Appendix D
Economics

Economic Appendix

01. Introduction

In 1986, Congress authorized the project described in the 1984 Feasibility Report. This included the construction of an urban-level (0.2% frequency or 500-year) levee system to provide flood damage reduction from the Mississippi River (now complete), channelization of nearly two miles of North and South Gabouri Creeks to achieve flood damage reduction for a 4% frequency event (a 25-year flood), and incidental recreation features on lands purchased for project features. Construction funds were first received in 1995. The non-Federal funding comes from a combination of historical preservation grants and a city sales tax.

When design and construction work was initiated, the City's highest priority was the completion of the Mississippi River levee. The remaining work for the creeks and recreation was postponed until construction of the Mississippi River levee was near completion in 1999. At that time, during review and analysis of the work planned for the creeks, it was determined that the authorized plan would need to be re-examined, given the physical, social, and political changes that had occurred since the 1984 Feasibility report.

The physical change was a result of the flood of 1993 which devastated the City of Ste Genevieve and resulted in the loss of a significant number of structures, including historic structures in the vicinity of the two creeks. Due to the adverse impacts of the 1993 flood, the re-evaluation of the project features now included two additional focus areas: 1) additional space available along the creeks for consideration of structural features, and 2) protection of the remaining historic structures.

Additionally, the social and political climate regarding channelization of streams has changed significantly since the project was authorized. Channelization of streams is not as acceptable to State and Federal agencies as it was in 1984 and current regulations require significant levels of mitigation to compensate for the environmental damages.

The purpose of the General Reevaluation study is to re-examine the authorized plans for North and South Gabouri Creeks, consider opportunities for alternative plans, and determine the most cost-effective, environmentally-conscious, and historically-sensitive plan. Once the authorized plans for the Creeks have been affirmed or modified, this study re-examines the authorized recreation plan to see if it also needs to be modified in accordance with the Creek plans and in consideration of the current recreation needs of the City of Sainte Genevieve.

02. Existing Condition

Overview of Methodology

Methodology employed for this economic analysis is in accordance with current principles and guidelines and standard economic practices, as outlined in the Planning Guidance Notebook – ER 1105-2-100. Costs are computed at 2016 price levels using the Federal Discount

rate of 3 1/8 percent. The period of analysis is 50 years, which reflects the design life for all of the alternatives, including the non-structural floodproofing alternative.

Structure Elevation: A structure's susceptibility to being inundated is a function of its location within the floodplain and its elevation. There are two sources of potential error in determining elevation. The first is the topographic ground elevation of the structure. This uncertainty is a function of the data source used to derive the elevation estimate. The other source of uncertainty is associated with estimates of first floor elevations above ground level (or foundation height). This variable is key, as a structure built on fill or with a large crawl space, for example, may sustain only minor or no damages, even though the surrounding ground is underwater. First floor elevation estimate errors also vary with the methods used to derive them, ranging from best-guess estimates from windshield surveys to professional surveys. Statistical uncertainty in elevation is typically determined by referencing the standard deviation estimates contained in Corp Engineering Manual 1110-2-1619 – *Risk Based Analysis for Flood Damage Reduction Studies (1 August 1996).* This publication presents standard deviation estimates for a wide range of measurement methods.

For this study, ground elevations and first floor elevations were surveyed using a conventional level. Based upon the Engineering Manual cited above, the error associated with first floor elevation estimates is assumed to be normal, with a standard deviation of 0.05 feet.

Structure Values: Structure values have been determined based upon depreciated replacement values (DRVs), using Marshall & Swift multiplication factors applied to square footage estimates as well as assessor's values. Square footage estimates were primarily obtained from county assessor's data. The primary source of potential error results from misclassification of a given structure in terms of its construction quality and condition. The errors associated with structure value estimates are assumed to be normal, with a standard deviation of 10 percent. Structure damage categories consist of bridge, commercial, industrial, residential, flood insurance and bridge, where appropriate for evaluation.

The Rock Island Real Estate team analyzed the market and neighborhoods for changes using public and private data. The team physically inspected properties for changes in condition and researched recent comparable sales listings in the area. The identified market changes were applied to update the structure values to October 2014 price level.

Depth-Damage Relationships: Depth-damage relationships indicate the percentage of the total structure and content value that would be damaged from various depths of flooding. Depth-damage relationships for residential without basement structures and their contents are based on data developed by IWR in EGM 04-01. The depth-damage relationships used in the economic analysis for residential with basement structures and their contents were provided by the U.S. Army Corps of Engineers (Corps), St. Paul District. These curves are based on damages experienced in Grand Forks, ND, during the 1997 flood event. The curves were selected for this analysis because they reflect regional characteristics similar to St Genevieve. Commercial depth-damage curves for both structure and content damage were not utilized since the structure inventory for this study does not have any commercial buildings. The depth-damage curves utilized can be found at the conclusion of this appendix.

The value of contents for the residential structures was assigned based on the results of the Corps

of Engineers Flood Damage Data Collection Program developed by the Institute of Water Resources (IWR). These values are published in the report entitled Depth-Damage Functions for Corps of Engineers Flood Damage Reduction Studies.

Table 1 summarizes the number and historic nature of the structures damaged by storm events up to the 0.2% probability (500-year) event. Table 2 present details of the structures damaged by the 1% flood event. Each of the structures listed below are estimated to be damaged since the 1% flood elevation is above where damages begin.

Table 1. Existing Conditions Structures Damaged by Historic Category

	National Register or Landmark Structures Damaged (Cumulative)	Non-Historic Structures Damaged (Cumulative)	Total Structures Damaged (Cumulative)
North Gabouri Creek			
50% (2-year) event	1	0	1
20% (5-year) event	1	0	1
10% (10-year) event	1	2	3
4% (25-year) event	2	2	4
2% (50-year) event	2	3	5
1% (100-year) event	2	3	5
0.5% (200-year) event	3	3	6
0.2% (500-year) event	4	4	8
South Gabouri Creek			
50% (2-year) event	1	1	2
20% (5-year) event	2	3	5
10% (10-year) event	3	3	6
4% (25-year) event	5	3	8
2% (50-year) event	5	3	8
1% (100-year) event	7	3	10
0.5% (200-year) event	7	3	10
0.2% (500-year) event	7	3	10

Table 2. Existing Conditions Structures Damaged

Structure Number	First Floor Elevation (feet NGVD)	Beginning Damage Elevation (feet NGVD)	1% Flood Elevation (feet NGVD)	1% Flood Depth Relative to First Floor (feet)	Beginning Damage Frequency	Historic Nature of Structure
North Gabouri Creek						
290	390.4	387.4	386.9	-3.5	0.2% (500-year)	Contributor to National Historic District
300	388.9	385.9	386.1	-2.8	2% (50-year)	Contributor to National Historic District
311	388.3	385.3	386.1	-2.2	10% (10-year)	
408	389.6	386.6	388.9	-0.7	4% (25-year)	Contributor to National Historic District
452	394.9	391.9	395.4	0.5	50% (2-year)	National Historic Landmark
454	398.3	395.3	396.5	-1.8	10% (10-year)	
460	394.5	391.5	391.4	-3.1	0.2% (500-year)	
468	398.1	390.1	389.0	-9.1	0.5% (200-year)	National Historic Landmark
South Gabouri Creek						
76	387.6	384.6	384.9	-2.7	1% (100-year)	Contributor to National Historic District
207	395.5	382.5	393.2	-2.3	50% (2-year)	
209	394.9	391.9	393.4	-1.5	20% (5-year)	
232	395.0	394.0	394.3	-0.6	1% (100-year)	
233	396.9	393.9	394.8	-2.1	4% (25-year)	National Register Eligible
236	396.5	393.5	394.8	-1.7	4% (25-year)	National Register Eligible
240	398.0	395.0	395.2	-2.8	1% (100-year)	National Register Eligible
244	397.8	394.8	397.3	-0.5	20% (5-year)	National Register Eligible

255	398.7	395.7	397.3	-1.5	10% (10-year)	National Register Eligible
257	403.8	400.8	406.0	2.2	50% (2-year)	National Register Eligible

The floodplains of both creeks, within the city limits, have very little land available for additional development. Significant areas of the floodplains have been purchased via FEMA or State buyout grants and are deed-restricted to prevent any further development. The City is participating in the National Flood Insurance Program and will regulate development in the 1% chance of exceedance (100-year) floodplain. Additionally, due to the presence of the Mississippi River levee and the commitment by the City to preserve all historic structures to the greatest extent possible, it is not anticipated that there will be any significant voluntary removal of historic structures within the creeks' floodplains.

Climate change reports differ on whether precipitation may increase or decrease and describe significant uncertainty in forecasting regional precipitation change in the next 50 to 100 years. Therefore, the study assumed that these watersheds are not anticipated to incur significant precipitation changes due to climate change within the anticipated 50 year period of analysis.

These anticipated future-without conditions will have marginal impacts upon hydraulic and hydrology characteristics within the study area. For the purpose of the assessment of future flood damages, the future-without-project conditions were assumed to be the same as the existing conditions.

Each alternative except the No Action plan addresses the risk for flood damages to some degree. However, no alternative eliminates the risk for flood damages completely and therefore there remains a residual risk. For all of the action alternatives, there is a residual risk of flooding for events greater than the 1% flood event. For the channelization alternatives, four structures do not fully benefit from the plan (452, 454, 236, and 255) and would continue to experience flood damages for events more frequent than the 1% flood event. The North Gabouri Levee alternative leaves two structures outside of the levee alignment (452 and 454) and their flood risk remains unchanged. The floodproofing alternative does not address the flood risk for three structures where damages begin at the 0.5% and 0.2% flood events.

03. Environmental Quality, Regional Economic Development and Other Social Effects

Other social effects that are addressed by these flood damage reduction plans include (1) the reduction in human suffering associated with being flooded and being surrounded by family, friends and neighbors that are flooded; (2) the reduction in shock and personal disruptions created by being flooded; (3) an increased sense of personal security; and (4) the reduction in potentially dangerous situations resulting from increased emergency (including police, fire and medical) service response time.

04. Benefit and Cost Analysis

The NED plan reasonably maximizes average annual net national economic development benefits, consistent with a federal objective for maximizing economic benefits. Alternative plans, including the NED plan, should be formulated using four criteria; (1) completeness; (2) effectiveness; (3) efficiency; and (4) acceptability. Benefits were not quantified and therefore the NED plan reflects the alternative of least cost that meets the four criteria.

Water Resources Development Act of 1986 (Public Law 99-662) authorizes the following language explaining benefit justification:

> "The project for flood control, Ste. Genevieve, Missouri: Report of the Board of Engineers for Rivers and Harbors, dated April 16, 1985, at a total costs of $34,400,000, with an estimated first Federal cost of $25,800,000 and an estimated first non-Federal cost of $8,600,000. **Congress finds that, in view of the historic preservation benefits resulting from the project, the overall benefits of the project exceed the costs of the project**."

05. Costs

Average annual costs are subtracted from NED average annual benefits generated by each project alternative to determine net NED average annual benefits for each project alternative. The total average annual construction costs estimate includes construction costs, interest during construction, annual operation, maintenance and repair costs, and all applicable contingency costs. All costs are annualized using the estimated project evaluation period of 50 years and a project interest rate of 3.125 percent. Costs are computed at 2016 price levels.

Construction first costs and interest during construction are determined for all project alternatives. Interest during construction was calculated using two equal year end payments. Interest is charged for each year funds are expended during the construction period because of the time value of money and project construction preventing alternative uses of the funds. A two-year construction period with the project interest rate of 3.125 percent is assumed for all alternatives, including non-structural alternatives.

Average annual costs are subsequently calculated for construction first costs as well as operations, maintenance, and repair costs. Construction first costs, interest during construction, average annual operation, maintenance, and repair costs for all project Alternatives, for North Gabouri and South Gabouri are presented in Table 3 and Table 4.

Table 3. North Gabouri Construction and Related Costs

North Gabouri Alternatives			
	Channel and Bridges	Levee, Limited Channel and Floodproofing	Floodproofing
Construction First Cost	$16,495,000	$10,927,000	$421,000
Interest During Construction	$517,482	$342,803	$13,208
Total Costs	$17,012,482	$11,269,803	$434,208
Average Annual Operation, Maintenance, and Repair Costs	$3,500	$1,800	$0
Average Annual Total Costs	$680,477	$450,259	$17,278

Table 4. South Gabouri Construction and Related Costs

South Gabouri Alternatives		
	Channel and Bridges	Floodproofing
Construction First Cost	$28,996,000	$674,000
Interest During Construction	$909,664	$21,145
Total Costs	$29,905,664	$695,145
Average Annual Operation, Maintenance, and Repair Costs	$2,800	$0
Average Annual Total Costs	$1,192,835	$27,662

06. Recommended Plan

Recommended Plan: After careful consideration of the alternative plans, including the economic analysis and an evaluation of each plans completeness, effectiveness, efficiency; and acceptability, the study team has recommended that the North Gabouri Floodproofing and the South Gabouri Floodproofing alternatives are to proceed with design and construction. Table 5 summarizes the key economic information regarding these plans.

Table 5. Summary of Economic Data for Recommended Plan

Project Alternative		Expected Annual National Economic Benefit and National Economic Benefit			
		Annual Benefits*	Annual Costs	Net Benefits	Benefit-Cost Ratio
North Gabouri	Floodproofing	17,278	17,278	-	1.0
South Gabouri	Floodproofing	27,662	27,662	-	1.0

**Annual benefits are assumed to exceed costs according to Water Resources Development Act of 1986 (Public Law 99-662)*

Depth-Damage Curves

One Story with Basement (1ST-B)		**One Story with Basement (1ST-B)**	
Residential **Structure**		Residential **Contents**	
Depth (ft)	Damage (%)	Depth (ft)	Damage (%)
-8	0	-8	0
-7	0.5	-7	0.5
-6	1	-6	1
-5	1.5	-5	1.5
-4	2	-4	2
-3	3	-3	3.5
-2	3.5	-2	5
-1	4.5	-1	9
0	7.5	0	15
1	20	1	40
2	31	2	58
3	37	3	70
4	41	4	76
5	44	5	80
6	46	6	82
7	48	7	84
8	49	8	85
9	50	9	85
10	53	10	85
11	57	11	85
12	63	12	85
13	63	13	85
14	63	14	85
15	63	15	85

Source: U.S. Army Corps of Engineers, St. Paul District, 1997

Two Story with Basement (2ST-B)		**Two Story with Basement (2ST-B)**	
Residential **Structure**		Residential **Contents**	
Depth (ft)	Damage (%)	Depth (ft)	Damage (%)
-8	0	-8	0
-7	0.5	-7	1.5
-6	1	-6	2
-5	1.5	-5	3
-4	2	-4	3.5
-3	2.5	-3	4
-2	3	-2	4.5
-1	3.5	-1	5
0	6.5	0	9
1	14	1	22
2	21	2	34
3	26	3	43
4	30	4	48
5	33	5	51
6	35	6	52
7	36.5	7	53
8	40	8	56
9	45	9	59
10	48	10	64
11	50	11	70
12	51	12	76
13	51	13	76
14	51	14	76
15	51	15	76

Source: U.S. Army Corps of Engineers, St. Paul District, 1997

One Story no Basement (1ST-NB)		**One Story no Basement (1ST-NB)**	
Residential **Structure**		Residential **Contents**	
Depth (ft)	Damage (%)	Depth (ft)	Damage (%)
-2	0	-2	0
-1	2.5	-1	2.4
0	13.4	0	8.1
1	23.3	1	13.3
2	32.1	2	17.9
3	40.1	3	22
4	47.1	4	25.7
5	53.2	5	28.8
6	58.6	6	31.5
7	63.2	7	33.8
8	67.2	8	35.7
9	70.5	9	37.2
10	73.2	10	38.4
11	75.4	11	39.2
12	77.2	12	37.7
13	78.5	13	40
14	79.5	14	40
15	80.2	15	40
16	80.7	16	40

Source: Economic Guidance Memorandum (EGM) 04-01, Generic Depth-Damage Relationships for Residential Structures with Basements

Two Story no Basement (2ST-NB)		**Two Story no Basement (2ST-NB)**	
Residential **Structure**		Residential **Contents**	
Depth (ft)	Damage (%)	Depth (ft)	Damage (%)
-2	0	-2	0
-1	3	-1	1
0	9.3	0	5
1	15.2	1	8.7
2	20.9	2	12.2
3	26.3	3	15.5
4	31.4	4	18.5
5	36.2	5	21.3
6	40.7	6	23.9
7	44.9	7	26.3
8	48.8	8	28.4
9	52.4	9	30.3
10	55.7	10	32
11	58.7	11	33.4
12	61.4	12	34.7
13	63.8	13	35.6
14	65.9	14	36.4
15	67.7	15	36.9
16	69.2	16	37.2

Source: Economic Guidance Memorandum (EGM) 04-01, Generic Depth-Damage Relationships for Residential Structures with Basements