total plan will contain the 1% and 0.2% events (no flood damages) and also shows the incremental increase in engineering performance as each increment or solution is added to the plan.

Table 43 Incremental Economic Performance of Fairfax-Jersey Cr Unit Separable Feature Remedies

(October 2004 Prices, 5.375% Interest Rate, 50 Year Period of Analysis, $000)

	INCREMENTAL ANALYSIS OF JC SHEETPILE WALL SITE SOLUTION	INCREMENTAL ANALYSIS OF BPU FLOODWALL SITE SOLUTION
FIRST ADDED INCREMENT:	**BPU Floodwall Remedy (least cost engineering solution)**	**JC Sheetpile Wall Remedy (least cost engineering solution)**
Total Annual Cost	$446.1	$527.0
Total Annual Benefits	$719.9	$10,411.4
Residual Annual Damage	$15,364.1	$5,672.6
Benefit-Cost Ratio	1.6	19.8
Net Benefits	$273.8	$9,884.4
NEXT ADDED INCREMENT:	**JC Sheetpile Wall Remedy (least cost engineering solution)**	**BPU Floodwall Remedy (least cost engineering solution)**
Incremental Annual Cost For Adding Last Site/Increment	$527.0	$446.1
Incremental Benefits Provided by Adding Last Site/Increment	$10,947.9	$1,256.4
Incremental Benefit/Incremental Cost Ratio	20.8	2.8
Incremental Increase in Net Benefits for Adding Last Site/Increment	$10,420.9	$810.3
Residual Damages after Adding Last Site/Increment	$4,416.2	$4,416.2

Table 44 Incremental Increase in Engineering Performance with Implementation of Each Solution and the Total Plan in the Fairfax-Jersey Creek Unit

Alternative/Remedy	Top of Levee/Floodwall Elevation (ft msl)	Conditional Probability of Design Containing 1% Event	Incremental Increase in Performance Over the Fut WO Proj Against 1% Event
Future Without Project Condition	760.5	0.82	-
BPU Floodwall Site Remedy (residual risk remains at JC Sheetpile Wall Site)	760.5	0.82	0.01
JC Sheetpile Wall Site Remedy (residual risk remains at BPU Floodwall Site)	760.5	0.98	0.16
Total Plan: BPU Floodwall Site Remedy AND JC Sheetpile Wall Site Remedy	760.5	0.99	0.17

Note: Any discrepancies due to rounding.

6.3 North Kansas City Unit Incremental Analyses

The North Kansas City Unit has two significant separable and independent potential failure sites due to underseepage, the Harlem site and the National Starch site. For the incremental analyses, based on the NED plan least cost engineering solution, the benefits and costs of implementing only the Harlem site solution (first added site) were determined, with the residual risk remaining at the National Starch site. The Harlem site solution would provide annual benefits of $3,781,400 at an annual cost of $89,800, with a benefit cost ratio of 42.1 and net benefits of $3,691,600. However, residual annual damage would total $7,653,300 because of the remaining risk at the National Starch site. Next the incremental benefits and incremental costs (based on the least cost engineering solution) were determined for the addition of the National Starch site solution to the plan. Adding the National Starch site

solution to the plan provides additional benefits of $2,882,500 at an incremental annual cost of $469,100, resulting in an incremental benefit-incremental cost ratio of 6.1 and an incremental increase in net benefits of $2,413,400. Residual annual damages were significantly reduced to $4,770,800. Conversely, the benefits and costs of first implementing the National Starch site solution (first added site) were also determined, with the residual risk remaining at the Harlem site. The National Starch solution provided benefits of $1,657,600 at an annual cost of $469,100, and a benefit cost ratio of 3.5. Net benefits were $1,188,500 and residual damages were $9,777,000. The incremental benefits and incremental costs of adding the Harlem site solution to the alternative were then determined on a last added basis. The analysis showed that the incremental benefits of adding the Harlem site solution to the plan ($5,006,300) were significantly greater than the incremental annual cost ($89,800). The incremental benefit-incremental cost ratio was 55.7. Net benefits increased by $4,916,500 and residual damages were decreased to $4,770,800. Table 45 summarizes the economic performance of the separable features and the total plan for the North Kansas City Unit. For comparison the annual damages under the Future Without-Project condition are also shown. The next table (Table 46) summarizes the incremental economic performance of the two separable feature solutions proposed in the North Kansas City Unit.

Table 45 Economic Performance of North Kansas City Unit Separable Feature Solutions and Total Plan

(October 2004 Prices, 5.375% Interest Rate, 50 Year Period of Analysis, $000)

Alt	North Kansas City Unit Equivalent Annual Damages/ Residual Damages	Proj First Cost	Proj Economic Cost	Total Annual Cost	Total Annual Benefits	Benefit/ Cost Ratio	Net Benefits
Future Without Project	$11,434.7	-	-	-	-	-	-
Harlem Site Solution Only (residual risk remains at Nat'l Starch site)	$7,653.3	$1,455.0	$1,523.0	$89.8	$3,781.4	42.1	$3,691.6
Nat'l Starch Site Solution Only (residual risk remains at Harlem Site)	$9,777.0	$7,063.0	$7,542.5	$469.1	$1,657.6	3.5	$1,188.5
Total Plan: Harlem Site Remedy AND Nat'l Starch Site Solutions	$4,770.8	$8,518.0	$9,065.5	$558.9	$6,663.9	11.9	$6,105.0

Table 46 Incremental Economic Performance of North Kansas City Unit Separable Feature Solutions

(October 2004 Prices, 5.375% Interest Rate, 50 Year Period of Analysis, $000)

	INCREMENTAL ANALYSIS OF NAT'L STARCH SITE SOLUTION	INCREMENTAL ANALYSIS OF HARLEM SITE SOLUTION
FIRST ADDED INCREMENT:	**Harlem Site Remedy (least cost engineering solution)**	**Nat'l Starch Site Remedy (least cost engineering solution)**
Total Annual Cost	$89.8	$469.1
Total Annual Benefits	$3,781.4	$1,657.6
Residual Annual Damage	$7,653.3	$9,777.0
Benefit-Cost Ratio	42.1	3.5
Net Benefits	$3,691.6	$1,188.5
NEXT ADDED INCREMENT:	**Nat'l Starch Site Remedy (least cost engineering solution)**	**Harlem Site Remedy (least cost engineering solution)**
Incremental Annual Cost For Adding Last Site/Increment	$469.1	$89.8
Incremental Benefits Provided by Adding Last Site/Increment	$2,882.5	$5,006.3
Incremental Benefit/Incremental Cost Ratio	6.1	55.7
Incremental Increase in Net Benefits for Adding Last Increment	$2,413.4	$4,916.5
Residual Damages after Adding Last Site/Increment	$4,770.8	$4,770.8

The reliability of the North Kansas City Unit against flooding increases as the separable increment solutions are added to the plan. Table 47 displays the probabilities that each solution and the total plan will contain the 1% and 0.2% events (no flood damages) and also shows the incremental increase in engineering performance as each increment or solution is added to the plan.

Table 47 Incremental Increase in Engineering Performance With Implementation of Each Remedy and the Total Plan in the North Kansas City Unit

Alternative/Remedy	Top of Levee/Floodwall Elevation (ft msl)	Conditional Probability of Design Containing 1% Event	Incremental Increase in Performance Over the Fut WO Proj Against 1% Event
Future Without Project Condition	755.5	0.85	-
Harlem Site Remedy (residual risk remains at Nat'l Starch Site)	755.5	0.93	0.08
Nat'l Starch Site Remedy (residual risk remains at Harlem Site)	755.5	0.88	0.04
Total Plan: Harlem Site Remedy AND Nat'l Starch Site Remedy	755.5	0.98	0.13

Note: Any discrepancies due to rounding

7.0 OVERALL PLAN

7.1 Project Costs of Overall Plan

7.1.1 MCACES Cost Estimates Refinements

Following identification of the recommended plans for each unit, cost estimates were refined to ensure that appropriate facilities were included in the recommended plan and that the costs are apportioned appropriately for the Federal cost shared project. For the

Argentine Unit recommended plan, a portion of the relocation costs were subsequently identified as being non-creditable relocations and not part of the cost-shared project. These non-creditable relocation costs are costs for privately owned pipes to be relocated up and over the proposed new levee, but for which there are no easements. Also included in this category are the costs for relocating discharge pipes for two private pump stations. In the Fairfax-Jersey Creek Unit, the Jersey Creek Sheetpile Wall alternative included Wharf area costs; however wharf area costs are not part of the Federal cost shared project. These non-creditable relocations costs and wharf area costs will be borne by the private owners, but are considered a direct cost of project implementation and are included in the benefit-cost analyses. The MCACES cost estimate for each recommended alternative was updated to October 2005 price levels by the Cost Engineering and Specifications Section, Design Branch, Kansas City District. Table 48 below displays the project first for the overall recommended plan at October 2005 prices.

Table 48 Summary of Project First Costs for Overall Plan

October 2005 Prices, $000

Unit/Alternative	Total First Cost of Federal Cost-Shared Project	Other Direct Costs*
Argentine Unit, Alt 2: Nom 500+3 Raise	$52,872.0	$1,898.0
Fairfax-Jersey Cr Unit		
BPU Floodwall Alt 1	$7,878.0	$0
JC Sheetpile Wall Alt 4	$4,984.0	$3,557.0
Total Fairfax-Jersey Cr Unit Plan	$12,862.0	$3,557.0
North Kansas City Unit		
Harlem Site Alt 3	$1,548.0	$0
National Starch Site Alt 1	$6,619.0	$0
Total North Kansas City Unit Plan	$8,167.0	$0
East Bottoms Unit , Alt 4	$1,645.0	$0
TOTAL OVERALL PLAN	$75,546.0	$5,455.0

*Non-creditable relocations in the Argentine Unit raise alternative and Wharf area costs in the Fairfax-JC Unit Jersey Creek Sheetpile wall alternative are not part of the Federal cost shared project; however they are accounted for in the economic analyses as Other Direct Costs of project implementation.

7.1.2 NED Costs, NER Costs, and Other Direct Costs

Although not shown separately in previous sections of this report, the Argentine Unit raises include costs for realizing the NED benefits for reduction of physical flood damages and also for realizing the NER benefits of preserving the 185 acres of well-established riparian habitat on the Kansas River foreshore in the study area. Riparian habitat of this size in such close proximity to an intensely developed urban area is relatively rare in the region and in the nation. Removing the trees and clearing the foreshore would decrease water surface profiles by about 0.6 feet near the Argentine Unit and would thus allow a lower levee/floodwall raise. However, preservation of these riparian habitat acres is considered important for the environment. Thus the raise alternatives for the Kansas River Units necessarily included the cost for an additional increment of raise equal to the difference in water surface profiles with and without the existing riparian habitat acres. The estimated cost for the additional 0.6 foot raise required in the Argentine alternatives to preserve the riparian habitat is estimated to be $1,500,000, and is considered to be the estimated cost of achieving (preserving) the NER benefits. Corresponding incremental costs (NER costs) in the Armourdale and CID units will be determined in the analyses for the final report

Other direct costs will occur with project implementation of the Argentine Unit alternatives. As discussed in a previous section, during rare flood events (.003 event and higher) some induced damages are likely to occur in areas upstream and downstream of the

Argentine Unit. As discussed in the preceding section, private companies and utilities will incur costs to relocate pipes over the new levee.

The total annual cost (including interest during construction, incremental increase in OMRR&R costs, and other direct costs) for the NED plan for each unit was then computed at the current FY 06 Federal interest rate of 5.125%. Table 49 on the following page separately displays the costs to achieve the NED benefits and NER benefits for the Argentine Unit and displays economic and other direct costs of implementing the NED plans in each Unit and for the overall plan.

Table 49 Summary of NED Cost, NER Cost, and Other Direct Costs for the NED Plan in Each Unit and for the Overall Plan

October 2005 Prices, 5.125% Interest Rate, 50 year period of analysis, $000

						Other Direct Costs (Annual)		
Unit	**Total First Cost**	**Interest During Const**	**Economic Cost**	**Annual Economic Cost**	**Annual OMRR&R Cost (Increm. Increase)**	**Non-Creditable Relocations and Other Costs***	**Induced Damages**	**Total Annual Cost**
Argentine Unit Alt 2, Nom 500+3	$52,872.0	$5,210.5	$58,082.5	$3,243.2	$12.6	$106.0	$207.2	$3,569.0
Cost For NED Benefits	$51,372.0	$5,095.8	$56,467.8	$3,153.1	$12.6	$106.0	$207.2	$3,478.9
Cost For NER Benefits	$1,500.0	$114.7	$1,614.7	$90.2	$0	**see note	**see note	$90.2
Fairfax-Jersey Cr Unit Total Plan, BPU Floodwall Alt 1 and JC Sheetpile Wall Alt4	$12,862.0	$851.1	$13,713.1	$765.7	$5.8	$198.6	$0	$970.1
North Kansas City Unit Total Plan, Harlem Site Alt 3 and Nat'l Starch Site Alt 1	$8,167.0	$433.5	$8,600.5	$480.2	$35.1	$0	$0	$515.3
East Bottoms Unit Alt 4	$1,645.0	$71.7	$1,716.7	$95.9	$25.5	$0	$0	$121.4
TOTAL OVERALL PLAN NED COSTS	$74,046.0	$6,452.1	$80,498.1	$4,494.9	$79.0	$304.6	$207.2	$5,085.7
TOTAL OVERALL PLAN NER COSTS	$1.500.0	$114.7	$1,614.7	$90.2	$0	**see note	**see note	$90.2
TOTAL OVERALL PLAN	$75,546.0	$6,566.8	$82,112.8	$4,585.0	$79.0	$304.6	$207.2	$5,175.8

NOTES: (any discrepancies due to rounding)

* For the Argentine Unit, non-creditable relocations costs include costs for relocating discharge piping and other utility piping over the levee. For the Fairfax-Jersey Cr Unit, wharf area costs are included. These costs will be borne by private entities and are not part of the Federal cost-shared project, but are accounted for in the economic analyses as Other Direct Costs.

** The 0.6 feet of raise to achieve NER benefits would cause some minor non-creditable relocations costs and some induced damages, but these have not been apportioned to NER benefits.

7.2 Overall Plan Residual Damages and Benefits

7.2.1 With-Project Exceedance Probability-Damage, Depths of Flooding and Structures Affected

Table 50, on the following page, displays river discharge, river stage, maximum structure depth, and damage that could occur with a flood event of the specified exceedance probability with implementation of the recommended plan in the Argentine, Fairfax-Jersey

Creek, North Kansas City and East Bottoms Units. There is no recommended plan for implementation in the Birmingham Unit. The number of structures that may be affected in each of the Units is also shown for each exceedance probability event.

Table 50 Exceedance Probability-Damage With Overall Recommended Plan

Exceedance Prob Event	2012 Dischg (cfs)	2012 Stage (ft)	Max Struc Depth*	Damage (2012) (Oct 05 prices, $000)	# of Struc Affected
Argentine					
.010	241,000	769.61	-	$0	0
.004	296,623	774.41	-	$0	0
.002	341,000	778.24	23.7	$991,613.0	712
.001	388,000	782.26	28.5	$1,711,029.0	720
Fairfax-Jersey Cr					
.010	287,000	751.53	-	$0	0
.004	323,781	755.20	-	$0	0
.002	348,000	757.61	-	$0	0
.001	390,000	760.09	24.8	$2,385,116.0	340
North Kansas City					
.010	401,000	748.81	-	$0	0
.004	472,071	751.92	-	$0	0
.002	530,000	754.45	23.7	$1,564,815.0	1657
.001	590,000	756.72	26.2	$1,910,938.0	1657
East Bottoms					
.010	401,000	738.26	-	$0	0
.004	472,071	740.67	-	$0	0
.002	530,000	742.63	-	$0	0
.001	590,000	744.37	-	$0	0
Birmingham					
.010	405,000	736.72	-	$0	0
.004	477,531	739.17	-	$0	0
.002	537,000	741.18	-	$0	0
.001	600,000	742.90	22.1	$254,703.0	202
Overall Plan					
.010				$0	0
.004				$0	0
.002				$2,556,428.0	2,369
.001				$6,261,786.0	2,919

*Based on lowest structure

7.2.2 Equivalent Annual Physical Damages by Category With and Without Recommended Plan in each Unit

Flooding will occur significantly less frequently with implementation of the recommended plan in each Unit, and thus equivalent annual damages are significantly reduced. Table 51 displays the with- and without-project equivalent annual physical damages by category of damage in each of the interim feasibility report units and for the overall plan. Physical damages reduced by category in each unit are also shown.

7.2.3 Equivalent Annual Non-Physical Costs of Flooding by Category With and Without Recommended Plan in each Unit

Table 52 displays the with- and without-project equivalent annual non-physical costs of flooding by category in each of the interim feasibility report units and for the overall plan. Costs of flooding reduced by category in each unit are also shown.

Table 51 Future With and Without Project Condition Equivalent Annual Physical Damages By Category in Units Addressed in Interim Feasibility Report

(Oct 2005 Prices, 5.125% Interest Rate, 50 Year Period of Analysis, $000)

	Equivalent Annual Physical Damages					
Levee Unit	**Commercial**	**Industrial**	**Public**	**Residential**	**Crop**	**Total Physical EAD**
Argentine						
Future Without Project	$8,894.2	$8,567.7	$1,373.9	$384.8	$0.0	$19,220.6
Future With Project	$1,640.6	$1,555.8	$251.3	$75.5	$0.0	$3,523.1
Physical Damage Reduced	$7,253.6	$7,011.9	$1,122.6	$309.3	$0	$15,697.5
Fairfax-Jersey Cr						
Future Without Project	$582.8	$13,551.5	$418.4	$0.0	$0.0	$14,552.7
Future With Project	$162.9	$3,643.5	$137.0	$0.0	$0.0	$3,943.4
Physical Damage Reduced	$419.9	$9,908.0	$281.4	$0.0	$0.0	$10,609.3
North Kansas City						
Future Without Project	$3,006.8	$5,196.0	$851.8	$966.5	$0.0	$10,021.2
Future With Project	$1,242.4	$2,140.3	$399.9	$400.9	$0.0	$4,183.6
Physical Damage Reduced	$1,764.4	$3,055.7	$451.9	$565.6	$0.0	$5,837.6
East Bottoms						
Future Without Project	$1,505.2	$4,374.1	$609.9	$15.4	$0.0	$6,504.5
Future With Project	$597.0	$1,655.9	$334.4	$6.2	$0.0	$2,593.6
Physical Damage Reduced	$908.2	$2,718.2	$275.5	$9.2	$0.0	$3,910.9
Total Physical EAD in these Units Without Project	$13,989.0	$31,689.3	$3,254.0	$1,366.7	$0.0	$50,299.0
Total Physical EAD in these Units With Overall Plan	$3,642.9	$8,995.5	$1,122.6	$482.6	$0.0	$14,243.7
Physical EAD Reduced in these Units With Overall Plan	$10,346.1	$22,693.8	$2,131.4	$884.1	$0.0	$36,055.3

Notes: Birmingham physical damages remain same as Future Without Project Condition
Any discrepancies due to rounding

Table 52 Future With and Without Project Condition Equivalent Annual Non-Physical Costs of Flooding in Interim Report Units

(Oct 2005 Prices, 5.125% Interest, 50 Year Period of Analysis, $000)

	Future Condition Equivalent Annual Non-Physical Costs of Flooding			
Levee Unit	**Clean-up**	**Emergency & Relocation/ Reoccupation**	**Traffic Disruption**	**Total Non-Physical Costs of Flooding**
Argentine				
Future Without Project	$489.4	$2,605.5	$10.0	$3,104.9
Future With Project	$102.5	$532.0	$2.6	$637.0
Non-Physical Damage Reduced	$386.9	$2,073.5	$7.4	$2,467.9
Fairfax-Jersey Cr				
Future Without Project	$314.3	$1,692.0	$4.3	$2,010.6
Future With Project	$95.7	$508.5	$1.4	$605.6
Non-Physical Damage Reduced	$218.6	$1,183.5	$2.9	$1,405.0
North Kansas City				
Future Without Project	$309.9	$1,416.5	$33.2	$1,759.6
Future With Project	$129.1	$586.3	$15.8	$731.3
Non-Physical Damage Reduced	$180.8	$830.2	$17.4	$1,028.3
East Bottoms				
Future Without Project	$143.5	$678.0	$18.2	$839.7
Future With Project	$67.1	$314.1	$11.5	$392.6
Non-Physical Damage Reduced	$76.4	$363.9	$6.7	$447.1
Total Non-Physical EAD in these Units Without Project	$1,257.1	$6,392.0	$65.7	$7,714.8
Total Non-Physical EAD in these Units With Overall Plan	$394.4	$1,940.9	$31.3	$2,366.5
Non-Physical Damages Reduced in these Units by Overall Plan	$862.7	$4,451.1	$34.4	$5,348.3

Note: Birmingham non-physical damages remain same as Future Without Project Condition
Any discrepancies due to rounding

7.2.4 Summary of Benefits, Costs, Net Benefits and Residual Damages of Overall Plan (Interim Feasibility Report Units)

Implementation of the NED alternative for each of the interim feasibility report units will provide flood damage reduction benefits and reductions in the other costs of flooding that are likely to occur when levees and floodwalls overtop or fail. The Argentine Unit NED alternative will also preserve 185 acres of riparian habitat near the urban Kansas City metropolitan area. Table 53 below displays the annual benefits, residual damages, annual cost, benefit-cost ratio, and net benefits for the overall recommended plan for the Phase 1 Units and for each unit individually. The overall plan has annual NED benefits of $41,403,600 compared with an annual NED cost of $5,085,700. Net NED benefits are the difference between the annual NED benefits provided by a project and the annual NED cost of the project. The overall NED plan provides net NED benefits of $36,317,900, and has a benefit cost ratio of 8.1. The annual NER cost of $90,200 will preserve the acres of riparian habitat along the Kansas River.

Table 53 Overall Plan Summary of Annual Damages, Benefits and Costs With and Without Project

October 2005 Prices, 5.125% Interest Rate, 50 Year Period of Analysis, $000

	Argentine Unit Nom 500+3 Raise	Fairfax-Jersey Cr Unit Total Plan	North Kansas City Unit Total Plan	East Bottoms Unit Plan	Overall NED Plan
WITHOUT PROJECT ANNUAL DAMAGES					
Physical Flood Damages	$19,220.6	$14,552.7	$10,021.2	$6,504.5	$50,299.0
Other Costs of Flooding	$3,104.9	$2,010.6	$1,759.6	$839.7	$7,714.8
Total WITHOUT Project Equivalent Annual Damages	$22,325.5	$16,563.2	$11,780.8	$7,344.3	$58,013.8
WITH PROJECT ANNUAL RESIDUAL DAMAGES					
Physical Flood Damages	$3,523.1	$3,943.4	$4,183.6	$2,593.6	$14,243.7
Other Costs of Flooding	$637.0	$605.6	$731.3	$392.6	$2,366.5
Total WITH Project Residual Annual Damages	$4,160.1	$4,549.0	$4,914.9	$2,986.2	$16,610.2
WITH PROJECT ANNUAL BENEFITS AND COSTS					
Flood Damage Reduction Benefits	$15,697.5	$10,609.3	$5,837.6	$3,910.9	$36,055.3
Reduction in Other Costs of Flooding	$2,467.9	$1,405.0	$1,028.3	$447.1	$5,348.3
Total Annual NED Benefits of Plan	$18,165.4	$12,014.3	$6,865.9	$4,358.0	$41,403.6
NER Benefits	Preservation of 185 acres of riparian habitat	--	--	--	Preservation of 185 acres of riparian habitat
Total Annual NED Cost	$3,478.9	$970.1	$515.3	$121.4	$5,085.7
Total Annual NER Cost	$90.2	$0	$0	$0	$90.2
NED Benefit Cost Ratio	5.2	12.4	13.3	35.9	8.1
Net NED Benefits	$14,686.5	$11,044.2	$6,350.6	$4,236.6	$36,317.9

Note: Any discrepancies are due to rounding

8.0 PROJECT PERFORMANCE OF OVERALL PLAN

8.1 Summary of Economic Performance of the Overall Plan

The economic performance and effectiveness of the final array of alternatives in each Unit are compared in Table 54 below. The table displays the expected value and probabilistic values of equivalent annual damage (EAD) and EAD reduced, thus showing the impact of uncertainty in evaluation of project benefits. The damages reduced represent the project benefits, and are shown in terms of annualized equivalent values as computed in the HEC-FDA program.

Table 54 Economic Performance of Overall Plan

Oct 2005 Prices, 5.125% Interest Rate, 50 Year Period of Analysis, $000

Plan	Top of Levee/ Floodwall Elev (ft)	Expected Value and Probabilistic Values of EAD and EAD Reduced					
		Equivalent Annual Damage			Probability EAD Reduced Exceeds Indicated Amount		
		Without Plan	With Plan	Damage Reduced	.75	.50	.25
ARGENTINE UNIT							
Future Without Project	776.00	$22,325.5	-	-	-	-	-
Alt 2 Nom 500+3 (NED Plan)	781.24		$4,160.1	$18,165.4	$7,852.47	$14,660.65	$24,639.82
FAIRFAX-JERSEY CREEK UNIT							
Future Without Project	760.5	$16,563.2	-	-	-	-	-
Total Fairfax-Jersey Cr Unit NED Plan (BPU Floodwall and JC Sheetpile Wall Solutions)	760.5		$4,549.0	$12,014.3	$4,241.49	$8,634.72	$16,529.34
NORTH KANSAS CITY UNIT							
Future Without Project	755.5	$11,780.8	-	-	-	-	-
Total North Kansas City Unit NED Plan (Harlem and National Starch sites Solutions)	755.5		$4,914.9	$6,865.9	$2,858.87	$5,154.55	$8,777.06
EAST BOTTOMS UNIT							
Future Without Project	746.3	$7,344.3	-	-	-	-	-
East Bottoms Unit NED Plan (Blue R. Confluence Site Solution)	746.3		$2,986.2	$4,358.0	$2,014.10	$2,968.23	$5,138.54

8.2 Engineering Performance

8.2.1 Annual Performance and Equivalent Long-term Risk for Overall Plan

How well the proposed overall project for the Kansas Citys Phase 1 Units will perform is indicated by the probability of the top of the levee/floodwall project being exceeded in a certain number of years. Long-term risk indicates how successfully the project will hold back floods given the uncertainties and over a long period of time. Table 55 shows for each Unit the long term risk or probability of the target stage/top of project being exceeded in a 10-, 25-, and 50- year period. The expected annual probability of the overall NED plan design being exceeded (probability of flooding in any given year) ranges from 0.002 in the Argentine Unit to 0.0003 in the East Bottoms Unit. Over ten years, the probability of the overall NED plan top of project being exceeded ranges from 0.003 in the East Bottoms Unit to 0.019 in the Argentine Unit. Over a 25 year period, the overall NED plan long term

risk ranges from 0.008 in East Bottoms to 0.048 in Argentine, and from 0.017 in East Bottoms to 0.093 in Argentine over a 50 year period.

Table 55 Annual Performance and Equivalent Long-term Risk of Overall Plan

Plan	Top of Levee/ Floodwall Elevation (ft)	Annual Exceedance Probability (Expected Probability that Flooding Will Occur in any Given Year)	Equivalent Long-term Risk (Probability of Exceedance (Flooding) Over the Indicated Time Period)		
			10 Years	25 Years	50 Years
ARGENTINE UNIT					
Future Without Project	776.00	.013	.125	.284	.487
Alt 2 Nom 500+3	781.24	.002	.019	.048	.093
FAIRFAX-JERSEY CREEK UNIT					
Future Without Project	760.50	.007	.064	.152	.281
Total Fairfax-Jersey Cr Unit Plan (BPU Floodwall and JC Sheetpile Wall Solutions)	760.50	.001	.013	.032	.062
NORTH KANSAS CITY UNIT					
Future Without Project	755.50	.005	.053	.128	.240
Total North Kansas City Unit Plan (Harlem and National Starch sites Solutions)	755.50	.001	.011	.027	.054
EAST BOTTOMS UNIT					
Future Without Project	746.30	.002	.024	.059	.115
East Bottoms Unit Plan (Blue R. Confluence Site Solution)	746.30	.0003	.003	.008	.017
OVERALL PLAN		.0003 to .002	.003 to.019	.008 to .048	.017 to .093

As shown in Table 56 on the following page, long term risk can be alternatively described in terms of chance of flooding in any given year or in a specified time period. For example, the equivalent long-term residual risk with the recommended Argentine Unit plan in place can be characterized as follows: There is a 1 in 76.9 chance that the Argentine Unit will flood in any year under the future without project condition. With the recommended plan, the Argentine Unit has a 1 in 500 chance of flooding in any year, a significant reduction in risk of flooding. Over fifty years, there is a 1 in 10.8 chance that the capacity of the project to protect against flooding will be exceeded one or more times. This shows a significant improvement over the future without project condition risk of 1 in 2.1 chance over 50 years. Over 25 years, there is a 1 in 20.8 chance of the project design capacity being exceeded (flooding), again a significant improvement over the 1 in 3.5 chance under the future without project condition. Over 10 years there is a 1 in 52.6 chance with the recommended plan compared with a 1 in 8.0 chance under the future without project condition.

Table 56 Alternative Display of Annual Performance and Equivalent Long-Term Risk

Plan	Top of Levee/ Floodwall Elevation (ft)	Chance of Exceedance (flooding) in any Given Year	Equivalent Long-term Risk (Chance of Design Being Exceeded (Flooding) Over the Indicated Time Period)		
			10 Years	25 Years	50 Years
ARGENTINE UNIT					
Future Without Project	776.00	1 in 76.9	1 in 8.0	1 in 3.5	1 in 2.1
Alt 2 Nom 500+3	781.24	1 in 500	1 in 52.6	1 in 20.8	1 in 10.8
FAIRFAX-JERSEY CREEK UNIT					
Future Without Project	760.50	1 in 142.9	1 in 15.6	1 in 6.6	1 in 3.6
Total Fairfax-Jersey Cr Unit Plan (BPU Floodwall and JC Sheetpile Wall Solutions)	760.50	1 in 1000	1 in 76.9	1 in 31.2	1 in 16.1
NORTH KANSAS CITY UNIT					
Future Without Project	755.50	1 in 200	1 in 18.9	1 in 7.8	1 in 4.2
Total North Kansas City Unit Plan (Harlem and National Starch sites Solutions)	755.50	1 in 1000	1 in 90.9	1 in 37.0	1 in 18.5
EAST BOTTOMS UNIT					
Future Without Project	746.30	1 in 500	1 in 41.7	1 in 16.9	1 in 8.7
East Bottoms Unit Plan (Blue R. Confluence Site Solution)	746.30	1 in 3,000	1 in 333.3	1 in 125.0	1 in 58.8
OVERALL PLAN		1 in 500 to 1 in 3,000	1 in 52.6 to 1 in 333.3	1 in 20.8 to 1 in 125.0	1 in 10.8 to 1 in 58.8

8.2.2 Conditional Probability of Design Non-Exceedance

One metric used to characterize the performance of a flood control project is overall project reliability against the 1% exceedance probability event. Project reliability against the 1% event is characterized in the HEC-FDA model by the probability of the project design containing the 1% event or the probability of design non-exceedance. Table 57 on the following page displays for each levee unit addressed in this interim report, the with- and without-project condition probability that the target stage (levee) will not be exceeded, given the occurrence of a 1% annual exceedance probability event. Both the potential for overtopping and the probability of geotechnical and structural failure are considered. The table also displays the top of levee margins above 1% and 0.2% event water surface profiles.

Table 57 Conditional Probability of Design Non-Exceedance

Plan	Top of Levee/Floodwall Elevation at Index Point (ft msl)	Overtopping Margin (ft) above 1% Event Water Surface Profile	Overtopping Margin (ft) above 0.2% Event Water Surface Profile	Conditional Probability of Design Containing 1% Exceedance Probability Event
ARGENTINE UNIT				
Future Without Project	776.0	6.39	-2.24	.49
Alt 2 Nom 500+3	781.24	11.63	3.0	.99
FAIRFAX-JERSEY CREEK UNIT				
Future Without Project	760.5	8.97	2.89	.82
Total Fairfax-Jersey Cr Unit Plan (BPU Floodwall and JC Sheetpile Wall Solutions)	760.5	8.97	2.89	.99
NORTH KANSAS CITY UNIT				
Future Without Project	755.5	6.69	1.05	.85
Total North Kansas City Unit Plan (Harlem and National Starch sites Solutions)	755.5	6.69	1.05	.98
EAST BOTTOMS UNIT				
Future Without Project	746.3	8.04	3.67	.96
East Bottoms Unit Plan (Blue R Confluence Site Solution)	746.3	8.04	3.67	1.00
OVERALL PLAN		6.69 to 11.63	1.05 to 3.67	.98 to 1.00

8.2.3 Residual Risk

Although floodplain users and occupants may desire 100% protection from flooding, this is an unachievable goal. No flood damage reduction project can guarantee 100% elimination of flooding. With any flood damage reduction project, it is important for floodplain users and occupants to be aware of the level of flood risk that remains even after implementation of a recommended project (see Tables 55 and 56 above). The probability and occurrence of flooding will be less frequent with the implementation of the recommended plan in each Unit in the Kansas Citys system. However, during major flood events, residents and other floodplain occupants may still be ordered to evacuate and move to higher ground. If levees failed or overtopped during these events, flood depths could reach more than 20 feet in the Units in the Kansas Citys system. Because the areas within the levee units are relatively flat, the entire area in each Unit could be flooded, potentially impacting all structures in the Unit.