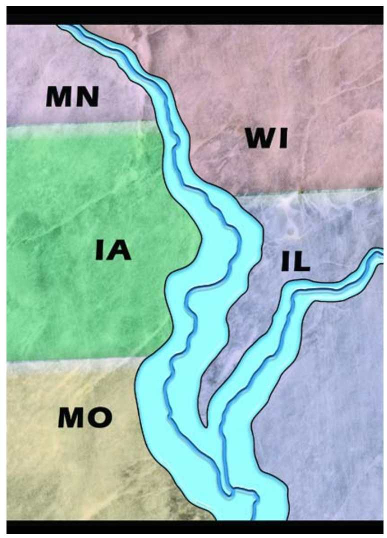
UPPER MISSISSIPPI RIVER COMPREHENSIVE PLAN



APPENDIX C

ECONOMIC ANALYSIS

Prepared by the
U.S. Army Corps of Engineers
Rock Island, St. Louis, and St. Paul Districts

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UPPER MISSISSIPPI RIVER COMPREHENSIVE PLAN

APPENDIX C
ECONOMIC ANALYSIS

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ECONOMIC ANALYSIS

I. INTRODUCTION

The Great Flood of 1993 resulted in catastrophic damages throughout much of the Upper Mississippi River Basin (main-stem and tributaries). Forty-seven deaths were attributed to the flood, and total event-related damages exceeded $15 billion. About half of those damages were related to agricultural losses. Approximately 74,000 people were evacuated, and 72,000 homes were damaged. In-place flood damage reduction facilities (i.e. levees, floodwalls, etc.) built by the U.S. Army Corps of Engineers (USACE) prevented an estimated $19 billion in potential further damages. While the Great Flood of 1993 could not be prevented, an integrated system of flood damage reduction (FDR) measures may have further reduced the amount of damages incurred.

This appendix describes the evaluation of existing conditions and the beneficial effects and costs of various systemic plans addressing damages caused by high flows of the Upper Mississippi River (UMR) and the Illinois Waterway (IWW). The assumptions associated with the analysis of this data are also described. The six major sections of this appendix summarize the analysis conducted by the Rock Island, St. Paul, and St. Louis Districts, U.S. Army Corps of Engineers.

Section 1 serves as the introduction to the Economic Analysis. Section 2 describes the general characteristics of the study area and summarizes historical flooding. Section 3 presents the procedures and assumptions used to develop existing conditions data and quantify flood damages and the potential benefits which would accrue to a flood damage reduction project. Section 4 presents the National Economic Development (NED) benefit and cost analysis for the alternative plans. The Regional Economic Development (RED) impacts of various alternatives are summarized in Section 5. The non-Federal financial analysis is summarized in Section 6. Throughout this analysis, price levels are stated as of 2005, with the required Federal discount rate of 5-3/8 percent for water resources projects being used to amortize costs for comparison with annualized benefits.

II. CHARACTERISTICS OF THE STUDY AREA

A. General

The study area encompasses parts of five states: Minnesota, Wisconsin, Iowa, Illinois, and Missouri, extending nearly 800 miles along the Mississippi River from Minneapolis-St. Paul downstream to southeast Missouri (below St. Louis), and along 200 miles of the Illinois River downstream from (but not including) the metropolitan Chicago area to the confluence with the Mississippi River. The year 2000 population of the study area exceeds 9.7 million. This figure includes counties adjacent to the Mississippi and Illinois Rivers, plus one county removed from these adjacent counties. The area includes major metropolitan cities and manufacturing centers, medium and small towns, and large concentrations of agricultural activity. This vast area was divided into four reaches that can be seen in figure C-1. Reaches 1, 2, and 3 are on the UMR, while Reach 4 runs the entire IWW (outside of the Chicago Metropolitan Area). The area is served by major state and Federal highways (including the Interstate highway system), railway, airline, and navigable waterway systems.

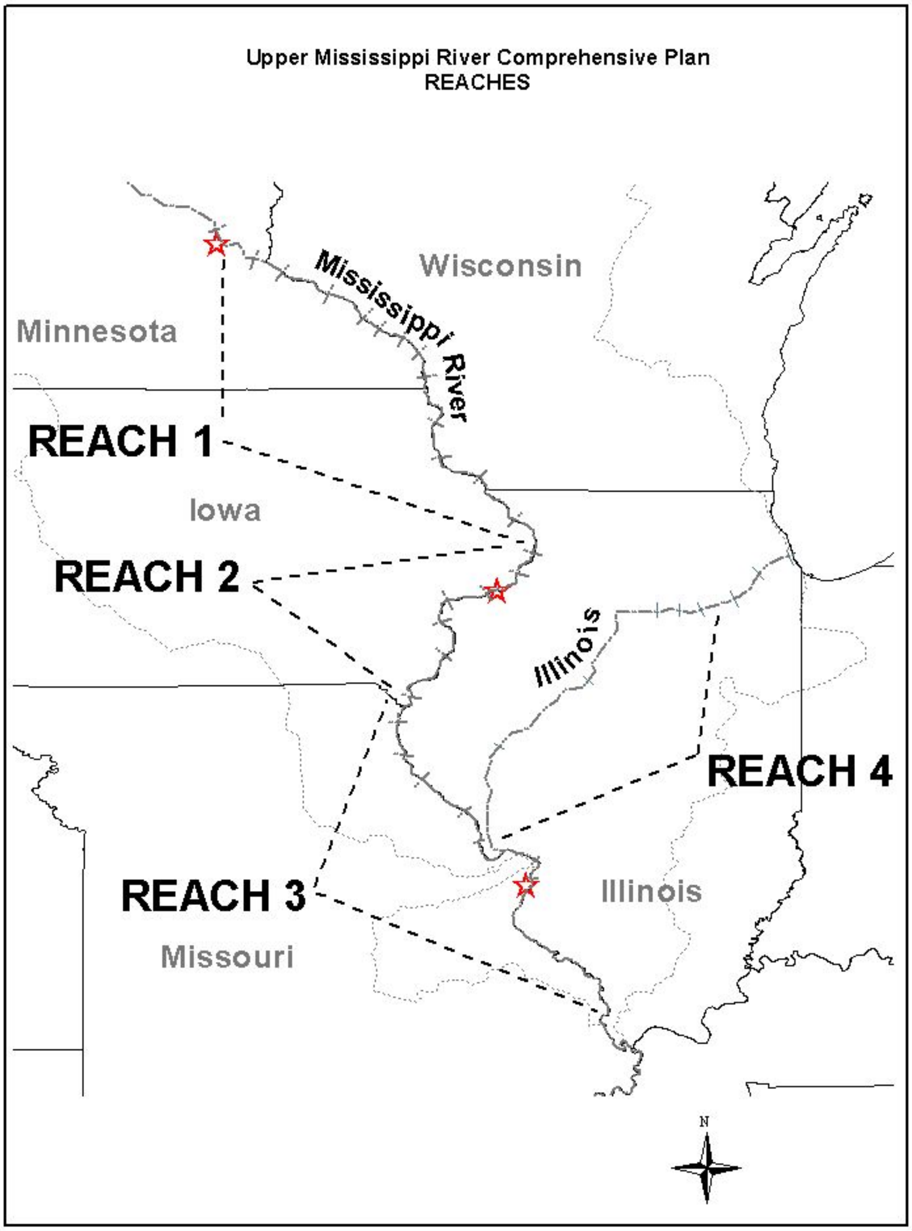

Figure C-1. Study Area

The study area in its entirety exhibits the following profile characteristics:

- Population growth is lower than the national growth trend for the last decade.
- More of the area's population is rural than the nation as a whole
- The area is less racially diverse than the nation as a whole
- High school graduation rates are higher than the national average.
- Personal income per capital is similar to the national average.
- Unemployment rates are lower than the national average.

These characteristics vary widely among regional sub-areas within the study area. The Tennessee Valley Authority (TVA), under contract with USACE for this study, compiled an *Existing Economic Conditions Report* dated March 2004. The profile above reflects the TVA finding. Refer to the TVA report, located at http://www2.mvr.usace.army.mil/UMRCP/Reports.cfm, for economic and demographic details concerning the study area (and sub-areas). This report shows the major population centers, income areas, transportation hubs, and other useful and interesting information.

B. Historical Flooding

The UMR system has experienced significant flooding in recent decades, most recently in the severe region-wide 1993 flood. For study area locations, refer to the map of streams and reaches at figure 1. Many levees—as existing at the time—were overtopped, causing extensive damage to agricultural, residential, commercial/industrial, and public properties. Seepage pumping, sandbagging, levee patrol, security patrol, infrastructure repair, and debris cleanup costs were incurred during and after flooding. Detailed comprehensive post-flood damage and impacts information was not collected by any entity after the 1993 flood, but gross estimates range into billions of dollars in magnitude.

Recent significant flooding on the UMR also occurred in 1996, 1997, 1998 and 2001. Severe flooding on the IWW occurred in 1979, 1982, 1985, 1995, and 1997. Flooding severity varied widely, depending upon river reach, storm characteristics, tributary locations and conditions, and other factors.

C. Study Area Existing Condition

The main-stem floodplains of the Upper Mississippi and Illinois Rivers have extensive existing flood control projects consisting of levees and floodwalls and large tributary reservoirs. The existing system of USACE flood damage reduction projects has prevented in excess of $83 billion in damage from UMR flooding during the past several decades. From a probability of occurrence perspective, the system prevents greater than 99 percent of potential flood damages. These projects vary widely in age and level of protection provided. Most components of this system are USACE projects, planned and built incrementally, rather than systemically. There are separable areas of the floodplain which have non-Federal projects, not meeting USACE design and construction standards. A detailed listing of study area flood control projects (Federal and non-Federal, with attributes) can be found at Reference XX. Under the without project condition, flood risk will continue to exist at varying degrees depending upon individual existing project situations. In unprotected areas, regulated floodplain building restrictions will likely result in reduced flood impacts into the future.

As seen in figure 1, the study area encompasses the entire UMR and the IWW. Table C-1 shows a physical description of the reaches used in the analysis. Table C-2 shows the variance in level of protection of the flood protection projects among the reaches as well as those unprotected areas that are in each reach. Tables C-2a and C-2b list critical infrastructure located in the UMR flood-plain.

Table C-1. Description of Reaches

Reach	Description	Range of River Miles
1	Fridley, MN to Lock and Dam 13 at Clinton, IA	863.9 to 522.5
2	Lock and Dam 13 at Clinton, IA to Lock and Dam 19 at Keokuk, IA	522.5 to 364.2
3	Lock and Dam 19 at Keokuk, IA to Thebes, IL	364.2 to 43.7
4	Illinois Waterway	291.0 to 19.4

Table C-2. Levee and Unprotected Area Summary by Reach

REACH 1

	Number	< 50 yr	50 yr	50–100 yr	100 yr	100-200 yr	200 yr	200-500 yr	500 yr	> 500 yr
Urban	**18**	**9**	**1**	**0**	**2**	**1**	**0**	**1**	**1**	**3**
Federal	6	---	---	---	---	1	---	1	1	3
Non-Federal	12	9	1	---	2	---	---	---	---	---
Private	0	---	---	---	---	---	---	---	---	---
Agriculture	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Federal	0	---	---	---	---	---	---	---	---	---
Non-Federal	1	1	---	---	---	---	---	---	---	---
Private	0	---	---	---	---	---	---	---	---	---
Other	**4**	**4**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
Unprotected	**17**									

REACH 2

	Number	< 50 yr	50 yr	50–100 yr	100 yr	100-200 yr	200 yr	200-500 yr	500 yr	> 500 yr
Urban	**11**	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**1**	**7**
Federal	9	---	---	---	1	---	---	---	1	7
Non-Federal	2	1	1	---	---	---	---	---	---	---
Private	0	---	---	---	---	---	---	---	---	---
Agriculture	**9**	**0**	**0**	**1**	**0**	**4**	**2**	**1**	**0**	**1**
Federal	9	---	---	1	---	4	2	1	---	1
Non-Federal	0	---	---	---	---	---	---	---	---	---
Private	0	---	---	---	---	---	---	---	---	---
Other	**4**	**4**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
Unprotected	**3**									

Table C-2. Levee and Unprotected Area Summary by Reach

REACH 3

	Number	< 50 yr	50 yr	50–100 yr	100 yr	100-200 yr	200 yr	200-500 yr	500 yr	> 500 yr
Urban	**13**	**0**	**0**	**0**	**0**	**1**	**1**	**2**	**0**	**9**
Federal	12	---	---	---	---	---	1	2	---	9
Non-Federal	0	---	---	---	---	---	---	---	---	---
Private	1	---	---	---	---	1	---	---	---	---
Agriculture	**49**	**22**	**6**	**2**	**5**	**6**	**9**	**1**	**0**	**0**
Federal	27	---	5	2	4	6	9	1	---	---
Non-Federal	13	11	1	---	1	---	---	---	---	---
Private	9	9	---	---	---	---	---	---	---	---
Other	**24**	**23**	**---**	**---**	**1**	**---**	**---**	**---**	**---**	**1---**
Unprotected	**14**									

REACH 4

	Number	< 50 yr	50 yr	50 – 100	100 yr	100-200 yr	200 yr	200-500 yr	500 yr	> 500 yr
Urban	**11**	**5**	**2**	**0**	**3**	**0**	**0**	**1**	**0**	**0**
Federal	7	3	2	---	1	---	---	1	---	---
Non-Federal	3	1	---	---	2	---	---	---	---	---
Private	1	1	---	---	---	---	---	---	---	---
Agriculture	**30**	**16**	**4**	**1**	**1**	**1**	**2**	**1**	**1**	**3**
Federal	23	10	3	1	1	1	2	1	1	3
Non-Federal	3	3	---	---	---	---	---	---	---	---
Private	4	3	1	---	---	---	---	---	---	---
Other	**6**	**6**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
Unprotected	**3**									

Table C-2. Levee and Unprotected Area Summary by Reach

TOTAL – UPPER MISSISSIPPI RIVER

	Number	< 50 yr	50 yr	50 -100 yr	100 yr	100-200 yr	200 yr	200-500 yr	500 yr	> 500 yr
Urban	**42**	**10**	**2**	**0**	**3**	**2**	**1**	**3**	**2**	**19**
Federal	27	---	---	---	1	1	1	3	2	19
Non-Federal	14	10	2	---	2	---	---	---	---	---
Private	1	---	---	---	---	1	---	---	---	---
Agriculture	**59**	**23**	**6**	**3**	**5**	**10**	**11**	**2**	**0**	**1**
Federal	36	---	5	3	4	10	11	2	---	1
Non-Federal	14	12	1	---	1	---	---	---	---	---
Private	9	9	---	---	---	---	---	---	---	---
Other	**32**	**31**	**---**	**---**	**1**	**---**	**---**	**---**	**---**	**---**
Unprotected	**34**									

TOTAL – STUDY AREA

	Number	< 50 yr	50 yr	50–100 yr	100 yr	100-200 yr	200 yr	200-500 yr	500 yr	> 500 yr
Urban	**53**	**15**	**4**	**0**	**6**	**2**	**1**	**4**	**2**	**19**
Federal	34	3	2	---	2	1	1	4	2	19
Non-Federal	17	11	2	---	4	---	---	---	---	---
Private	2	1	---	---	---	1	---	---	---	---
Agriculture	**90**	**39**	**10**	**4**	**6**	**11**	**13**	**3**	**1**	**4**
Federal	59	10	8	4	5	11	13	3	1	4
Non-Federal	19	17	1	---	1	---	---	---	---	---
Private	13	12	1	---	---	---	---	---	---	---
Other	**38**	**37**	**---**	**---**	**1**	**---**	**---**	**---**	**---**	**---**
Unprotected	**37**									

Table C-2a. Critical Infrastructure at Risk of Inundation due to the 500-year Frequency Flood Event

Mississippi River Basin - Rock Island District

Levee District	Superfund	Hazardous Waste Handlers	Petrochemical Storage	NPDES	Water Intakes	Water Wells	Power Plants	Power Substations	Television Towers	Radio Towers	Cellular Phone Towers	Pager Towers	Hospitals	Nursing Homes	Schools	Airports	Post Offices	Prisons	Fire Stations	Police Stations	Military	Landfills	Total
Guttenberg	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**4**
Dubuque	1	30	6	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**38**
East Dubuque	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Clinton	0	25	3	1	0	2	0	0	0	0	1	1	0	0	0	0	1	1	0	3	0	0	**38**
Fulton	0	0	0	0	0	3	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	**6**
Meredosia	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**
East Moline	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**3**
Bettendorf	0	15	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**19**
Rock Island Arsenal	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Rock Island	0	4	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	**9**
Andalusia	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	**3**
Muscatine-Madd Creek	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**4**
Muscatine Island	0	33	3	0	26	0	1	1	0	0	1	0	0	0	2	1	1	0	2	0	1	1	**73**
Iowa-Flint Creek No.4	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	**4**
Des Moines County No.7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**

Levee District	**Superfund**	**Hazardous Waste Handlers**	**Petrochemical Storage**	**NPDES**	**Water Intakes**	**Water Wells**	**Power Plants**	**Power Substations**	**Television Towers**	**Radio Towers**	**Cellular Phone Towers**	**Pager Towers**	**Hospitals**	**Nursing Homes**	**Schools**	**Airports**	**Post Offices**	**Prisons**	**Fire Stations**	**Police Stations**	**Military**	**Landfills**	**Total**
Keithsburg	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	**4**
Des Moines County No.8	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**3**
Oquawka	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Green Bay	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**
Niota	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	**1**
Des Moines-Mississippi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	**3**
Hunt-Lima	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	**7**
Indian Grave Upper	0	2	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	**6**
Indian Grave Lower	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**
Canton	0	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	**6**
Fabius River	0	3	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	**6**
Marion County	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**
Sny Reach I	0	1	0	1	0	4	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	**9**
Unprotected	1	50	11	26	34	42	6	2	0	2	0	0	0	0	1	0	6	0	6	4	0	0	**191**
Total	**2**	**175**	**31**	**37**	**61**	**66**	**8**	**3**	**0**	**2**	**3**	**1**	**0**	**0**	**17**	**3**	**15**	**2**	**10**	**8**	**2**	**2**	**337**

Table C-2b. Critical Infrastructure Features Inundated by the 500-year Frequency Flood Event

Mississippi River Basin - St. Louis District

Levee District	Superfund	Haz. Waste Handlers	Petrochemical Storage	NPDES	Water Intakes	Water Wells	Power Plants	Power Substations	Television Towers	Radio Towers	Cellular Phone Towers	Pager Towers	Hospitals	Nursing Homes	Schools	Airports	Post Offices	Prisons	Fire Stations	Police Stations	Military	Landfills	Total
Bois Brule	0	0	0	2	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	**6**
Brevator	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Chouteau Island	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Clear Creek	0	0	0	0	0	9	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	
East Cape Girardeau	1	0	0	1	0	0	0	0	0	2	1	0	0	0	2	1	0	0	0	0	0	0	
Miller Pond	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
North Alexander	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	
Preston	0	4	0	1	0	0	0	0	0	0	0	0	0	0	3	1	1	0	0	0	0	0	
Big Five	1	5	0	3	0	9	0	0	0	2	1	0	0	0	8	2	2	0	1	0	0	0	**34**
Columbia Bottoms	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	**1**
Columbia	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	**3**
Consolidated N. County	0	1	0	0	0	0	0	0	0	0	2	0	0	0	2	0	1	0	0	1	0	0	**7**
Degonia & Fountain Bluff	0	2	0	1	0	1	0	0	0	0	1	0	0	0	1	1	2	0	1	0	0	0	
Grand Tower	0	0	0	1	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	
Degonia & Grand Tower	0	2	0	2	0	3	0	0	0	0	1	0	0	0	2	1	2	0	1	1	0	0	**15**
Elsberry	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	**2**

Levee District	**Superfund**	**Haz. Waste Handlers**	**Petrochemical Storage**	**NPDES**	**Water Intakes**	**Water Wells**	**Power Plants**	**Power Substations**	**Television Towers**	**Radio Towers**	**Cellular Phone Towers**	**Pager Towers**	**Hospitals**	**Nursing Homes**	**Schools**	**Airports**	**Post Offices**	**Prisons**	**Fire Stations**	**Police Stations**	**Military**	**Landfills**	**Total**
Foley	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	**1**
Fort Chartres & Ivy Landing	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	
Harrisonville	0	7	0	1	0	6	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	
Harrisonville, Stringtown	0	8	0	1	0	6	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	**19**
Kaskaskia Island	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**
King's Lake	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Old Monroe	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	**2**
Pettus-Burns-Prewitt-Jaeger	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Prairie Du Rocher	0	3	0	2	0	2	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	**10**
Saint Peters	0	2	0	2	0	7	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	**12**
Sandy Creek	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Sny Island NO. 3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**4**
Sny Island NO. 4	0	0	0	0	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**4**
St Genevieve NO.2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Winfield L&DD	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**3**
Unprotected	0	16	1	36	12	38	3	2	0	0	0	0	0	1	7	4	5	0	3	3	0	1	**132**
Total	**2**	**56**	**1**	**61**	**13**	**88**	**3**	**2**	**0**	**5**	**8**	**0**	**0**	**1**	**43**	**14**	**18**	**0**	**8**	**6**	**0**	**1**	**262**

III. METHODOLOGY

A. General Conditions

This study area was evaluated using traditional expected value (damage and flood probability analysis). Risk and uncertainty analysis was not undertaken for this reconnaissance level of detail. Current stage frequency profiles were used to provide elevations for floods with varying probability. These water surface profiles were used to evaluate both the without project (existing condition) and with project conditions.

B. Flood Damage Data Collection

Flood damage information (i.e., structure and content values, and depth-damage estimates) for existing projects in the study area was gathered from a variety of sources. Much information was provided by previously completed USACE project studies (Basin Reconnaissance, Feasibility, etc) or available summaries from those studies. This type of data varies widely in age (i.e., current, years, decades) and in land use reporting (changes in usage may be unknown). The dollar denominated values for flood damage data has been adjusted to current price levels using McGraw Hill's Engineering News Record (ENR) cost factors.

A comprehensive list of unprotected urban areas was developed for both the UMR and the IWW. As the data collection process continued, some unprotected areas were deleted from the list due to such factors as :

- majority or all of area is located on high ground or bluff
- majority of residential buildings in area are cabins

C. Existing Conditions

Several assumptions were made in developing data to uniformly analyze each levee district and flood protection project. Because of the breadth of the study, the level of detail of each flood protection project analyzed had to be simplified from a typical feasibility or reconnaissance study analysis. Therefore, each flood protection project would have a single midpoint elevation and a single or beginning damage elevation to simplify the AAD analysis of each project. Furthermore, a start of damages elevation was calculated for each evaluated area. This elevation is presented in terms of approximate flood frequency.

1. Midpoint Elevation

a. Standard Midpoint Method. The locations and elevations of the critical point were calculated using a standard midpoint method. Data from the Flow Frequency Study (http://www.mvr.usace.army.mil/) was used to determine upstream and downstream overtopping elevations for levees included in the study. The midpoint elevation for each levee in the study was determined:

$$\textit{Midpoint Elevation} = \frac{\textit{Upstream Elevation} + \textit{Downstream Elevation}}{2}$$

The location of the midpoint elevation was determined by averaging the upstream overtopping location(?) river mile and the downstream overtopping location river mile of the mainstem portion of the flood protection project:

$$\textit{Midpoint Location} = \frac{\textit{Upstream River Mile} + \textit{Downstream River Mile}}{2}$$

For the midpoint method, it is assumed that the levee profile between the upstream overtopping elevation and the downstream overtopping elevation is a constant slope. Although most levee profiles do not follow a constant slope, this method is a logical means of approximating existing conditions.

b. Modified Midpoint Method. In some cases, the standard midpoint method does not reasonably portray existing conditions. It was clear that for some levees, the upstream overtopping elevation or the downstream overtopping elevation differed substantially from the levee profile.

For cases where the standard midpoint method did not adequately represent existing conditions, the critical location and elevation was obtained from Flow Frequency Study data. The critical points were selected only if they represented a significant length of levee and did not correspond to a local condition in the levee, such as a road crossing. This method is similar to fitting a best-fit trend line to numerical data. The thick black line in Figure C-2 illustrates the condition where the modified assumption was used.

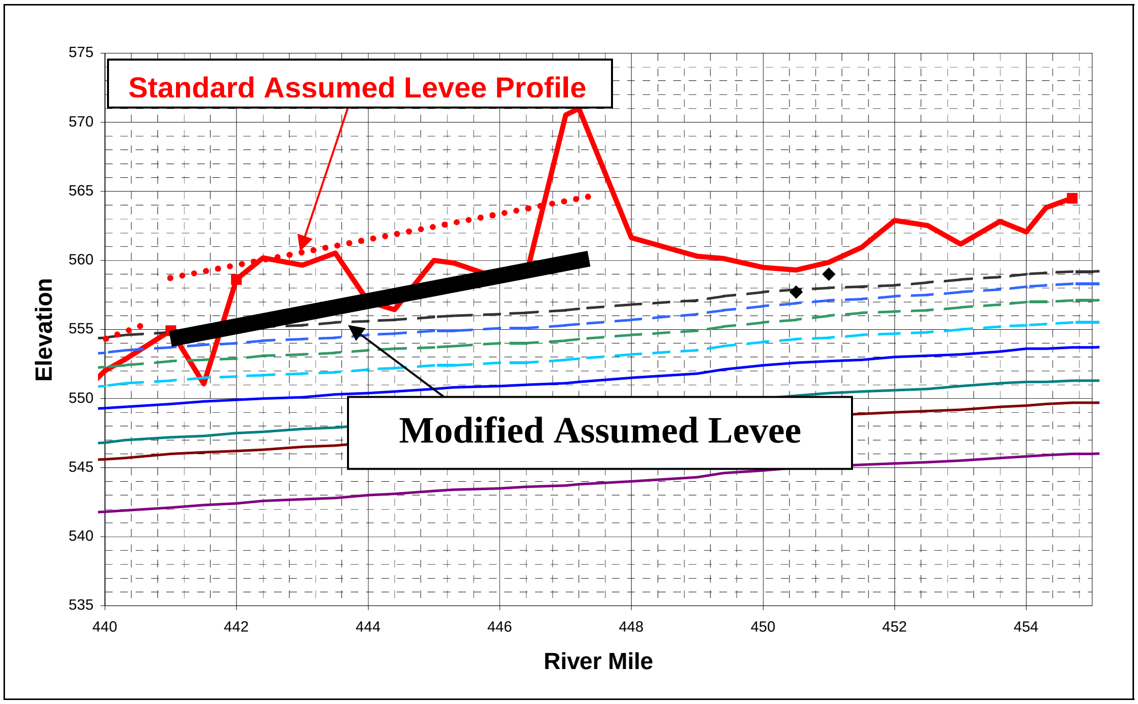

Figure C-2. Illustration of Midpoint Elevation Calculations

2. Beginning Damage Elevation. The beginning damage elevation is an estimate of where economic damages will start to accrue. It is assumed that no damages will occur below this point on the levee, and that damages will generally increase as the river stage rises past this point.

For Federal levees, the beginning damage elevation was assumed to be:
- 1.5 feet below the top of the levee for urban levees
- feet below the top of the levee for agricultural levees

For non-Federal levees, the beginning damage elevation was assumed to be:
- 3.0 feet below the top of the levee for urban levees
- 2.0 feet below the top of the levee for agricultural levees

Non-Federal levees have higher uncertainty associated with them because they are not always designed or constructed according to standard specifications. Although limited exceptions to these assumptions have been observed, the assumptions are sufficient for the scope of this study.

This method assumes that the top of a Federal levee is constructed to an elevation that is 2 or 3 feet above the design flood elevation depending on the type of levee construction. The additional height of the levee exists to reduce risk associated with the uncertainty of natural flooding conditions. This freeboard is used to protect against wave wash. In most cases, half of the levee freeboard is given credit towards damage reduction in the analysis of the alternative plans.

3. Start of Damages (Approximate Frequency). The approximate level of protection is estimated by comparing the design flood elevation to the stage frequency profiles. For a specific river mile, the level of protection is determined by bounding the design flood elevation between stages for two exceedance probabilities at the nearest river mile. The greater exceedance probability (higher probability of occurring) is selected. The approximate level of protection is then calculated:

$$Levelof\ \Pr otection = \frac{1}{Exceedance\Pr obability}$$

For example, assume the design flood elevation is 621.5 at river mile (RM) 614.2. In the Mississippi Stage Frequency Profile table, the nearest river mile is 614.0. Proceeding across the row at RM 614.0, the design flood elevation of RM 621.5 lies between RM 621.3 (Exceedance Probability=0.01) and RM 622.4 (Exceedance Probability=0.005). The exceedance probability of 0.01 has the highest probability of occurring; therefore, that value is selected. The level of protection is then calculated:

$$Levelof\ \Pr otection = \frac{1}{0.01} = 100$$

The level of protection at RM 614.2 is therefore approximately 100+ years. Following is a list of the frequencies that the flood protection projects were grouped into:

- <50 yr
- 50 yr
- 50-100 yr
- 100 yr
- 100-200 yr
- 200 yr
- 200-500 yr
- 500 yr
- >500 yr

4. The 0% Rule. When recording the level of protection, it became clear that in some cases, the zero damage elevation was only slightly less than the higher level of protections. Therefore, the 70% rule was implemented to more accurately portray the existing level of protection. If the design elevation were 70% of the way to the next highest level of protection, the higher level of protection was used.

Mathematically speaking, if:

$$DesignElevation > FloodElevation_{lower} + 0.7(FloodElevation_{upper} - FloodElevation_{lower})$$

then the higher level of protection shall be used. For example:

$$621.3 + 0.7(622.4 - 621.3) = 622.07 < 622.2$$

Since the design elevation of RM 622.2 is greater than the deign elevation of RM 622.07, the 100-200 yr level of protection shall be used.

5. Alternative Plans. Hydraulic data for each plan was received in spreadsheet form from the Hydraulics analysis team. This data included with-project levee elevations and induced rises if there were any. Information was also given as to what particular action that levee was receiving, i.e. levee district is left at existing conditions, used as storage area, or raised to a certain elevation.

6. Emergency Action Scenarios. Hydraulic data for emergency action scenarios were received in spreadsheet form from the Hydraulics team. This data included which levees would be raised and by what amount they would be raised. No benefit and cost evaluation was attempted for these scenarios.

7. Selective Buyouts. Alternative H (no systemic B/C evaluation) includes the concept of selective buyout of drainage districts to increase flood storage area and provide additional wildlife habitat. Selection criteria would include the requirement that the cost of improved levee protection would exceed the cost of property buyouts. Green Island Levee and Drainage District, Illinois is an example of this concept. Buyout cost estimates are approximately 25 percent of the cost of providing 500-year levee protection. However, even this lower cost would not be justified from a flood damage reduction benefit perspective.

D. Analysis

1. Existing Conditions. For the analysis of the without project conditions, damages were carried to the 0.002 flood frequency. Following is a description of the how the damage elevation was determined for the analysis of the existing conditions.

For Federal levees, the beginning damage elevation was assumed to be:

- 1.5 feet below the top of the levee for urban levees
- 1.0 feet below the top of the levee for agricultural levees

For non-Federal levees, the beginning damage elevation was assumed to be:

- 3.0 feet below the top of the levee for urban levees
- 2.0 feet below the top of the levee for Agricultural levees

2. Alternative Plans. The alternative plans that were analyzed are summarized in Table 3. Table 4 shows how the beginning damages elevation was calculated for the alternative plans.

Table C-3. Alternative Plans

	Proposed Level of Protection (frequency)		
Plan	**Urban**	**Agricultural**	**Unprotected**
A Confined	500 yr	500 yr	500 yr
B Unconfined	500 yr	500 yr	500 yr
C Unconfined	500 yr	200 yr	500 yr
D Unconfined	500 yr	100 yr	500 yr

Table C-4. Alternative Plan Beginning Damages Elevation

Proposed Level of Protection (LOP)	**Beginning Damages Elevation**
<200 yr	Plan Top of Levee (TOL) - 1.0
≥ 200 yr	Plan TOL - 1.5

3. Average Annual Damages and Benefits

a. General. Average Annual Damages (AAD) are defined as the monetary value of National Economic Development (NED) flood loss that can be expected in any given year based on the magnitude and probability of loss from all possible flood events. AAD are the calculated area under the Damage/Frequency curve (See Figure 3). This is estimated by the function:

$$AAD = \sum_{1}^{n} \left((P_{x-1} - P_x) * \left(\frac{D_{x-1} + D_x}{2} \right) \right)$$

where:

AAD = Average (Expected) Annual Damage
x = Flood event
P = Probability (%) of flood event
D = Flood event damage
n = Probability/Damage points

Average annual benefits (AAB) are defined as the difference in AAD between the without project (existing condition) and with project condition.

The accuracy of the AAD calculations is dependant upon the quality of the input data used for the calculation. Some levee districts had detailed, up-to-date damage curves, while other levee districts had little information available. Therefore, site-specific calculations were made for each levee district, reflecting the varying amount and quality of information available. A sheet of calculations, graphs, and source data for each levee district was retained and filed for subsequent review of AAD calculations.

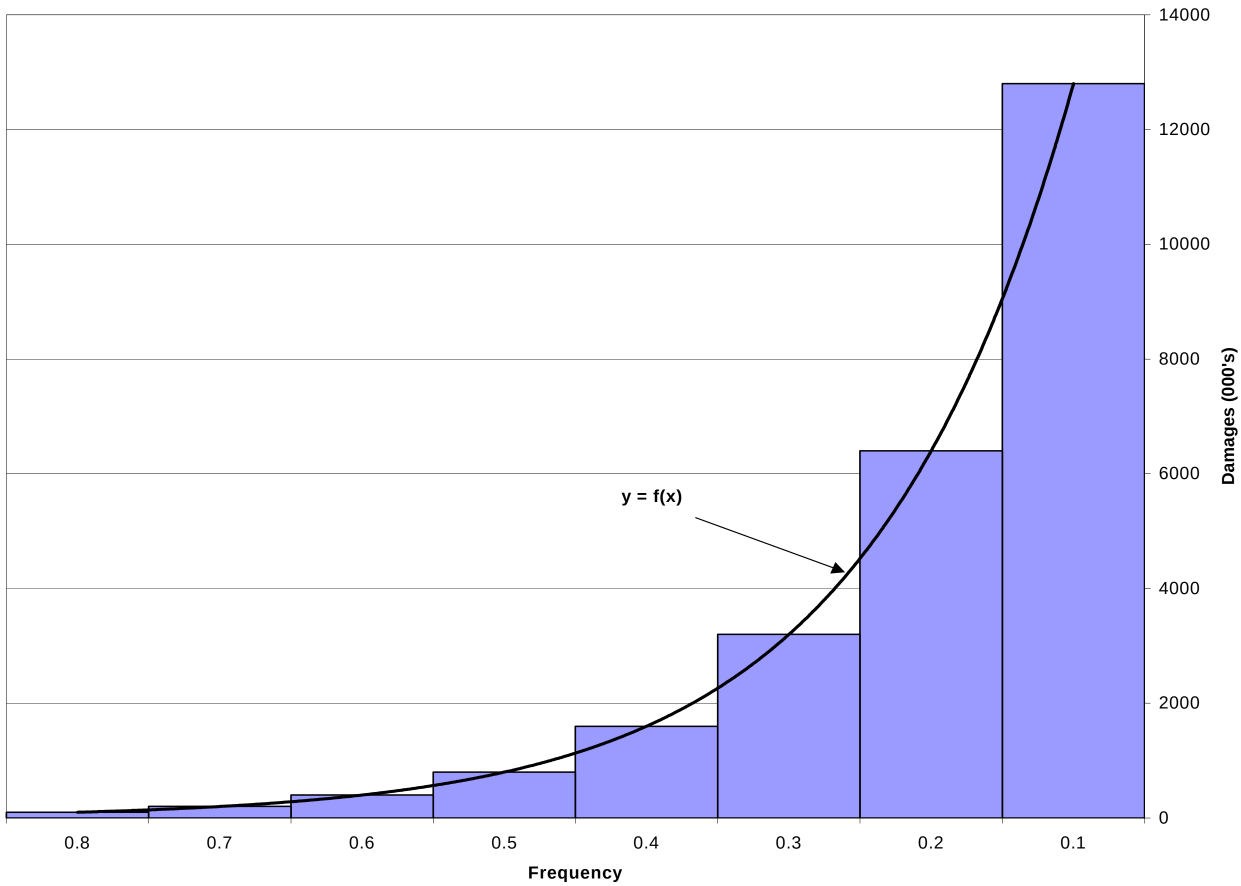

Figure C-3. Sample Damage Curve

Some assumptions used in AAD calculations—w here prior study data was not available—include:

- The inundated crop area was assumed to be 50 percent corn and 50 percent soybeans.
- Typical production costs per crop acre were used to estimate damages.
- Where information about structures protected by the levee was not available, structural damages were based on averages from prior studies.
- The cost of emergency measures and damage to infrastructure was assumed to be 30 percent of the total damages (crops + structures).
- For levees with detailed damage curve information, the Building Cost Index from McGraw Hill's Engineering News Record (ENR) was used to adjust the damages to current prices.
- Consistency was the top priority in the analysis of existing conditions and the alternative plans. For example, there should be fewer residual damages for a proposed 500-year level of protection than for a proposed 100-year level of protection.

b. Existing Condition (Without Project). The UMR and the IWW currently have many flood damage reduction projects which provide high levels of protection to urban and agricultural areas. These projects were planned and constructed incrementally rather than systemically. Based upon annual estimates of damages prevented by Federally constructed projects, the great majority of flood conditions (and flood damages) are protected against. From the perspective of AADs (flood frequency versus flood damage for the range of possible floods), greater than 99 percent of expected annual damage has been reduced by existing projects on the Mississippi River. On the IWW, greater than 97 percent of expected annual damage has been reduced Therefore, this study is pursuing alternatives which would reduce the remaining (less than) 1 percent of expected annual damages for the Mississippi River areas and the remaining (less than) 3 percent of annual damages for the IWW areas. These remaining ADDs are known as the *Residual Annual Damages* of the existing "system" of flood control projects.

Table 5 shows the AAD totals for each reach. Refer to Main Report for a site-by-site listing of AADs, as well as physical, critical infrastructure, hydraulic and environmental data.

Table C-5. Existing Condition Average Annual Damages

	AAD (000's)			
Reach	**Urban**	**Agricultural/ Other**	**Unprotected**	**Total**
1	3,626	33	1,667	**5,326**
2	464	166	1,546	**2,176**
3	171	8,996	1,628	**10,795**
Upper Mississippi Subtotal	**4,261**	**9,195**	**4,841**	**18,297**
4	1,007	2,008	565	**3,580**
Total	**5,268**	**11,203**	**5,406**	**21,877**

c. Alternative Plans (With Project). Table C-6 shows the average annual benefits (AAB) for the alternative plans which were evaluated. Table C-7 shows the residual AADs for each alternative plan. Refer to Table 3 for the proposed levels of protection for each alternative plan. Induced rises for each plan were added to the flow profiles and taken into account in the calculations of AAD.

Table C-6. Alternative Plan Average Annual Benefits

	AAB (000's)			
Reach	**A**	**B**	**C**	**D**
1	3,564	3,564	3,562	3,532
2	1,826	1,836	1,700	1,601
3	10,394	4,785	4,936	4,233
Upper Mississippi River Subtotal	**15,784**	**10,185**	**10,198**	**9,366**
4	3,385	3,276	2,091	1,888
Total	**19,169**	**13,461**	**12,289**	**11,254**

Table C-7. Alternative Plan Residual Average Annual Damages

	AAD (000's)			
Reach	**A**	**B**	**C**	**D**
1	1,762	1,762	1,764	1,794
2	350	340	476	575
3	401	6,010	5,859	6,562
Upper Mississippi River Subtotal	**2,513**	**8,112**	**8,099**	**8,931**
4	195	304	1,489	1,692
Total	**2,708**	**8,416**	**9,588**	**10,623**

IV. NED BENEFIT-COST ANALYSIS

A. General

Construction and costs detailed in this report are in 2005 price levels. Interest during construction (IDC) and annualized costs are computed using a 5-3/8% rate as mandated for Federal water resource projects. A three-year construction span and a 50-year project life have been used for the period of analysis. IDC was calculated for mid-year expenditure and appropriate construction period. No operation and maintenance (O&M) costs have been estimated.

B. Economic Summary

Table C-8 presents a summary economic analysis for the plans considered. As indicated, none of the plans evaluated suggests economic justification from the NED perspective.

Table C-8. Costs and Benefits by Alternative

Alternative Plan	Reach	Total Cost Estimate	AAB (000's)	AAC (000's)	Benefit Cost Ratio	Net AAB (000's)
A	1	640,096	3,564	41,836	**.09**	-38,272
	2	382,208	1,826	24,981	**.07**	-23,155
	3	5,962,357	10,394	389,694	**.03**	-379,300
	Upper Mississippi Subtotal	**6,984,661**	**15,784**	**456,511**	**.03**	**-440,727**
	4	1,759,922	3,385	115,027	**.03**	-111,642
	Total	**8,744,583**	**19,169**	**571,538**	**.03**	**-552,369**
B	1	645,262	3,564	42,174	**.09**	-38,610
	2	447,828	1,836	29,270	**.06**	-27,434
	3	2,234,005	4,785	146,012	**.03**	-141,227
	Upper Mississippi Subtotal	**3,327,095**	**10,185**	**217,456**	**.05**	**-207,271**
	4	1,679,663	3,276	109,781	**.03**	-106,505
	Total	**5,006,758**	**13,461**	**327,237**	**.04**	**313,776**
C	1	639,520	3,562	41,798	**.09**	-38,236
	2	319,829	1,700	20,904	**.08**	-19,204
	3	1,768,521	4,936	115,589	**.06**	-110,653
	Upper Mississippi Subtotal	**2,727,870**	**10,198**	**178,291**	**.06**	**-168,093**
	4	1,030,817	2,091	67,373	**.03**	-65,282
	Total	**3,758,687**	**12,289**	**245,664**	**.05**	**-233,375**
D	1	638,265	3,532	41,716	**.08**	-38,184
	2	245,511	1,601	16,045	**.10**	-14,445
	3	1,004,526	4,233	65,655	**.06**	-61,422
	Upper Mississippi Subtotal	**1,888,302**	**9,366**	**123,416**	**.08**	**-114,051**
	4	1,017,208	1,888	66,484	**.03**	-64,596
	Total	**2,905,510**	**11,254**	**189,900**	**.06**	**-178,647**

V. RING LEVEES PROTECTING SMALL AGRICULTURAL TOWNS

Within some large agricultural levee districts there are a few small towns which are protected from flooding by the district's agricultural levees, which are generally lower than urban levels of protection. Plan F would construct ring levees (urban level design) around these towns and also provide emergency access to high ground by raising roads leading to those higher elevation areas. Ring levee protection of Hull, Illinois (within the Sny Island Levee District) is used as an example of this conceptual plan.

The 1990 Reconnaissance Report (Sec. 205) for Hull, Illinois was used as the basis for estimating the costs and benefits of this Plan F conceptual site example. Costs from the Reconnaissance Report for the 200-year ring levee were updated to current price levels using the Engineering News Record (ENR) index. Costs were also estimated for raising an existing highway to provide flood-free access to high ground from Hull. Flood damage reduction benefits from the 1990 report were updated to current price levels using the ENR index. The table below summarizes costs and benefits for this ring levee example. Federal interest in pursuing this alternative is not indicated. Because of the high cost of constructing a ring levee and raising an access road, it is anticipated that ring levee studies for other towns would arrive at similar results.

Ring Levee Cost and Benefit Summary
(2005 prices, 5-3/8% rate, 50-year period)

Project Costs:	
Ring Levee	$ 5,960,000
Access Road Raise	8,320,000
Total Costs	$14,280,000
Annualized Cost	$ 944,000
Annual Benefits	112,000
Benefit-to-Cost Ratio	.12

VI. TRANSPORTATION DETOUR COSTS

During the 1993 flood, approach roads leading to several Mississippi River bridges were flooded, impassable, and out of use for up to 90 days. These impacted approach roads generally run through floodplain levee districts. As the analysis below indicates, significant detour impacts ensue from the loss of use of these approach roads. Cross-river traffic and within-reach traffic are at risk. There is extensive personal, commercial, and public vehicle traffic directly affected by closure of these bridges.

Without reliable protection, it is assumed that the approach roads will be flooded (based on approach road low elevations) and traffic impeded with the same frequency as that with which structural flood damages will occur. The analysis below reflects this impact/frequency relationship. Existing levee failure will force motorists to use detour routes, incurring additional costs for vehicle operation and opportunity cost of time.

(a) The bridges have average daily traffic counts (table C-9) as reported by the respective State Departments of Transportation.

Table C-9. Average Daily Traffic Counts - Mississippi River Bridges

Bridge	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Julien Dubuque	-	18,200	-	-	-	20,800	-	18,600	-	18,900
Savanna-Sabula	-	1,950	-	-	-	2,400	-	2,000	-	1,950
New North Clinton	-	9,300	-	-	-	10,000	-	10,700	-	11,400
Gateway	-	9,400	-	-	-	10,200	-	10,400	-	11,700
LeClaire	22,100	20,500	-	-	-	23,600	-	30,200	-	34,100
Iowa-Illinois Memorial	58,000	66,600	-	-	-	72,200	-	73,500	-	71,100
Rock Island Centennial	13,800	12,900	-	-	-	15,200	-	20,200	-	20,200
Interstate 280	17,000	21,800	-	-	-	21,600	-	21,600	-	22,600
Muscatine	-	3,750	-	-	-	4,500	-	4,250	-	4,250
MacArthur	11,900	11,700	12,500	11,300	11,800	11,300	10,900	11,600	11,900	11,100
Ft. Madison	3,150	3,550	-	3,650	3,850	3,850	4,650	4,000	-	3,800
Keokuk Municipal	13,600	13,700	-	15,500	16,500	16,500	11,400	14,300	-	12,500
Quincy Memorial	14,700	15,700	-	16,800	20,700	18,800	21,000	17,200	-	17,900
Mark Twain Memorial	9,700	11,000	-	12,600	12,500	12,500	11,500	10,800	-	11,700
Champ Clark	-	3,700	-	4,200	3,950	3,950	4,050	3,400	-	3,300
Clark	24,700	24,400	30,900	28,200	32,200	32,800	28,100	26,600	-	26,800
New Chain of Rocks	49,800	50,200	47,200	46,300	55,000	50,000	52,300	54,900	-	56,800
McKinley	11,200	8,900	10,500	11,800	11,300	11,800	9,450	8,400	-	
MLK Memorial	26,500	24,900	25,200	27,100	24,700	27,100	25,200	27,400	-	31,800
Eads	-	-	-	-	-	4,700	-	-	4,700	6,400
Poplar Street	118,000	125,000	129,000	122,000	119,000	122,000	119,000	117,500	-	121,000
Jefferson Barracks	39,200	42,000	42,900	47,600	50,700	50,400	50,100	48,900	-	54,900
Chester	5,300	5,700	6,000	5,100	6,100	5,900	5,900	5,800	-	5,600
Ozark Trails	9,300	9,500	9,500	-	-	11,600	11,800	11,600	-	11,600
Cairo 60,62	4,300	4,300	4,300	-	4,300	4,050	4,100	4,700	-	4,450
Interstate 57	8,400	9,000	9,300	-	9,800	9,800	9,800	9,800	9,700	9,700

(b) The assumed detour routes would require additional distances as reported in Table 10. These detours would require the listed additional travel time based on an average speed of 30 miles per hour. For this preliminary analysis, impacts to bridge traffic at Ft. Madison and Keokuk (Iowa), Quincy (Illinois), and Hannibal, Louisiana and Chester (Missouri) were evaluated. During the 1993 flood event, these bridges were out of service, and usable bridge alternatives were located at significant distances (St. Louis area bridges remained in service during the 1993 flood event). Of the six bridges, the Quincy Bridge has the greatest daily traffic counts and is centrally located within the region (table C-10). Therefore, its protection will likely accrue the greatest relative benefits for its own traffic, and for traffic diverted from other nearby bridge locations.

(c) The estimated 2004 average variable cost for operating passenger cars is $0.35 per mile. An average operating cost of $1.13 per mile was used for light trucks, heavy trucks, and emergency vehicles. These cost estimates include maintenance, repair, tire, fuel and oil costs. (Operating cost references are: American Automobile Association; Mid-West Truckers Association).

(d) An average passenger car occupancy of 1.6 adults and one child was assumed. Travel-time cost of one-third the average regional hourly wage rate was used for adults. An opportunity cost of time for passenger cars is estimated to be $7.22 per hour of detour time per vehicle.

(e) The approximate hourly wage rate of $16 was used as the value of time for non-passenger car vehicles. This averages wages for light and heavy truck drivers, emergency vehicle drivers and attendants, and various other vehicle operators.

(f) Daily costs resulting from increased vehicle operations and lost opportunity of time are shown in table C-11.

(g) Major levee-breaching floods (such as 1993, an approximate 0.2 percent frequency event in the downstream portion of the Mississippi River study area) will inundate bridge approaches and prevent usage for 90 days, resulting in detour costs. For example, bridge closure at Quincy would result in $182 million in detour costs. A linear stage/cost relationship was constructed for bridges evaluated, with zero-cost starting just below the top-of-levee elevation.

Tables C-12 and C-13 relate the stage/frequency/costs relationships for the Quincy Bridge detour cost impacts and for protection of the Fabius DLD (through which the Quincy Bridge approach road runs) as a whole. More reliable protection for the Quincy Bridge would also result in detour cost savings to the traffic from bridge outages at Keokuk, Hannibal and Louisiana. Greater protection of the bridge approach through the Fabius DLD by means of levee improvements is far less costly (about one-fourth the cost) than a lengthy road raise project). A Fabius DLD improvement project appears to warrant further study (positive benefit-to-cost ratio indicated in table C-13) as a non-systemic project, given the beneficial effects of the potential regional detour cost savings which would accrue.

Table C-10. Mississippi River Bridge Detour Distances

Existing Condition					With-Project Condition			
Bridge Location	**1994-2003 Average Daily Traffic (ADT)**	**Nearest "Open" Bridge**	**Distance to "Open" Bridge**	**Cross-river Detour Distance**	**Nearest "Open" Bridge**	**Distance to "Open" Bridge**	**Cross-river Detour Distance**	**With-Project Detour Reductions**
Burlington, IA								
Ft Madison, IA	3,800	Burlington	20	40	Burlington	20	40	0
Keokuk, IA	14,300	Burlington	40	80	Quincy	30	60	20
Quincy, IL	17,900	Burlington	70	140	Quincy	0	0	140
Hannibal, MO	11,600	Burlington	95	190	Quincy	25	50	140
Louisiana, MO	3,800	St Louis	95	190	Quincy	50	100	90
Chester, MO	5,700	Cape Girardeau	60	120	Chester, MO	0	0	120

Assumptions
1. Bridges at Burlington and St Louis Area remain open, as occurred during record flood of 1993.
2. For gross evaluation, assume 100% ADT detours to nearest open bridge and to original cross-river point (i.e., East Hannibal, IL to Hannibal, MO).
3. Assumed 90% of ADTs for passenger vehicles; remaining 10% for composite "all other" category..
4. Vehicle operating costs for passenger and composite vehicles are averaged/generic, and will need refinement in detailed study.
5. Operator/Passenger detour delay (opportunity of time) costs are very generic, and will need refinement in detailed study.
6. Any detailed study of detour cost issues will be coordinated with State DOTs, to take advantage of existing knowledge, data and models.

Table C-11 – UMR Comprehensive Plan Quincy Bridge (West Quincy, Fabius LDD) Detour Costs. Analysis of Average Annual Traffic - Quincy Bridge

Existing Condition					Vehicle Operating. Costs			Opportunity Time Costs		
	Avg Daily Traffic	**Detour Days per overtop event**	**Avg Daily Bridge Trips**	**Total Trips Detoured (A)**	**Cross-river Detour Distance (B)**	**Operating costs per mile ($) (C)**	**Add'l Operating cost per year ($) (AxBxC)**	**Traveler Time per trip in hours (d/r=t) (D)**	**Time cost per hour ($) (E)**	**Opportunity Time cost per hour ($) (AxDxE)**
Avg Daily Traffic	17,900									
Passenger Cars	80%	90	14,320	1,288,800	140	0.35	63,151,200	4.667	7.32	44,025,408
All Other Vehicles	20%	90	3,580	322,200	140	1.13	50,972,040	4.667	16.00	24,057,600
	Total Number of Trips		**17,900**	**1,611,000**	**Add'l. Operating Costs**		**114,123,240**			**68,083,008**
								Total Cost for 90-Day Detour		**$182,206,248**

Table C-12. Quincy, IL Bridge Average Annual Detour Cost Evaluation

EXISTING CONDITION							Average Annual Damages				
% Chance of Occurrence	Quincy Elevation	Quincy Bridge	Hannibal Bridge	Keokuk Bridge	Louisiana Bridge	Total Damages	Quincy Damages	Hannibal Damages	Keokuk Damages	Louisiana Damages	Total Avg Annual Damages
0.5	475.8	0	0	0	0	0	0	0	0	0	0
0.2	478.8	0	0	0	0	0	0	0	0	0	0
0.02	485	0	0	0	0	0	0	0	0	0	0
0.01	486.6	0	0	0	0	0	0	0	0	0	0
0.006	487.5	0	0	0	0	0	0	0	0	0	0
0.005	488.1	0	160,248,432	0	0	160,248,432	0	80,124	0	0	80,124
0.004	488.3	0	160,248,432	0	0	160,248,432	0	240,373	0	0	240,373
0.003	489	182,206,248	160,248,432	83,177,952	0	425,632,632	91,103	400,621	41,589	0	533,313
0.002	489.9	182,206,248	160,248,432	83,177,952	52,495,176	478,127,808	273,309	560,870	124,767	26,248	985,193
0.001	491	182,206,248	160,248,432	83,177,952	52,495,176	478,127,808	455,516	721,118	207,945	78,743	1,463,321
0.0005	492	182,206,248	160,248,432	83,177,952	52,495,176	478,127,808	546,619	801,242	249,534	104,990	1,702,385
0.0003	493	182,206,248	160,248,432	83,177,952	52,495,176	478,127,808	583,060	833,292	266,169	115,489	1,798,011
						AVERAGE ANNUAL DAMAGES	**583,060**	**833,292**	**266,169**	**115,489**	**1,798,011**

WITH-PROJECT CONDITION							Average Annual Damages				
% Chance of Occurrence	Flow or Elevation	Quincy Bridge	Hannibal Bridge	Keokuk Bridge	Louisiana Bridge	Total Damages	Quincy Damages	Hannibal Damages	Keokuk Damages	Louisiana Damages	Total Avg Annual Damages
0.5	475.8	0	0	0	0	0	0	0	0	0	0
0.2	478.8	0	0	0	0	0	0	0	0	0	0
0.02	485	0	0	0	0	0	0	0	0	0	0
0.01	486.6	0	0	0	0	0	0	0	0	0	0
0.006	487.5	0	0	0	0	0	0	0	0	0	0
0.005	488.1	0	42,170,640	0	0	42,170,640	0	21,085	0	0	21,085
0.004	488.3	0	42,170,640	0	0	42,170,640	0	63,256	0	0	63,256
0.003	489	0	42,170,640	62,383,464	0	104,554,104	0	105,427	31,192	0	136,618
0.002	489.9	0	42,170,640	62,383,464	27,629,040	104,554,104	0	147,597	93,575	13,815	254,987
0.001	491	0	42,170,640	62,383,464	27,629,040	104,554,104	0	189,768	155,959	41,444	387,170
0.0008	491.4	0	42,170,640	62,383,464	27,629,040	104,554,104	0	198,202	168,435	46,969	413,607
0.0006	491.7	0	160,248,432	83,177,952	52,495,176	243,426,384	0	218,444	182,991	54,982	456,417
0.0003	493	182,206,248	160,248,432	83,177,952	52,495,176	425,632,632	27,331	266,518	207,945	70,730	572,525
						AVERAGE ANNUAL DAMAGES	**27,331**	**266,518**	**207,945**	**70,730**	**572,525**
						AVERAGE ANNUAL BENEFITS	**555,729**	**566,773**	**58,225**	**44,759**	**1,225,486**

Table C-13. Quincy, IL Bridge Detour Benefit/Cost Evaluation

EXISTING CONDITION						Average Annual Damages			
% Chance of Occurrence	Flow or Elevation	Detour [1] Damages	Crops Damages	Structures Damages	Total Damages	Detour [1] Damages	Crops Damages	Structures Damages	Total Average Annual Damages
0.5	475.8	0	0	0	0	0	0	0	0
0.2	478.8	0	0	0	0	0	0	0	0
0.1	480.7	0	0	0	0	0	0	0	0
0.01	486.6	0	0	0	0	0	0	0	0
0.006	487.5	0	0	0	0	0	0	0	0
0.005	488.1	160,248,432	0	0	160,248,432	80124	0	0	80124
0.004	488.3	160,248,432	0	0	160,248,432	240,373	0	0	240,373
0.003	489	425,632,632	0	0	425,632,632	533,313	0	0	533,313
0.002	489.9	478,127,808	4,480,000	6,232,000	488,839,808	985,193	2,240	3,116	990,549
0.001	491	478,127,808	4,480,000	6,232,000	488,839,808	1,463,321	6,720	9,348	1,479,389
0.0005	492	478,127,808	4,480,000	6,232,000	488,839,808	1,702,385	8,960	12,464	1,723,809
0.0003	493	478,127,808	4,480,000	6,232,000	488,839,808	1,798,011	9,856	13,710	1,821,577
					AVERAGE ANNUAL DAMAGES				**1,821,577**

WITH-PROJECT CONDITION						Average Annual Damages			
% Chance of Occurrence	Flow or Elevation	Detour [1] Damages	Crops Damages	Structures Damages	Total Damages	Detour [1] Damages	Crops Damages	Structures Damages	Total Average Annual Damages
0.5	475.8	0	0	0	0	0	0	0	0
0.2	478.8	0	0	0	0	0	0	0	0
0.1	480.7	0	0	0	0	0	0	0	0
0.01	486.6	0	0	0	0	0	0	0	0
0.006	487.5	0	0	0	0	0	0	0	0
0.005	488.1	42,170,640	0	0	42170640	21085	0	0	21085
0.004	488.3	42,170,640	0	0	42170640	63256	0	0	63256
0.003	489	104,554,100	0	0	104554100	136618	0	0	136618
0.002	489.9	104,554,100	0	0	104,554,100	241,172	0	0	241,172
0.001	491	104,554,100	0	0	104,554,100	345,727	0	0	345,727
0.0008	491.4	104,554,100	0	0	104,554,100	366,637	0	0	366,637
0.0007	491.7	243,426,400	4,480,000	6,232,000	254,138,400	384,036	224	312	384,572
0.0003	493	425,632,600	4,480,000	6,232,000	436,344,600	517,848	2,016	2,804	522,669
					AVERAGE ANNUAL DAMAGES				**522,669**
					AVERAGE ANNUAL BENEFITS				**1,298,908**

[1] includes detour costs for 4 bridges

SUMMARY — **Cost Estimate 21,920,000** — **Annualized Cost Estimate $1,270,935** — **Annual Benefits $1,298,908**

Benefit-to-Cost Ratio 1.02 — **With-Project Protection and Period of Analysis 50** — **Discount Rate 0.05375**

VII. REGIONAL ECONOMIC DEVELOPMENT (RED) IMPACTS

The Tennessee Valley Authority (TVA), under contract with the USACE, completed a Regional Economic Impacts modeling analysis based upon implementation of systemic flood damage reduction alternatives for the UMR. The Executive Summary of the TVA report describes the analysis outcome. The complete report is available at http://www2.mvr.usace.army.mil/UMRCP/Reports.cfm.

Executive Summary of TVA Evaluation

This study examines the economic impacts of three flood protection plans: (1) confined 500 year, (2) unconfined 500 year, and (3) unconfined 500 year with less than 100 year agricultural protection plan. The 500-year protection plan (termed Plan C1) would achieve flood damage reduction (FDR) benefits using a purely structural approach. The major feature would be raising existing levees and floodwalls to the 500-year protection level, with no restrictions regarding induced river stages. At such a high level of protection, levees and floodwalls could be certified for future development. With escalating land values for development (due to this extremely high level of protection), a habitat incentives/conservation easements program would not likely be a competitive alternative land use.

The unconfined 500-year plan (termed Plan U1) would achieve FDR benefits using levees and floodwalls in all floodplain areas except for agricultural unprotected areas. All existing urban protected, urban unprotected, and agricultural protected areas would be protected to the 500-year level. Unlike Plan C1, Plan U1 attempts to (1) limit the induced water surface rise imposed by new levee construction to below one foot for the 100-yr event, and (2) minimize impacts to the Lower Mississippi Valley Mississippi River and Tributaries (MR&T) projects. Like Plan C1, this plan would not likely compete well for future habitat development.

The unconfined 500 year plan with the associated less than 100 year agricultural plan (termed Plan U3) is identical to Plan U1, except that its flood protection level in the agricultural protected areas has been lowered to less than 100 years. Since the protected agricultural areas in the U3 plan would not be eligible for certification, they could serve as a viable candidate for habitat restoration incentives and easements.

In the study, five potential economic impact paths were evaluated: construction, economic development, land value enhancement, farm income gains, and flood damages averted. Since Plans C1 and U1 provide flood protection for at least the 100 year flood for urban and agricultural areas, the five state benefits provided should be similar, exclusive of the impacts of the construction itself. The costs for Plan C1 are higher than for Plan U1 since more construction would be required to provide the greater level of flood protection; thus the regional benefits due to construction should be higher in Plan C1.

The regional benefits for Plan U3 should be lower than those benefits found in Plans C1 and U1 due to levee improvements in the agricultural areas being upgraded only to protect against a less than 100 year flood event. Costs should also be lower in Plan U3; thus the regional benefits due to construction should be lower than in Plan C1. Table C-14 shows the project cost of the three plans as present values discounted at 5.625%. Plan C1 costs $5.803 billion as compared to costs for U1 and U3, respectively of $3.6 billion and $2.7 billion.

Table C-14. Project Cost Present Values for Alternatives C1, U1, and U3 (Billions of $03)

	C1	**U1**	**U3**
5 State Area	$5.803	$3.632	$2.671

In their study, the TVA estimates the flood control economic impacts with an economic model constructed by Regional Economic Models Inc. (REMI) of Amherst, Massachusetts. REMI models are econometric models with highly detailed input-output industry categories. REMI translates the direct impacts into total impacts reflecting multiplier relationships between some change in an economy (a direct impact) and the succeeding economic activity that occurs as a result of that change (the indirect and induced impacts of the project or action). The direct impacts from improved flood protection of the project proposals occur in five areas: construction, economic development, land value enhancement, farm income gains, and damages averted.

Table C-15 shows the REMI-estimated total regional benefits of the flood control projects in the five-state study area, as measured by present value GRP, are $30.381 billion in C1, $27.091 billion in U1 and $22.029 billion in U3. Benefits are dominated by economic development and construction, together accounting for 95 percent of total benefits ($29.086 billion) in alternative C1. This is not to argue that other impacts are not significant, because damages averted are estimated to be $179 million, and farm income is $1.045 billion. The economic development impact of the increase in property is $72 million.

Table C-15. Five State Area Present Value GRP Impacts by Type of Impact for Alternatives C1, U1, and U3 (Billions of $03)

Impact	**C1**	**U1**	**U3**
Construction	$8.559	$5.268	$3.803
Economic Development	$20.527	$20.527	$18.079
Damages Averted	$0.179	$0.179	$0.099
Land Values	$0.072	$0.072	$0.006
Farm Income	$1.045	$1.045	$0.042
Total	**$30.381**	**$27.091**	**$22.029**

Table C-16 shows the distribution by state of total economic impacts, as measured by GRP, for each of the three plans. Benefits cluster in Illinois, which accounts for 79 percent of total benefits in all three cases, Iowa and Missouri make up most of the remainder. For the C1 alternative, the Illinois GRP impacts are $24 billion. Also for C1, Iowa, at $2.7 billion, and Missouri at $2.2 billion, together account for 16.5 percent; Wisconsin, at $819 million, and Minnesota, at $548 million, make up the remaining 4.5 percent.

Table C-16. Present Value GRP Impacts for Alternatives C1, U1 and U3 - (Billions of $03)

Region	C1	U1	U3
Illinois	$23.999	$21.459	$17.518
Iowa	$2.768	$2.687	$2.411
Minnesota	$0.548	$0.498	$0.423
Missouri	$2.248	$1.804	$1.230
Wisconsin	$0.819	$0.642	$0.477
Total	**$30.381**	**$27.091**	**$22.029**

Impacts for two other monetary measures captured in this study are closely proportional to GRP impacts. Total impacts for these two measures are shown in Table C-17.

Table C-17. Additional Present Value Measures of Total Impacts for Alternatives C1, U1, and U3 **(Billions of $03)**

Measure	C1	U1	U3
Real Personal Income	$25.295	$22.730	$17.719
Output	$51.518	$45.618	$36.985

Table C-18 shows the distribution by state of total economic impacts, as measured by average annual employment, for each of the three plans.

Table C-18. Average Annual Employment Impacts by State for Alternatives C1, U1 and U3 **(Average Annual Number of Jobs Added)**

Region	C1	U1	U3
Illinois	20,724	19,039	15,431
Iowa	2,430	2,397	2,192
Minnesota	291	275	237
Missouri	1,800	1,353	855
Wisconsin	445	364	252
Total	**25,690**	**23,428**	**18,966**

VIII. NON-FEDERAL SPONSOR FINANCIAL ANALYSIS

Any future feasibility study (systemic or site-specific) would require identification of a non-Federal sponsor and the evaluation of that sponsor's capability to finance study and project cost-sharing requirements.