



**US Army Corps
of Engineers**

Kansas City District

**FEASIBILITY REPORT
AND
ENVIRONMENTAL ASSESSMENT
WITH APPENDICES**

**MISSOURI RIVER LEVEE SYSTEM
UNITS R471-460 AND L-455
ST. JOSEPH, MISSOURI / ELWOOD, KANSAS**

SEPTEMBER 2006

HEARTLAND ENGINEERS 

MRLS R471-460 AND L455
FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

SEPTEMBER 2006

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Drawing Plates located at end of report.
R.01 - R.11 for Unit R460-471
L.01- L.02 for L455

FONSI and Environmental Assessment (Attached)

Appendices as Follows (All Attached In Order)

- Appendix A – Public Involvement
- Appendix B – Engineering (Including Engineering Drawings)
- Appendix C – Socioeconomics
- Appendix D – Real Estate (Including Real Estate Plates)
- Appendix E – HTRW
- Appendix F – Cost Estimating

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Syllabus

The metropolitan area of St Joseph, Missouri is protected by a federal levee system constructed in the mid-1960s. This system consists of two separate units. Unit R471-460 is located on the right bank of the Missouri River and protects the cities of Elwood and Wathena, Kansas, as well as the Rosecrans Memorial Airport and Missouri Air National Guard facilities. Unit L-455 is located on the left bank of the Missouri River and protects portions of the City of St. Joseph. Both units also protect significant agricultural property and unincorporated areas. Both units are part of the Missouri River Levee System authorized by the 1944 Flood Control Act.

While this flood damage reduction system is designated as a Federal project, it has long been turned over to the local sponsors for operation and maintenance. The Corps of Engineers continues to conduct regular inspections and technical review of significant modifications to the system. These non-Federal sponsors are: the South St. Joseph Levee District, the St. Joseph Airport Levee District, and the Elwood-Gladden Drainage District.

During the Missouri River Flood of 1993, the right bank unit failed flooding homes, businesses, and infrastructure. The left bank unit passed the flood but was near to overtopping. As a result, there was a concern that the levees may provide less than the design level of flood damage reduction. At the request of the local levee districts, a review of the levees was initiated in 1999 to evaluate the existing level of flood damage reduction and determine alternatives for possible improvement. Section 216 of the 1970 Flood Control Act provided the study authority to investigate the performance of the levee system and the potential for improvements.

Comparison of the existing conditions with the original design and construction determined that the current levee system was not properly designed to provide the authorized level of flood damage reduction. The feasibility study evaluated various improvement alternatives using a risk-based analysis, including the no-action plan. The recommended plan calls for raising a significant reach of unit R471-460 up to 3.37 feet above the existing elevation and raising a short reach of unit L-455 up to 0.94 feet above the existing elevation. The plan also includes improvements to the geotechnical and structural features of the existing project. The levee alignment will remain the same although there will be an increase in portions of the base width. This will minimize local disruptions to both the populace and the environment. Borrow areas have been identified close to the existing levee and will require minor mitigation.

The recommended plan is the National Economic Development (NED) plan which maximizes the net benefits of the project. Proposed modifications to the two units are individually and collectively economically justified. The NED plan is also the locally preferred plan.

There are no significant direct or cumulative environmental impacts of the NED plan primarily because it sustains the existing levee rather than encumbering additional resources for a “new” flood damage reduction project. The long-term environmental and cultural consequences of plan implementation are positive as the increased reliability of the units act to guard the social and environmental fabric that has developed within the protected areas for the last 40 years. A

minimal amount of wetlands would be lost; however mitigation is planned accordingly.

In December 1999, the Federal Emergency Management Agency determined that the right bank unit no longer provided the minimum level of flood damage reduction required for inclusion in the National Flood Insurance Program. The unit was formally decertified. This has created an economic hardship to the communities in the study area due to higher flood insurance costs and restrictions on development. The recommended plan will provide for the base level of flood damage reduction and allow certification of unit R471-460 by FEMA.

The total estimated implementation cost of the NED plan is \$32,686,000 shared between the Corps and three non-Federal levee sponsors. The average annual costs of the NED plan are \$2,008,900; benefits, \$6,635,800; net benefits, \$4,626,900. The resulting benefit to cost ratio is 3.3 to 1. The sponsors would receive credit for any necessary lands, easements, rights-of-way, relocations or disposal areas (LERRD). The total Federal share of the plan is \$21,246,000 or 65 percent of the total cost and the sponsors share is \$11,440,000 or 35 percent. The sponsors will take ownership of project improvements and assume all operation, maintenance, repair, and replacement costs of the completed works.

MRLS L455 AND R460-471
FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

I. Introduction

The Missouri River Levee System (MRLS) Units R471-460 and L-455 (Figure 1) are located on opposite sides of the Missouri River and provide local flood damage reduction for the metropolitan area of St. Joseph, Missouri, and surrounding communities. Both levee units are a part of the comprehensive MRLS, authorized by the Federal Flood Control Act of 1944 (Public Law 534, 78th Congress). The design of the St. Joseph levee system is described in “Missouri River Levees, Sioux City, Iowa, to the Mouth, Definite Project Report,” dated 17 March 1947. The Chief of Engineers approved the report on 21 April 1947.

These units were designed by the Corps of Engineers, Kansas City District (Corps) and constructed between 1962 and 1968. The two units combine to provide flood damage reduction to approximately 21,000 acres of rural and urban land; including the Cities of St. Joseph, Missouri, and Elwood and Wathena, Kansas. Significant investment in the protected area includes the Rosecrans Memorial Airport and Missouri Air National Guard Base.

Unit R471-460 was overtopped and subsequently breached during the flood of 1993. Following the failure of that unit, and the subsequent repairs under P.L. 84-99, the following local communities and organizations sent letters requesting a study of the levee system:

South St. Joseph Drainage and Levee District, April 13, 1994
The City of Wathena, Kansas, April 18, 1994
St. Joseph Area Chamber of Commerce, April 21, 1994
The City of Elwood, Kansas, April 21, 1994
Elwood-Gladden Drainage District, May 13, 1994

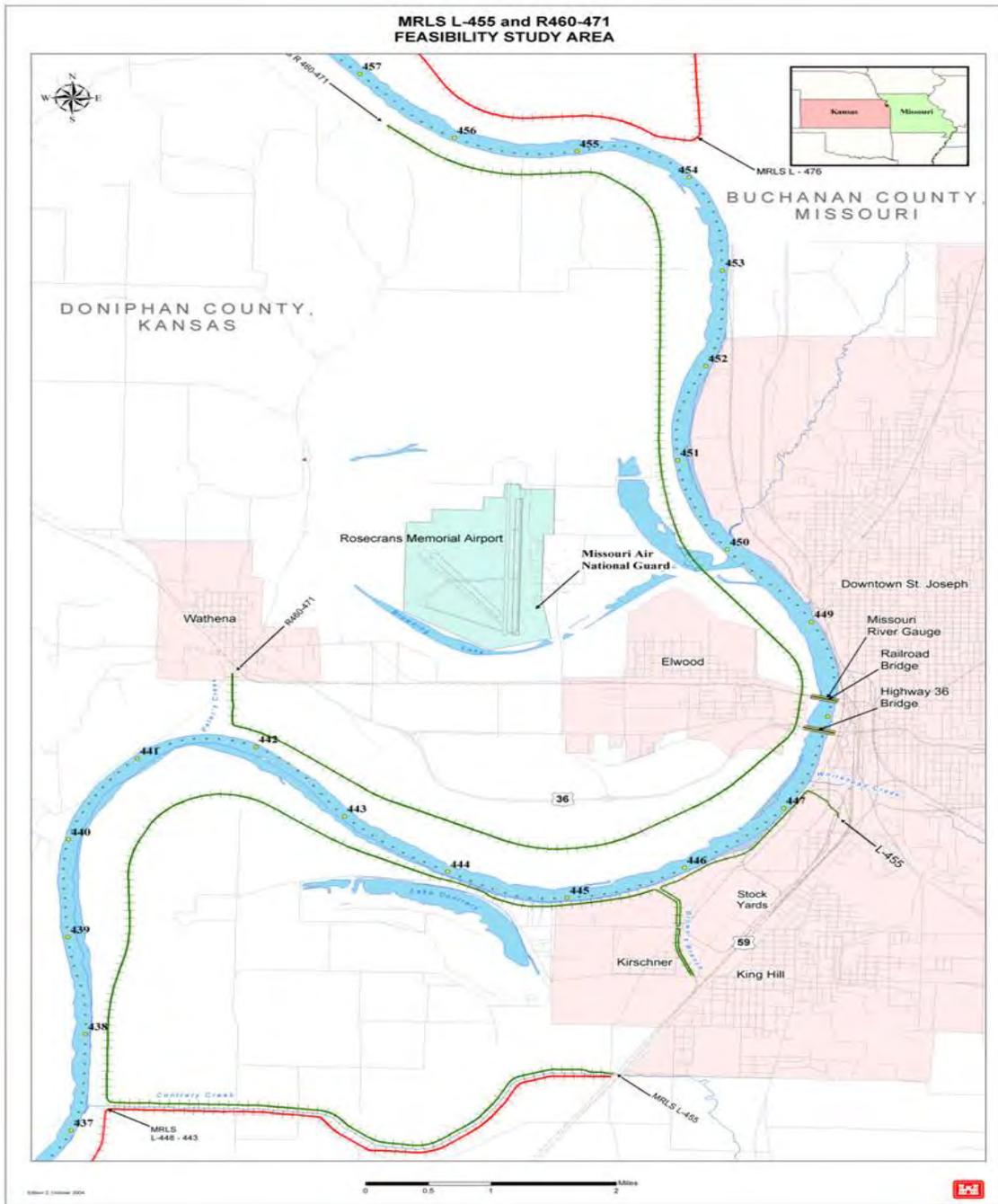
In response to these requests, Congress provided funding for a Reconnaissance Study in the Energy and Water Appropriation Act of 1995, P.L. 103-316 (August 26, 1994). The study began in May 1995 and was completed in May 1996. It concluded that there was at least one economically feasible alternative in which there was a Federal interest to proceed with a Feasibility Study.

The Feasibility Study was initiated in May 1999 with the signing of a Feasibility Cost Sharing Agreement. It is financed on a cost-share basis in accordance with the Water Resources Development Act of 1986. The Federal Sponsor is the U.S. Army Corps of Engineers, Kansas City District. The non-Federal Sponsors are the South St. Joseph Drainage District, the St. Joseph Airport Levee District, and the Elwood-Gladden Drainage District. The cost of the study is shared between the Corps (50%) and the non-Federal Sponsors (50%).

In December 1999, the Federal Emergency Management Agency (FEMA) determined that unit R471-460 no longer provided the minimum base flood level of flood damage reduction and

formally decertified the unit. This action has subjected the properties protected by this unit to higher insurance premiums under the National Flood Insurance Program (NFIP).

Figure 1 – Study Area Map



A significant delay occurred when the local sponsors and the Corps agreed to delay the Feasibility Study for overall updated hydraulic information. A broader and separately authorized study, the Upper Mississippi and Missouri River Flow Frequency Study (UMMRFFS), developed updated estimates of flows and water surface profiles for the entire Missouri River using updated gage records and state of the art technology – the UNET model. The UNET model results were not finally published until June 2003. The feasibility study used this updated hydraulic information.

II. Study Authority

This Feasibility Study is authorized by Section 216 of the 1970 Flood Control Act. Section 216 reads as follows:

The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of projects, the construction of which has been completed and which were constructed by the Corps of Engineers in the interest of navigation, flood control, water supply, and related purposes, when found advisable due to the significantly changed physical or economic conditions, and to report thereon to Congress with recommendations on the advisability of modifying structures or their operation, and for improving the quality of the environment in the overall public interest.

A Reconnaissance Study was completed in May 1996 and identified a Federal interest for continuing into the feasibility phase. A Feasibility Cost Sharing Agreement was signed with the local sponsors in 1999.

III. Study Purpose and Scope

The purpose of the feasibility study is twofold. First, the study serves to update and verify data on the reliability of the existing flood damage reduction units. Secondly, the study provides a means to examine and develop alternative plans (including a review of the “no Federal action” alternative) to restore the reliability of the units to reduce damages from potential flooding on the Missouri River in the vicinity of St. Joseph, Missouri, with the ultimate aim of a final recommended plan for authorization and implementation. The recommended plan for increasing the reliability of the system will be selected through the basic tests of technical effectiveness & completeness, economic feasibility, and environmental acceptability.

IV. Prior Project Documents, Studies, and Reports

Several studies and reports have been completed pertaining to the study area and surrounding areas. These reports were used to gather information regarding the levee units and past flood events:

- Missouri River Levees (Sioux City, Iowa to the Mouth) Definite Project Report, March 1947
- General Design Memorandum – Levee Unit L-455, September 1959
- Missouri River Agricultural Levee Restudy Program Hydrology Report, March 1962
- General Design Memorandum – Levee Unit R471-460, December 1965
- Operations and Maintenance Manual – MRLS Unit L-455, 1969
- Missouri River Flood Plain Pilot Study, St. Joseph to Kansas City, November 1977
- Operation and Maintenance Manual – MRLS Unit R471-460, December 1986
- Reconnaissance Study, St. Joseph, Missouri, December 1987
- Project Information Report, MRLS, South St. Joseph Unit, Levee Unit L-455, October 1993
- Project Information Report, MRLS, Elwood-Gladden Unit, Levee Unit R471-460, January 1994
- Emergency Levee Repair, MRLS Unit 471-460, Doniphan County, Kansas and Buchanan County, Missouri, Construction Plans and Specifications, February 1994
- The Great Flood of 1993 Post-Flood Report, Lower Missouri River Basin, September 1994
- Reconnaissance Report, MRLS Units L-455 and R460-471, May 1996
- Upper Mississippi River System Flow Frequency Study (UMRFFS), 2003

V. Existing Projects

Units R471-460 and L-455 were constructed as part of the comprehensive Missouri River Levee System (MRLS) authorized by the Flood Control Act of 1944. Additional MRLS units are located immediately up and down stream on the Missouri River. During the flood of 1952, the river cut across the French Bottoms, the area where Rosecrans Airport is located, leaving behind an oxbow lake (Browning Lake) on the right bank. Levee unit R471-460 was later constructed along the new channel alignment.

These units were originally designed and constructed to provide flood damage reduction for a flow of 325,000 cfs with 2 feet of freeboard, plus 1 foot for dynamic effects such as super-elevation on the outside of bends and pile-up on exposed flanks. The levee freeboard was above the constant flow profile of the original design hydraulics and included 0.15 foot per mile slope for the effect of a rising hydrograph.

There are six major Federal reservoirs on the main stem of the Missouri River in the Dakotas and Montana. The reservoir furthest downstream is the Gavins Point Dam in southern South Dakota, which is approximately 360 river miles upstream of the St. Joseph area. This system of reservoirs provides flood damage reduction benefits all along the Missouri River, but the system is difficult to operate specifically for the St. Joseph area because of the four to five day travel lag between a release at Gavins Point and the arrival of that water at St. Joseph. Review of the Missouri River lakes is not specifically addressed by this study; however, the effects of lakes on

river hydrology are incorporated into the models used in this study.

VI. Problem Identification

A. Existing Conditions and Flood History

1.0 Study Area

The Missouri River has a drainage basin of 424,300 square miles upstream from St. Joseph. Hills and bluffs that rise from 100 to 200 feet above the relatively wide and flat Missouri River bottomland characterize the topography in the study area. Numerous creeks and tributaries that dissect the bluffs bounding the Missouri River provide interior drainage in the study area. The broad alluvial flood plain is three to five miles wide and consists of low-lying nearly level terrain. The Missouri River borders the eastern bluffs in the northern part of the study area and then crosses over to border the western bluffs in the southern part of the study area. In the crossover, the river is funneled between levee units R471-460 on the north and L-455 on the south.

The study area (Figure 1) includes the flood plain of the Missouri River and tributaries protected by units R471-460 and L-455. This area encompasses the southwestern portion of St. Joseph, Missouri, the entire town of Elwood, Kansas, and the southeast edge of Wathena, Kansas. St. Joseph, the Buchanan County seat, is located in northwest Missouri on the east bank of the Missouri River. Elwood and Wathena are located in northeast Kansas, in Doniphan County, across the river from St. Joseph.

The area protected by levee unit R471-460 on the right bank of the river is 13,524 acres. It includes the towns of Elwood, Kansas, (2000 pop. 1,145), Wathena, Kansas, (2000 pop. 1,348) and unincorporated rural areas. This area includes 3,374 acres situated in the State of Missouri, which was cut off as a result of the 1952 flood and subsequent realignment of the Missouri River. The cut-off area is the former French Bottoms and contains Rosecrans Memorial Airport and Missouri Air National Guard Base. Total investment protected by R471-460 is estimated at over \$500 million.

The area protected by levee unit L-455, located on the left bank of the river immediately downstream and south of levee unit R471-460, is 7,500 acres. It includes the southern portion of St. Joseph, Missouri, (2000 pop. 73,990) and unincorporated areas. Important features of the protected area include the stockyards and old central industrial district; home to several large companies and public facilities including the St. Joseph water treatment plant. Total investment protected by L-455 is estimated at over \$1.4 billion.

2.0 Existing Flood Threat

Prior to the construction of the levee units, this reach of the Missouri River had an approximate channel capacity of 110,000 cfs and routinely flooded river bottomland in the vicinity of St. Joseph, Missouri. Also, without the levees, flood stages in excess of 15 feet caused significant

flood damage to St. Joseph, Missouri. For this study, a detailed update of the hydraulics was completed with current state of the art hydraulic modeling, utilizing calibration to the 1993 flood event. The discharges for this study were taken from the UMRFFS study completed in 2003. The UMRFFS currently estimates the 1-percent event discharge to be 261,000 cfs and the 0.2-percent event discharge as 324,000 cfs.

In 1994, FEMA initiated a flood insurance study of Buchanan County encompassing protected areas behind both R460-471 and L-455. In 1996, the Natural Resources Conservation Service (NRCS), working as a technical agent for FEMA in conducting the flood insurance study, asked the Corps of Engineers to verify certification of the R460-471 levee unit. After a process of hydraulic evaluations made in conjunction with the reconnaissance study, the Kansas City District determined that the R460-471 levee unit could not pass the 1 percent chance flood with 90 percent reliability nor did it have adequate freeboard. In December 1999, the R460-471 unit was formally decertified.

3.0 Historic Floods and Damages

Floods on the Missouri River are caused by widespread storm systems over several days or weeks, sometimes combined with runoff of spring snowmelt in Wyoming, Montana, and the Dakotas. Floods in the Missouri River Basin carry great quantities of silt and debris, and are of comparatively low velocity and of several days duration. The table below lists the estimates of the five largest annual peaks at the location of the U.S. Geological Survey (USGS) gauge at St. Joseph.

TABLE 1 HISTORIC FLOODS AT ST. JOSEPH	
Year	Measured Discharge (cfs)
1952	397,000
1881	370,000
1844	350,000
1993	335,000
1903	252,000

Note: The 1993 event is the only historic event that occurred under the influence of full main stem reservoir control, which was completed in the mid 1960's.

The 1844 event is considered the greatest known event in the lower Missouri Basin, but there was little development in the area to be impacted. On April 1, 1881, a large ice jam on the Missouri River near Yankton, South Dakota, broke apart releasing floodwaters down the Missouri valley. This event caused widespread damage in several communities up and downstream, but little information is available regarding specific impacts at St. Joseph.

Flood of 1952

On April 22, 1952, the Missouri River crested at a new record stage of 26.8 feet. Flood Stage at St. Joseph is 17 feet. Rapid snowmelt in northern Montana caused the river to swell, causing

massive devastation in Nebraska and Iowa. After passing St. Joseph, the flood dissipated down the valley, receiving little tributary flow. The 1952 flood still stands as the flood of record for most locations on the Missouri River, with the highest measured discharge.

Despite the efforts of the town to protect Rosecrans Airport, the airport eventually flooded, damaging many of the temporary World War II buildings beyond economical repair. During the flood, the Missouri River scoured a new channel across the neck of the French Bottoms, east of the airport. After the flood, the U.S. Army Corps of Engineers constructed a new cut-off channel for the river between river miles 449.4 and 452.0. An oxbow lake (Browning Lake) was formed in the old Bellemont Bend and Elwood Bend portions of the river channel. The cut-off channel modified portions of Bon Ton Bend and St. Joseph Ben, and separated the city from the airport. A highway bridge was later constructed to connect the two.

The 1952 Flood also severely damaged the Lake Contrary Amusement Park, which never fully recovered from the damage and later closed (see Figure 2).

Figure 2 - Contrary Lake Amusement Park during the Flood of 1952



Flood of 1993

Heavy rains in the Missouri and upper Mississippi River valleys during June 1993 caused flooding of both rivers that eventually engulfed portions of nine states and caused billions of dollars in damages. Figures 3 and 4 present photos of the study area during the flood.

Unit R460-471 failed from overtopping on July, 26, 1993, causing over \$65 million in damages. Virtually the whole town of Elwood, Kansas was devastated. An estimated 450 homes, and more

than 100 businesses, in the town of 1,079 people were inundated. The average depth of floodwaters in Elwood was six feet. Rosecrans Memorial Airport, serving the St. Joseph area and housing a Missouri Air National Guard Base, suffered an estimated \$16 million dollars in flood damages. Repairs were made to return unit R471-460 to pre-flood conditions under Public Law 84-99.

During the 1993 event, Unit L-455 protected 7,500 acres of industrial, residential, and farmland, preventing approximately \$176 million in damages. However, floodwaters were close to overtopping the levee, which would have caused catastrophic damages to an industrial area estimated to contain assets of over \$1 billion and an annual payroll in excess of \$50 million. Businesses closed down because of concern for the safety of the levee, resulting in lost wages, productivity, and sales.

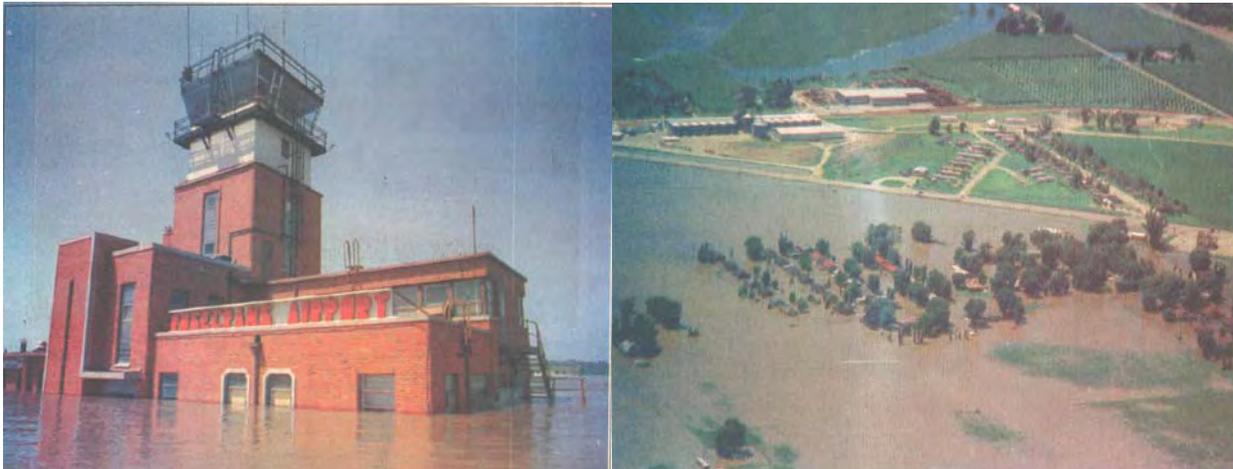
Figure 3 – Breach of Unit R471-460 during and after the Flood of 1993





Figure 4 – Photos of Study Area during Flood of 1993





Clockwise from top left: Looking west where U.S. Highway 36 crosses the Missouri River and disappears into flooded Elwood, Kansas; floodwaters surround the St. Joseph water treatment plant; floodwaters in Wathena, Kansas; Rosecrans Memorial Airport terminal building.

One exception was the St. Joseph electric power plant located behind the left bank levee. Alternative sources of power in the region had shut down because of high floodwaters and, despite low levels of flooding from interior drainage, the plant continued to supply power to the region avoiding serious brownouts. Two sewage treatment plants and the St. Joseph's water treatment plant are also protected by L-455. The water pump system on the Missouri River water intake was flooded, eliminating the water source to the water treatment plant for a nearly a week. The 1993 flood established a new record stage at St. Joseph of 32.1 feet, on July 26, 1993.

4.0 Floodplain Conditions

The communities of St. Joseph, Missouri, and Elwood and Wathena, Kansas, all participate in the National Flood Insurance Program (NFIP). Property owners in a participating community within the 1 percent chance flood zone, and other specially designated zones, can obtain flood insurance. Any proposed construction in the 1 percent chance flood plain must generally be elevated above the 1 percent chance flood elevation, or in compliance with local ordinances. The floodway is an area hydraulically defined that must be reserved in an unobstructed condition in order to pass the base (1 percent chance) flood without increasing flood levels more than one foot. Existing floodplain ordinances generally prohibit construction or development within the floodway.

The FEMA regulatory floodway and floodplain boundaries in the study area are currently indicated by the Flood Insurance Rate Map (FIRM), Buchanan County, Missouri, Panels 0075 B and 0125 B and Doniphan Co., Kansas, Panels 0075 B and 0125 B, all dated August 1, 1983; and City of St. Joseph, Missouri, Panel 0020 C, dated Sept. 19, 1984. New maps reflecting the decertification of Unit R471-460 have not been issued at the time of this report.

By letter of May 19, 2000, FEMA notified the City of St. Joseph that they were preparing to update the NFIP mapping for Buchanan County, Missouri. As part of their process, they had previously requested the Corps to verify that the levee units shown on the Buchanan County FIRM would pass a flood having a one-percent chance of being exceeded in any given year (base flood). The Corps responded that unit R471-460 did not meet the criteria to pass the base flood.

A meeting was held June 6, 2000, at Rosecrans Memorial Airport with representatives of the City of St. Joseph, the local levee districts, Kansas City District, and FEMA Region VII. At this meeting, FEMA presented the details of the “AR Zone” designation for areas where a Federal flood damage reduction system no longer passes the base flood but restoration is underway. The AR Zone designation recognizes that flood hazards are temporary until restoration is complete. In order to be placed in an AR Zone a community must petition FEMA, develop a restoration plan, and commit to cost-shared levee restoration within ten years.

If an AR Zone is not established, then the alternative is an AE Zone designation, which applies to all areas subject to the one-percent chance flood. Both AR and AE designations require mandatory purchase of flood insurance and new construction standards. However, floodplain management requirements and insurance rates are reduced in the AR Zone. Furthermore, properties currently covered by flood insurance will not have their rates raised by an AR Zone designation as long as coverage is continuously maintained.

5.0 Geotechnical Conditions

The Engineering Appendix presents the results of the geotechnical evaluation of the existing conditions performed as part of the feasibility flood study of the Missouri River Flood Levee System at St. Joseph, Missouri. The flood damage reduction project within the study area was designed by the Kansas City District U. S. Army Corps of Engineers and was constructed under its supervision.

The left bank unit is operated and maintained by the South St. Joseph Levee District and the right bank unit is operated and maintained by the Elwood-Gladden Drainage District and the St. Joseph Airport Levee District

The primary goal of this phase of the geotechnical evaluation was to gather and review all available data and develop an assessment of the existing conditions of each levee unit by identifying the critical reaches for each unit and their probability of failure for different river stages. Additionally, the past performance of the levee system was evaluated. This information is to assist in an assessment of the future performance of the levee during flood events. In particular, the following tasks were performed for this study:

- Review of existing sources of information,
- Description of each existing levee unit including design features and subsurface conditions.
- Reliability analyses of each unit and identification of critical reaches of each unit

The evaluation of the existing condition was based on the original subsurface investigation performed for the design of the project. This was supplemented with additional investigations, such as cone penetrometer tests and laboratory testing performed on selected samples collected from borings drilled in some areas considered critical.

6.0 Economic Setting

Economic development in the contemporary study area is focused on a cluster of life science manufacturing concerns located in the St. Joseph Stockyards and extending across the river into the Elwood area. This cluster of firms ties into other such firms elsewhere in St. Joseph and in Kansas City to the south. Major industries in the study area include pork and soybean processing, veterinary drug manufacturing, herbicide manufacturers, animal food and supplements manufacturers, and leather manufacturing.

Other major industries in the L-455 area include food container and packaging manufacturers, battery manufacturing, and steel building frame manufacturers. Major utilities include wastewater treatment and electric power.

In the R471-460 area, Rosecrans Airport and the Missouri Air Guard base are the key economic components. Other major industries in the right bank area include grocery wholesaling, warehousing and storage, home supply retail, boom manufacturing, construction, and truck chassis and components manufacturing.

Agriculture is a major land use in the study area. Farmed crop acreage accounts for about 5,100 of 7,219 total acres in the L-455 area (71% of the total) and about 7,200 of 13,424 total acres in the R471-460 area (54%). Agricultural land uses are found primarily in the western portion of L-455 and the northern portion of R471-460.

7.0 Environmental Setting

High stages in the Missouri River generally occur in the spring and fall. Runoff may be coincident with the months of heaviest precipitation (total average annual precipitation is 34 inches), but Missouri River flows are greatly influenced by snow melt runoff from the Rocky Mountains.

The Missouri River runs generally from north to south through the study reach and has been extensively channelized. Riparian woodlands exist as narrow strips along the river. The dominant vegetation in the riparian areas is a mix of cottonwood, sycamore, maple, oak, and hickory trees. Wetlands exist within the study area as small pockets and old meander scars and in the riparian strips. Table 2 lists the types and amounts of various land types found in the study area.

TABLE 2 – LAND TYPES IN STUDY AREA			
Type	Total Acres	Type	Total Acres
Side Channels	0.13	Grassland	234.76
Tributary Rivers/Streams	2.17	Cultivated	846.3
Developed	7.35	Cultivated with Levee	25.72
Naturally Bare	2.77	Emergent Wetland	131
Deciduous Trees	388.32	Scrub Shrub Wetland	65
Shrubland	153.08	Forested Wetland	545

An old oxbow of the Missouri River (the French Bottoms) was cut off when the river changed course during the flood of 1952. Remnants of the oxbow remain as Browning Lake, and are protected by unit R471-460. Lake Contrary located at approximately river mile 443 in the area protected by unit L-455. Both of these lakes provide recreational opportunities to the study area..

8.0 Fish and Wildlife

Wildlife found in the study area includes various deer, squirrel, beaver, mink, muskrat, opossum, coyote, raccoon, and striped skunk. Smaller mammals, such as mice, voles, rats, and bats account for the majority of the species present. Numerous amphibians and reptiles are common to the study area including multiple species of frogs, turtles, lizards, snakes.

The project area provides year-around habitat for approximately 31 bird species, with nearly 80 additional species using the project area for seasonal nesting and residency. Over 110 species use the corridor over the study area for seasonal migration.

The rivers' fishery is characterized by species typical of large, turbid rivers, including game fish species such as the smallmouth, buffalo, common carp, river carpsucker, shortnose and longnose gar, channel, flathead, and blue catfish, white crappie, freshwater drum, green sunfish, and bluegill. Forage species present include gizzard shad and various minnows and shiners.

The U.S. Fish and Wildlife Service lists the following Federally-listed threatened and endangered species as possibly occurring in the vicinity of the Missouri River in Doniphan County, Kansas, and Buchanan County, Missouri: piping plover, bald eagle, least tern, pallid sturgeon, and Indiana bat.

In addition to Federally-listed species, the Kansas Department of Wildlife and Parks also lists the following State-listed threatened and endangered species as possibly occurring in Doniphan County: American burying beetle, chestnut lamprey, eastern spotted skunk, silverband shiner, snowy plover, western earth snake, and white-faced ibis.

The Missouri Department of Conservation lists the pied-billed grebe as a sensitive species possibly occurring in the vicinity of the project.

Additional information on fish & wildlife species found in the study area including threatened and endangered species can be found in the Environmental Assessment.

The Corps of Engineers Missouri River Fish & Wildlife Mitigation Program is currently pursuing the purchase of land from willing sellers throughout the Missouri River corridor to implement habitat restoration efforts. Land has recently been purchased in the St. Joseph Study Area for inclusion in this program and additional land purchases are in negotiation. The planning and design of projects under this program are separate from the efforts and recommendations of this Feasibility Study; however, any proposed project under this program authority is expected to complement the recommendations herein and will be coordinated during project implementation.

9.0 Wetlands

National Wetlands Inventory Maps and NRCS soils maps have been reviewed. Site visits, including a Corps of Engineers wetland determination in the study area, were conducted. Numerous wetlands exist within the project area as small pockets, old meander scars, and within the riparian strips. Primarily, wetlands in this area are forested, followed by emergent and scrub-shrub. More information on the wetland determination methods used, and the results of the review, is included in the Environmental Assessment.

The Corps of Engineers Missouri River Enhancement Program is pursuing a project at Lake Contrary for restoration of the lake and its surrounding wetland and riparian habitat features. The planning and design of this proposed project is separate from the efforts and recommendations of this Feasibility Study; however, any proposed project under this program authority is expected to complement the recommendations herein and will be coordinated during project implementation.

10.0 Cultural Resources

A literature and background review of the study area was completed in 1996 and 2001. The review included the National Register of Historic Places, site records from the Kansas and Missouri State Historic Preservation Officers, archeological reports from projects in the region, and appropriate historical documents. The cultural resource review found no archeological sites or historic structures recorded within the study area. Since the 1996 review, no additional sites have been recorded within the study area.

The Corps also conducted an accreted land study of the area of potential effect to help determine the potential for archeological sites within the study area. The study was undertaken by using GIS to overlay historic Corps of Engineer Missouri River channel maps from 1804, 1879, 1892, 1926, 1954, as well as current maps to show the various locations of the river channel. The former channel locations are considered accreted land. The study found that much of the proposed project area is comprised of land accreted after 1879. These results along with the

results of the background literature review were coordinated with the appropriate SHPO, and it was determined that no historic properties would be affected by the project.

11.0 Hazardous, Toxic, and Radioactive Waste

A Feasibility Study Hazardous, Toxic, and Radiological Waste (HTRW) assessment of levee units L-455 and R471-460 was completed in 1999. This assessment included a search and review of the Environmental Protection Agency's database covering the St. Joseph and Elwood corridors and a site visit and interview with a local sponsor representative.

Potential HTRW sites on both levee units were review and resolved as not being of concern to the feasibility study. The completed assessment, including a summary of each site and how they were addressed, is included in Appendix E.

B. Future Conditions Without Project

1.0 Future Flooding

By current estimates, unit R471-460 has a 51.3-percent chance of passing a 1-percent chance (100-year) flood event. Large areas of existing residential, business and industrial development are now in a zone no longer afforded 100-year level of flood damage reduction, and increased economic hardship is expected to result. Modifications or improvements to businesses are constrained. New investment within the area would be constrained due to flood insurance requirements. The cities and infrastructure protected by R471-460 will enter into an economic decline with less viability for improvement or enhancement and increasing economic blight. If a project is not authorized to restore certification to the right bank, FEMA will enact a major zoning change that will greatly increase flood insurance requirements and greatly degrade the economic health of the area. Currently, mission essential upgrades to the Missouri Air National Guard Base at the airport are being jeopardized by the status of the levee. Some increases in investment are likely to take place including the expansion of the Air National Guard base but at much greater cost to the users. If the project recommended by this study is not implemented by the Federal government, then the non-Federal Sponsors will be faced with a significant financial burden of trying to implement the project themselves, or they will have to rely on flood-fighting to protect the area from future floods.

Current analysis shows that Unit L-455 currently has a 93.6-percent chance of containing a 1-percent chance flood. Potential expansion of the City of St. Joseph to the south will result in existing agricultural property being converted to residential, commercial, or industrial uses. As new investment increases, damages associated with flooding will increase.

2.0 Socioeconomic Considerations

Approximately 60 percent of the flood plain in the study area is agricultural, comprising about

12,300 acres. Residential and industrial uses make up about 25 percent of the floodplain, totaling approximately 1,968 homes and 290 businesses and facilities. Total investment for the study area is \$2 billion. The remaining land uses in the area are public and transportation infrastructure, woodlands, and wetlands.

Numerous city streets, county roads, State and Federal highways, and railroads cross the floodplain. Rosecrans Memorial Airport and the Missouri Air National Guard base are located in the floodplain. The wastewater treatment facilities for St. Joseph, Elwood, and Wathena are all located in the floodplain as well as other public utilities. In addition, there is agricultural land protected by the levees that could be developed for commercial and industrial uses. However, there is also an abundance of undeveloped land in the St. Joseph area that is not in the floodplain. Continuing industrial, commercial, residential, and transportation development is expected and, while much of the development will take place outside of the floodplain, pressures for floodplain use are expected to intensify.

The entire study area is part of the St. Joseph Metropolitan Statistical Area (MSA) (2000 pop. 102,490). Relative to the States of Missouri and Kansas as well as the nation, the population of the St. Joseph MSA is significantly older, more racially/ethnically homogeneous, and less educated. Home values are lower in the MSA than for the two states and the nation, per capita income is smaller, and the poverty rate is greater.

3.0 Environmental Considerations

Future conditions regarding the natural environment would likely be much as they are under the current condition. Natural growth of riparian and wetland habitats may occur subsequent to any changes in the current agricultural practices in the area. Without project implementation, the study area will remain under strict floodplain ordinances limiting new development, thus limiting environmental impacts such development might impose. However, potential increased flood-fighting, flood damage, and/or flood damage restoration efforts may temporarily impact the environmental setting.

C. Planning Problems and Opportunities

The primary study area problem is that the existing levees no longer provide the design level of flood damage reduction. This is supported by their performance during the 1993 flood and updated analysis performed using current criteria and modeling capabilities with a levee in place at this location.

This study presents the opportunity to restore the local flood damage reduction system to the design level and thereby minimize damages from future flood events. By doing so, there is the opportunity to provide the communities affected by previous floods with the confidence to continue with future economic development. Opportunities for protection or enhancement of the natural resources of the area also exist and may be addressed by this study or by other related activities currently taking place in the study area.

VII. Hydrology and Hydraulics

A. General

Hydrologic and hydraulic analyses were performed on the Missouri River by the Corps to produce water surface profiles for the Missouri River near St. Joseph, Missouri. The study area consists of approximately 56 river miles on the Missouri River, from RM 428 to RM 484. The existing conditions model was calibrated to the Upper Mississippi River Flow Frequency Study (UMRFFS) flood profiles for the study reach.

Hydrology for the Missouri River was originally evaluated and published in a Hydrology Report dated March, 1962. Since that time, the data presented in that report has been used by the Corps to estimate flood flows for subsequent flood damage reduction studies, FEMA flood insurance studies, and similar purposes. The UMRFFS study produced a detailed analysis of the effects of reservoir regulation on the main stem of the Missouri River and determined regulated flow frequency estimates applicable to the St. Joseph Feasibility Study. These discharges have been used to establish the existing conditions flow frequency data used in this study. A comparison of the two discharges is shown in Table 3.

Frequency (% Chance of Exceedance)	Return Interval (years)	1962 Missouri River Discharge at St. Joseph Gage (cfs)	UMRFFS Missouri River Discharge at St. Joseph Gage (cfs)
0.2	500	330,000	324,000
1	100	270,000	261,000
2	50	246,000	233,000
10	10	185,000	174,000

Expressing discharge probability in percent chance exceedance (occurrence) is currently used in lieu of a flood return interval expressed in years. Percent chance exceedance expresses the probability of the discharge occurring each year. A return interval is the period of time over which, on average, one flood event will equal or exceed that discharge. For example, a 1% chance exceedance flood event has a one-in-one-hundred chance of being equaled or exceeded in any given year. If a 1% chance exceedance flood event were to occur this year, the probability of occurring next year and the year after is still the same, 1%. On average, only one flood event would equal or exceed the 1% chance event during a 100-year time period, thus the term a 100-year flood event. For this document, discharge will be expressed as a percent chance of exceedance followed by the equivalent return interval. All profiles presented herein represent the “most probable” or “nominal” estimates of water surface elevations. It is possible that actual water surface elevations may be higher or lower than those shown.

The Hydrology and Hydraulic section of the Engineering Appendix documents development of

water surface profiles through the existing St. Joseph reach and evaluates alternatives for improving the integrity of the existing flood damage reduction system. The models developed in this study were used to model existing conditions, future conditions without project, and future conditions with project alternatives.

In addition, results from other studies are presented that characterize the existing conditions. These additional studies include: an analysis of levee tiebacks (levees along tributary streams that provide connection to higher ground); development of interior floodwater/exterior water surface elevation relationships; and impacts due to any proposed improvements.

B. Hydrologic Modeling

The overall hydrology and flow frequencies on the Missouri River in the St. Joseph area have been estimated in three major studies: *Missouri River Levees, Sioux City, Iowa to the Mouth* (1947); the *Missouri River Agriculture Levee Restudy Program* (1962); and *Upper Mississippi River System Flow Frequency Study* (2003). A discussion of each of those study results is provided in the Hydrology and Hydraulic chapter of the Engineering Appendix.

C. Hydraulic Modeling

The basis for the hydraulic analysis was the development of an existing and future conditions HEC-RAS model. HEC-RAS, version 3.1.3, as developed by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, was used in the analysis. This model attempted to calibrate to the flood event of 1993 from measured high-water marks and corresponding instantaneous discharge estimates. Since the St. Joseph reach was subject to a large levee failure on R471-460, the steady state HEC-RAS model had difficulty in calibrating to the 1993 profile. However, the UMRFFS included the use of an unsteady hydraulic model, UNET, for generation of flood profiles calibrated to the 1993 high water marks. The unsteady UNET model is capable of modeling the significant flow lost through the R471-460 breach in 1993 to be able to reproduce the 1993 flood profile through the St. Joseph study reach. Therefore, the HEC-RAS model used for the current St. Joseph study was calibrated to the UNET profiles generated for UMRFFS. Once the model was calibrated, a series of steady flow water surface profiles was created based on the flood discharges previously discussed. More detail of the hydraulic modeling efforts and results is provided in the Hydrology and Hydraulics section of the Engineering Appendix.

D. Authorized vs. Existing Performance

The general comprehensive plan for the Missouri River Levee System approved by Congress in the Flood Control Act of 1944 (P.L. 534, 78th Congress). The detailed plan for local flood damage reduction at St. Joseph, Missouri, was later published in *Missouri River Levees, Sioux City, Iowa to the Mouth, Definite Project Report*, 17 March 1947. This report assigns a design flood discharge of 325,000 cfs at St. Joseph. The 1947 report does not assign a frequency to the

design discharge.

By the time the two St Joseph projects (R460-471 and L455) were constructed, the *Missouri River Agricultural Levee Restudy Program – Hydrology Report* had been published (March 1962). This report re-addressed flood frequencies on the Missouri River. The flood frequencies generated in the 1962 Restudy provided the basis for flood damage reduction studies, flood insurance studies, and FEMA maps, for the next 40 years. The 1962 Restudy, taking into account the Missouri River main stem reservoirs, reported that at the St. Joseph gage the 500-year discharge was 330,000 cfs and the 100-year discharge was 270,000 cfs. Thus before the projects were constructed the anticipated level of flood damage reduction was nearly 500-year.

As presented previously in Table 3, the UMRFFS results indicate that flow frequencies in the St. Joseph area have not changed much from the 1962 study. The UMRFFS discharges are 324,000 cfs for the 0.2% chance (500-year) event and 260,000 cfs for the 1% chance (100-year) event. However, in the preparation of this feasibility study analysis, a detailed and technologically current hydraulic model of this specific project location has been prepared. This model has had the benefit of updated data such as cross sectional information and data provided by the UMRFFS study, and especially the experience of a major flood event with a levee actually in place, the 1993 flood, for calibration purposes. After development and calibration of the hydraulic model for the St. Joseph area, the estimate of the nominal 1 percent chance profile has increased.

Current analysis indicates that unit R460-471 currently has only a 51.3% probability of successfully passing the 1-percent chance (100-yr) discharge and would likely overtop at a discharge of 276,000 cfs. The St. Joseph levee system will not currently pass the original design discharge of 325,000 cfs.

Based on the determination that the system could not pass the authorized design flow, and in response to the observed events of 1993, additional research of the original design was conducted. Although cross-sections and channel geometry at the time of design (1965) were not available, detailed mapping of the Missouri River created in 1974 (six years following the completion of levee construction) was accessible. The original 1965 design was based on the authorized flow of 325,000 cfs and a comparison of levee crest elevations shows that the existing levee is at or above the design elevations. When the 1965 design parameters and the 1974 channel cross-sections were modeled together, the resulting water surface profile elevation was higher than the existing crest of unit R471-460. Greater detail of this analysis is provided in Section 2 of Appendix B.

The Corps of Engineers has determined that although MRLS Unit R471-460 was constructed as designed, the original design was not sufficient to provide the flow discharge capacity originally authorized by Congress. Improvements recommended later in this report will be categorized as corrections of a design deficiency and should not require additional Congressional authorization for implementation. It should be noted that this study has formulated and evaluated alternatives under current criteria and guidance for risk and reliability analysis and optimization of economic

benefits. The recommendations of this report may not fully restore the levee to the original design authorization but will provide for a system that functions in a safe, viable, and reliable manner, as was intended by its original designers.

E. Overtopping Location

No flood damage reduction project can guarantee total elimination of flooding. Corps of Engineers suggested guidance in Engineering Technical Letter (ETL) 1110-2-299 recommends the inclusion of design features into levee systems to attempt to control overtopping. This is so that if the discharge capacity of a project is exceeded, overtopping of the levee will occur at a known location along the unit. This allows the local community to anticipate where flooding impacts will first occur and theoretically lessens the flooding hazard. The selection of the preferred overtopping location per the guidance focuses on identifying the “least hazardous location” within the protected area.

Per the guidance, the least hazardous location is the location at which an overtopping failure will cause the least hazard to life and property within the protected area. This can include open areas such as golf courses, agricultural fields, or other undeveloped areas, oxbow lakes or other interior ponding, or the downstream end of a levee unit. Designing a levee system to initially overtop in a designated least hazardous location can prevent loss of life due to sudden levee failure, allow for increased warning time of impending flooding, and protect evacuation routes that may be needed during a flood event.

In the 1993 flood event, unit R460-471 failed due to overtopping in the northern (upstream) portion of the unit. This area consists of open agricultural fields and lies some five miles upstream of the intensely developed communities and areas of Elwood and Wathena, Kansas. There are no developed properties adjacent to the levee at this location, the area is upstream of an existing oxbow lake that can absorb some of the flow, and the distance to existing communities provides added warning time to existing infrastructure that may be used for evacuation.

Often, the least hazardous overtopping location in levees is at the downstream end. However, in this situation, moving the overtopping location further downstream from that previously experienced will place the residents and infrastructure of these communities at an increased hazard of quicker overtopping and inundation. Thus, the overtopping location in the northern undeveloped areas of the R460-471 Unit, the same overtopping location as experienced in the 1993 flood, lessens the threat of sudden inundation to intensely developed areas, and to the lines of communication infrastructure and evacuation routes of the unit. A comparison of this overtopping location to other possible locations, and the anticipation that the northern zone of the unit will remain in agricultural use of the foreseeable future, indicates that the 1993 overtopping point is the least hazardous location for this study area.

Based on the hazard review and determination, the hydraulic modeling conducted for this feasibility study assumed an overtopping location in the northern zone similar to that which occurred in the 1993 flood. Furthermore, minor refinements with very limited or no net cost increases to the project may be considered during the project design phase to ensure controlled overtopping in the northern area of Unit R460-471.

Unit L-455 has not shown any risk of overtopping during past events and therefore an overtopping location analysis was not conducted.

VIII. Economic Flood Damage Estimates

A. Economic Damage Analysis Methodology

The economic structure inventory in this study is categorized in terms of four basic land uses: residential, non-residential (including businesses, non-profit institutions such as churches and schools, public facilities and utilities), roads and streets, and agriculture (crops – farm sets are categorized in residential). Inundation damages to these property categories are the focus of the economic analysis. The price level for this analysis is October 2005. The Federal interest rate of 5.125 percent was used in annualizing costs and benefits over the 50-year period of analysis

The study area was divided into four reaches for the economic analysis, including two on each bank, as summarized in Table 4. The L-455 protected area extends from the downstream end at Contrary Creek at Missouri RM (River Mile) 437.35 to the upstream end at Whitehead Creek at RM 447.3. This area is divided into two reaches by the tiebacks along Brown’s Branch at RM 445.7. The upstream reach is a densely developed urban area which includes the central industrial district in the old stockyards as well as part of the King Hill neighborhood. The more rural downstream reach includes an extension of the central industrial district along Lower Lake Road, the residential areas of Kirschner-Purtell and Lake Contrary (the latter is an unincorporated area immediately southwest of St. Joseph’s city limits), and farmed land to the west and south of Lake Contrary. The two L-455 reaches are not hydraulically independent; flooding in the upstream reach could enter the downstream reach. However, flooding that begins downstream cannot back up into the upstream reach, and the overtopping point and critical geotechnical section for L-455 both are on the downstream segment of the levee.

Reach	Levee unit	Downstream river mile	Upstream river mile	Econ index point	Areas included
LB-US	L-455	445.70	447.30	446.32	Urban SW portion of St. Joseph; Stockyards & King Hill neighborhood
LB-DS	L-455	437.35	445.70	441.39	Lake Contrary; surrounding ag areas; Kirschner-Purtell neighborhood
RB-US	R-471-460	449.50	456.50	449.99	Rosecrans Airport; Air Guard base; ag area
RB-DS	R-471-460	441.80	449.50	449.44	Town of Elwood; town of Wathena (portion); Hwy. 36

On the right bank, the R471-460 area also is divided into downstream and upstream components, although there is no physical feature that clearly delineates the two reaches. The protected area extends from Peters Creek at RM 441.8 to the upstream tieback near Treece Road at RM 456.5. This area is divided into two reaches at RM 449.5, a somewhat arbitrary point highlighting differences in the water surface profiles affecting the upstream and downstream portions of the levied area. The downstream right bank area includes the town of Elwood, Kansas, a portion of the town of Wathena, Kansas, and the commercial and industrial area along U.S. Highway 36

connecting the two towns. The upstream reach includes the Rosecrans Airport area, the Missouri Air National Guard base, a large farming region north of the airport, and a number of rural residences. The airport and Air Guard base are in the Missouri portion of the reach, while the farmed areas are primarily in the Kansas portions.

A structure-by-structure field survey was carried out by economics staff in 2004. Each structure in the protected areas within the 0.2% floodplain (and slightly beyond in some areas) was surveyed, accounting for more than 2,200 structures. Information noted for each structure included address; identification of business/facility and industry at non-residential properties; type of home (single, duplex, multiple, mobile home); construction type and quality; with or without basement; number of stories; first floor elevations relative to ground elevations; condition; and estimated age. Significant outbuildings and outdoor inventory or equipment also were noted. 1998 GIS mapping was obtained from the city of St. Joseph and the Corps' Missouri River floodplain mapping. The available maps were contoured at intervals of four feet and also contained many spot elevations. In addition, square footage for each building was estimated by Corps staff from the footprint of each building in the protected areas.

The other major data collection task involved extensive on-site interviews with major companies and facilities in the study area for the purpose of collecting detailed values and depth-damage data. It was not possible within the study scope to interview all or most businesses in the study area. Therefore, emphasis was placed on those businesses and facilities with the largest investments in the protected areas. In this study area, a large percentage of total property value is accounted for by a few very large facilities. Ultimately, 20 extensive interviews were carried out, including 14 in the L-455 area and six in the R471-460 area. Based on the final economic database values, the interviewed firms and facilities accounted for 57% of all non-residential investment and 47% of total investment in the study area.

Appendix C contains a detailed account of how values, damage potential, and elevations were assigned to businesses and facilities, homes, roads and streets, and crop acreage. The damage analysis employs the HEC-FDA software (Hydrologic Engineering Center's Flood Damage Reduction Analysis program), a risk analysis software product that is the Corps standard for flood damage reduction analyses. HEC-FDA integrates economic data with hydraulic/hydrologic and geotechnical/structural engineering data, including uncertainty factors for each type of data, to produce estimates of project economic and engineering performance under existing without-project conditions and alternatives

Engineering inputs for the model include water surface profiles with stages and discharges for a range of eight selected flood events. In this analysis, profiles were obtained for eight events: 50%, 20%, 10%, 5%, 2%, 1%, 0.5%, and 0.2% chance events, plus invert stages. Sets of profiles were prepared for both the 2013 and 2038 analysis years. Discharge-probability and stage-discharge relationships were provided for each reach, including uncertainty factors. Top of levee stages based on critical levee low points were translated to each index point, as were exterior-interior stage relationships. Geotechnical probability of failure curves were developed for one critical section on each levee and then adjusted to the appropriate index points.

The economic damage analysis evaluates without and with project conditions based on a 50-year period of analysis, the standard assumption for a Federal levee. In addition to the existing conditions analysis which represents conditions as of 2006, the analysis also assumes a base year of 2013, the approximate year any project would become operational, and a future condition year of 2038, which is the midpoint of the 50-year period beginning in 2013. No additional, separate analysis for the present or existing condition was prepared since there would be no known differences relative to the 2013 base year in terms of either economic development or hydrologic/ hydraulic conditions. Therefore, the analysis for 2013 should adequately portray both existing and base year conditions.

B. Study Area Investment

The economic structure inventory for this analysis, as defined in the field survey and subsequently developed and refined, is summarized in Table 5.

TABLE 5						
STUDY AREA INVESTMENT TOTALS						
In \$1,000s	L-455		R471-460		TOTAL	
RESIDENTIAL						
# Homes	1,301	66.1%	667	33.9%	1,968	
Structure Value	\$68,066.5		\$37,905.3		\$105,971.8	
Contents Value	\$47,646.5		\$26,533.7		\$74,180.2	
Total Value	\$115,713.0	64.2%	\$64,439.0	35.8%	\$180,152.0	9.0%
NON-RESIDENTIAL						
# Businesses / Facilities	166	57.2%	124	42.8%	290	
Structure Value	\$322,262.8		\$196,012.3		\$518,275.1	
Contents Value	\$877,551.2		\$245,813.5		\$1,123,364.7	
Total Value	\$1,199,814.0	73.1%	\$441,825.8	26.9%	\$1,641,639.0	82.2%
ROADS						
Miles	52.9	66.4%	26.8	33.6%	79.7	
Total Value	\$102,698.9	65.4%	\$54,235.1	34.6%	\$156,934.0	7.9%
CROPS						
Acres	5,100	41.5%	7,200	58.5%	12,300	
Total Value	\$7,650.0	41.5%	\$10,800.0	58.5%	\$18,450.0	0.9%
GRAND TOTAL	\$1,425,875.9	71.4%	\$571,299.9	28.6%	\$1,997,175.0	100.0%

Total investment in homes, businesses and facilities, roads, and crop acreage is an estimated \$2 billion. The L-455 area accounts for 71% of the total, or \$1.426 billion. R471-460 area investment is an estimated \$571 million, accounting for the remaining 29% of the study area. There are 1,968 homes and 290 businesses and facilities in the study area. The L-455 area contains two-thirds of the homes (1,301) and 57% of the non-residential properties (165). L-455 also contains 53 miles of roads, streets and railroad track (about two-thirds of the study area total) and 5,100 crop acres (about 41% of the total). The R471-460 area contains 667 homes and 125 non-residential properties, as well as 27 miles of roads and 7,200 crop acres.

Dividing up the investment by category, residential accounts for 9%, non-residential comprises 82.2%, roads account for 7.9%, and crops make up the remaining 0.9% of total investment.

C. Damage Results

This section summarizes results of the economic analysis as they pertain to beginning damage points and selected flood events. A more detailed analysis and discussion of the with and without project condition damages is presented in Appendix C.

Expected Annual Damages – Existing and Base Year Conditions Without Project

Expected annual damages (EAD) under existing and base year conditions are summarized in Table 6. Total study area EAD is an estimated \$7.84 million. About 77% of this total, or \$6.06 million, is associated with the R471-460 unit. The L-455 unit accounts for the remaining EAD total of \$1.77 million. The R471-460 levee has greater EAD than L-455 despite having a much smaller property base because the decertified right bank levee is not as high and has more significant geotechnical issues.

TABLE 6 EXPECTED ANNUAL DAMAGES BY CATEGORY EXISTING / BASE YEAR CONDITIONS - WITHOUT PROJECT					
in \$1,000's	Residential	Non-Residential	Roads	Crops	Total
L-455					
Downstream	\$101.5	\$1,078.8	\$40.5	\$2.3	\$1,223.1
Upstream	\$2.3	\$542.5	\$5.9	\$0.0	\$550.7
L-455 Total	\$103.8	\$1,621.3	\$46.4	\$2.3	\$1,773.8
R471-460 Total					
Downstream	\$738.4	\$2,726.0	\$232.8	\$5.1	\$3,702.3
Upstream	\$20.5	\$2,319.3	\$4.3	\$18.2	\$2,362.4
R471-460 Total	\$758.9	\$5,045.3	\$237.2	\$23.3	\$6,064.7
Study Area Total	\$862.7	\$6,666.6	\$283.6	\$25.6	\$7,838.5

Expected Annual Damages – Future Conditions Without Project

As shown in Table 7, EAD increases from \$7.84 million in the existing and base conditions to \$9.03 million in the future conditions of 2038. This is an increase of 15%. The increase in EAD is disproportionately due to L-455, where EAD increases almost 33%. The increase in the R471-460 area is only about 10%. Note: R471-460 upstream reach shows drop in EAD from base to future conditions due to relocation of Missouri Air Guard base to higher ground by future condition.

TABLE 7				
EXPECTED ANNUAL DAMAGES				
FUTURE WITHOUT-PROJECT CONDITION (2038)				
Damage in \$1,000's	2013	2038	% Change	EAD
L-455				
Downstream				
Residential	\$101.5	\$109.3	7.7%	\$105.5
Non-Residential	\$1,078.8	\$1,159.5	7.5%	\$1,120.6
Roads	\$40.5	\$44.7	10.4%	\$42.7
Crops	\$2.3	\$2.4	6.1%	\$2.4
Total	\$1,223.1	\$1,315.9	7.6%	\$1,271.1
Upstream				
Residential	\$2.3	\$5.1	120.3%	\$3.8
Non-Residential	\$542.5	\$1,022.9	88.6%	\$790.9
Roads	\$5.9	\$11.5	94.2%	\$8.8
Crops	\$0.0	\$0.0	0.0%	\$0.0
Total	\$550.7	\$1,039.4	88.7%	\$803.4
L-455 TOTAL	\$1,773.8	\$2,355.3	32.8%	\$2,074.5
R471-460				
Downstream				
Residential	\$738.4	\$919.1	24.5%	\$831.9
Non-Residential	\$2,726.0	\$3,415.8	25.3%	\$3,082.7
Roads	\$232.8	\$294.2	26.3%	\$264.5
Crops	\$5.1	\$6.0	19.6%	\$5.6
Total	\$3,702.3	\$4,635.1	25.2%	\$4,184.6
Upstream				
Residential	\$20.5	\$34.6	68.2%	\$27.8
Non-Residential	\$2,319.3	\$1,964.1	-15.3%	\$2,135.6
Roads	\$4.3	\$7.4	71.0%	\$5.9
Crops	\$18.2	\$30.0	64.4%	\$24.3
Total	\$2,362.4	\$2,036.0	-13.8%	\$2,193.6
R471-460 TOTAL	\$6,064.7	\$6,671.1	10.0%	\$6,378.3
STUDY AREA TOTAL	\$7,838.5	\$9,026.5	15.2%	\$8,452.8

The primary distinction between existing/base and future conditions in this study involves increases in Missouri River stages. Water surface profiles prepared for the future condition in this study reflect stage increases over existing/base year conditions for all events analyzed. Stages increase by up to 0.7 feet in the largest events. The stage increases, based on published

historical analysis of Missouri River stages over time, are believed to be caused by the effects of sedimentation. More information on the hydraulic data and its assumptions can be found in Appendix B to this report.

Beginning Damage Elevations

Under existing conditions of 2006 or base year conditions of 2013, the R471-460 area could suffer flood damage in an event smaller than the 1% chance event – specifically, in an event within the range of 2% chance (50-year) to 1.33% chance (75-year). Damage to the L-455 area, on the other hand, would require a flood of a 0.2% chance magnitude. These probabilities take into account both overtopping and failure. The probabilities are approximate since risk analysis outputs are furnished only for a few selected events.

Single Event Damages

Table 8 presents the damages for specific flood magnitudes under existing conditions.

TABLE 8			
SINGLE EVENT DAMAGES - EXISTING CONDITIONS (2006)			
(in 1000's)			
	L-455	R471-460	Total
<u>1% Event</u>			
Total Damage	\$0.0	\$304,332.8	\$304,332.8
Homes Affected	0	663	663
Businesses Affected	0	121	121
Average Depths	0.0	6.7	
Maximum Depths	0.0	17.7	
<u>0.5% Event</u>			
Total Damage	\$0.0	\$343,429.5	\$343,429.5
Homes Affected	0	666	666
Businesses Affected	0	124	124
Average Depths	0.0	8.1	
Maximum Depths	0.0	19.0	
<u>0.2% Event</u>			
Total Damage	\$316,015.1	\$369,501.6	\$685,516.7
Homes Affected	590	666	1,256
Businesses Affected	23	124	147
Average Depths	9.8	10	
Maximum Depths	20.8	20.8	

A 1%-chance (or 100-year) flood under existing conditions would be associated with a discharge of 261,000 cubic feet per second (cfs). A flood of this magnitude would result in damages of \$304.3 million, all in the R471-460 area. L-455 would not be flooded. All but 4 of the 667 homes in the R471-460 area and all but 4 of the 125 businesses and facilities would be affected. Depths in the flooded areas would average 6.7 feet and would reach as much as 17.7 feet.

A 0.5%-chance, or 200-year flood, under existing conditions would be associated with a discharge of 287,000 cfs. The L-455 area would not be flooded, but the R471-460 area would suffer damages of \$343.4 million. All but one of the 125 businesses and facilities and all but 1 of the 667 homes in the right bank area would be affected by depths averaging 8.1 feet and reaching as much as 19 feet.

A 0.2% or 500-year flood, under existing conditions, would reach a discharge of 324,000 cfs. Damages in the R471-460 area would total \$369.5 million or 54% of total damage in the study area. In the right bank area, 666 homes and 124 businesses and facilities would be damaged by depths of up to 20.8 feet and averaging about 10 feet. The L-455 area's downstream reach would experience similar depths, resulting in damage of \$316 million or 46% of the total study area damage. Twenty-three businesses and facilities and 590 homes would be affected, all in the downstream left bank area. The upstream reach of L-455 would not flood. Damage in the study area overall would total \$685.5 million.

In a 0.2% chance event under 2038 conditions, flooding would occur in both units. Damages would top \$1 billion, almost two-thirds of which would be sustained in the L-455 area.

Nonexceedance Probability Ratings

Key results for each unit are summarized in Tables 9 and 10, under existing and future conditions respectively.

TABLE 9 LEVEE ENGINEERING PERFORMANCE RATINGS EXISTING / BASE WITHOUT-PROJECT CONDITON (2013)						
	R471-460			L-455		
	overall	downstream	upstream	overall	downstream	upstream
Top of levee elevations						
Reference river mile		449.4	450.0		441.4	446.3
Existing (without-project) TOL		822.1	822.8		816.0	821.2
Annual Exceedance Probability						
Median (as %)	1.4%	1.4%	1.4%	0.1%	0.1%	0.1%
Expected (as %)	1.7%	1.7%	1.7%	0.1%	0.3%	0.1%
Long-Term Risk (years)						
10 years						
Exceedance probability	16.1%	16.2%	16.1%	2.5%	2.5%	1.2%
Exceedance chance over period	1 in 6.2	1 in 6.2	1 in 6.2	1 in 39.8	1 in 39.8	1 in 83.3
25 years						
Exceedance probability	35.6%	35.6%	35.6%	6.2%	6.2%	3.0%
Exceedance chance over period	1 in 2.8	1 in 2.8	1 in 2.8	1 in 16	1 in 16	1 in 38.5
50 years						
Exceedance probability	58.5%	58.6%	58.5%	12.1%	12.0%	5.9%
Exceedance chance over period	1 in 1.7	1 in 1.7	1 in 1.7	1 in 8.4	1 in 8.4	1 in 17.1
1%-chance flood event context						
Levee height superiority (feet)						

Reference flood elevation		821.2	821.9		812.9	817.5
Without-project	0.9	0.9	0.9	3.1	3.1	3.7
Nonexceedance probability (as %)						
Without-project	51.3%	51.4%	51.3%	93.6%	93.6%	97.3%
Overtopping only	67.8%	67.9%	67.8%	95.0%	95.0%	97.3%
0.2%-chance flood event context						
Levee height superiority (feet)						
Reference flood elevation		824.7	825.5		815.8	820.7
Without-project	-2.7	-2.7	-2.7	0.2	0.2	0.6

TABLE 10 LEVEE ENGINEERING PERFORMANCE RATINGS FUTURE WITHOUT-PROJECT CONDITION (2038)						
	R471-460			L-455		
	overall	downstream	upstream	overall	Downstream	upstream
Top of levee elevations						
Reference river mile		449.4	450.0		441.4	446.3
Existing (without-project) TOL		822.1	822.8		816.0	821.2
Annual Exceedance Probability						
Median (%)	1.70%	1.70%	1.70%	0.10%	0.10%	0.20%
Expected (%)	2.10%	2.10%	2.10%	0.30%	0.30%	0.30%
Long-Term Risk (years)						
10 years	19.38%	19.38%	19.03%	2.68%	2.68%	2.51%
25 years	41.64%	41.64%	41.01%	6.56%	6.56%	6.15%
50 years	65.94%	65.94%	65.20%	12.69%	12.69%	11.92%
1%-chance flood event context						
Levee height superiority (feet)						
Reference flood elevation		821.8	822.5		812.9	818.0
Without-project	0.3	0.3	0.4	3.1	3.1	3.7
Nonexceedance probability (as %)						
Without-project	41.8%	41.8%	42.9%	92.8%	92.8%	94.0%
Overtopping only	56.6%	56.6%	57.6%	94.0%	94.1%	94.0%
0.2%-chance flood event context						
Levee height superiority (feet)						
Reference flood elevation		825.5	826.2		815.8	821.3
Without-project	-3.4	-3.4	-3.4	0.2	0.2	0.6

The main results of the risk analysis pertaining to each unit are as follows:

R471-460

- The R471-460 unit has only a 67.8% chance of containing a 1%-chance flood event under existing/base year conditions and a 56.6% chance under future conditions; well below the 90% or better reliability required for FEMA levee certification. Under future conditions, the non-exceedance probability drops to 41.8%. These non-exceedance probabilities account for damage due to either overtopping or levee failure.
- R471-460 has a margin above the nominal 1% chance flood elevation of 0.9 feet under existing or base year conditions, compared to the three foot margin that is necessary to meet the criterion for FEMA certification of levees. The margin drops to 0.3 feet under future conditions.
- If overtopping alone is considered without geotechnical or structural considerations, the R471-460 unit has a 67.8% chance of containing the 1% flood under existing/base conditions, still well below the 90% standard even without adding geotechnical risk factors
- In its current condition, a 0.2% chance flood would exceed the R471-460 top of levee by 2.7 feet.
- Over 10 years, under existing/base year conditions, the chance of overtopping or failure would be 16%; over 25 years, 36%; over 50 years, 58%.

L-455

- The L-455 levee would have a 93.6% chance of containing a 1% chance flood event under existing or base year conditions, considering risk of both overtopping and failure. Under future conditions, the nonexceedance probability becomes 92.8%.
- If geotechnical considerations are left aside, L-455 would have a 95% chance of containing a 1% chance overtopping event.
- The levee has a margin of 3.1 feet over the nominal 1% chance flood elevation.
- L-455's height exceeds the nominal 0.2% chance flood elevation, although only by 0.2 feet.
- Long term risk of overtopping or failure is about 2.5% over 10 years; 6% over 25 years; and 12% over 50 years.

IX. Plan Formulation

A. Planning Constraints

The following planning constraints affect many decisions related to study execution:

- The study shall be conducted in accordance with the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, as approved by President Ronald Reagan, February 3, 1983 and accepted by the United States Water Resources Council on February 22, 1983. These guidelines are contained in the U.S. Army Corps of Engineers Engineering Regulation (ER) 1105-2-100, *Policy and Planning, Guidance for Conducting Civil Works Planning Studies*.
- Feasible projects will comply with the principles of Executive Order 11988 which addresses floodplain management and Section 404 of the Clean Water Act concerning the protection of wetlands. Project planning must be accomplished to minimize project effects on floodplains in general, and wetlands and other environmental features. Mitigation must be considered where applicable
- Project formulation will adhere to FEMA guidelines adopted by the State of Missouri regarding the regulatory floodway. These guidelines require that construction in the base flood plain be accomplished in such a manner as to limit any resulting increase in the 1.0-percent-chance flood elevation to less than one foot.
- Project Design alternatives recognize the provisions of Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act and the Hazard Mitigation Grant Program administered by FEMA and the Missouri State Emergency Management Agency.
- Relationships between the levee units will be maintained. For this feasibility study, the examination of measures to increase the performance of the system will be guided by an overarching principle that seeks to achieve a relatively consistent level of performance throughout the system. This essentially means that the study should avoid recommending:
 - Any measures which would directly or indirectly exacerbate any performance weaknesses (or relative weaknesses) of either unit.
 - Any measures that would contribute to increasing the level of performance of one unit without a commensurate increase or at the expense of the other unit.

- Project alternative screening will consider the financial capability of the local sponsors. Feasibility phase financial constraints play a very significant role in the execution of this study. Sponsor affordability and associated financial constraints demand that feasibility analysis, scoping, and planning decisions must first focus on those areas, measures and solutions which address pressing needs or significant performance weaknesses within the overall system as these will provide the greatest relative opportunity for reliability improvements.
- All other items of the study will be in accordance with the standards of the U.S. Army Corps of Engineers.

B. Planning Objectives

A primary objective of Corps feasibility studies is to comply with the national objective of water and related land resources planning. This includes contributing to the National Economic Development (NED) consistent with protecting the Nation's environment. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. The NED Plan is that alternative that maximizes net benefits over the period of analysis.

Following the decision by FEMA in 1999 to de-certify the levee, it became imperative to the communities within the protected zone to restore the ability of the system to pass the FEMA Base Flood and regain certification. FEMA defines the Base Flood as the 1.0% chance (100-yr) flood, and requires that a levee pass this flood with a minimum 90% reliability. At the request of the sponsors, restoring the FEMA certification of Unit R471-460 was established as an additional primary planning objective for the Feasibility Study.

Other planning objectives for the Feasibility Study include:

- Update and verify data on the reliability of the existing project performance under flood conditions.
- Develop alternative plans (to include a review of the "no Federal action" alternative) for reestablishing the overall reliability of the existing system, increasing economic flood damage reduction benefits over the existing condition, and provide a final recommended plan for implementation that is technically sound and economically feasible.
- Reduce the potential for loss of life and human suffering caused by flooding within the project area.
- Minimize the impact of any proposed project within the project area and surrounding

areas.

- Maintain the current environmental conditions and preserve the cultural and historical resources within the project area and surrounding areas.

C. Measures Considered for Plan Formulation

Traditional Corps analyses for identification of the NED plan (the plan with the highest net benefits) involve identifying an array of measures (structural and non-structural) to achieve the stated objectives and then determining the most cost-effective combination of those measures that fully addresses the identified problems.

1.0 Non-Structural Measures

Flood Warning System with Temporary Evacuation Plan. This alternative would provide study area businesses and residences with warning of a predicted flood. Additionally, those having the capability to relocate would have the opportunity to do so. Typically, a rain and/or stream gage infrastructure is required to monitor hydrologic conditions in the basin and serve as a basis for providing early prediction and warning of impending high water at pre-designated areas prone to flooding. A key requirement is a realistic and funded/resourced response plan implemented by jurisdictional governing agencies.

Flood Proofing. Flood proofing existing structures consists of several strategies or methods depending upon structure types. These include raising them to place the first flood elevation above the level of threatened flooding; waterproofing of structures up to maximum or specified flood height; providing closure gaps for opening below flood levels; or building flood walls or levees around individual structures. These measures would reduce flood damages and benefit only those properties treated.

Permanent Evacuation / Floodplain Buy Out. Permanent evacuation is the relocation of damageable investment to areas that are not within a flood hazard zone. Then, the remaining properties (and abandoned structure if applicable) must be converted to a land use purpose compatible with flood plain conditions (e.g. parks and recreation or agriculture).

Modification of Missouri River Water Levels. A change in the average water surface profile of the Missouri River might be accomplished by changes in the operation of upstream dams.

2.0 Structural Measures

Channel Modification. Channel Modification would consist of widening, deepening, or otherwise realigning the existing river. In this manner, hydraulic efficiency is improved and water surfaces are reduced to eliminate or lessen flooding.

Realignment of Levee. Realignment of an existing flood damage reduction project could

expand the floodplain and provide more space for the river to spread out during a flood, thus lowering the local flood profile. This would require considerable additional real estate, new levee and drainage structure construction, and would cause some areas currently protected to be exposed to lower flood events.

Raise the Existing Levee. Increasing the height of an existing flood damage reduction project will increase the ability and reliability of the project to pass a flood event of specific magnitude. The height of the raise will depend upon the chosen design flood profile. Multiple flood profiles should be evaluated to determine the optimal height.

D. Screening of Measures

Plans consist of measures or combinations of measures with the greatest potential to reduce damages. The initial screening process allows only plans that have the potential to be technically and economically feasible and environmentally sound to be carried forward for economic screening. The initial screening was accomplished on the first array of plans developed from the available measures retained for formulation. For the initial formulation and screening, detailed quantification of performance and effects was not required. Professional judgment and obvious critical adverse factors were used to narrow the alternative plans to a smaller array for detailed screening. The “No Federal Action” plan is retained throughout for comparison.

Each of the proposed alternatives is identified as retained for, or eliminated from, further plan formulation.

Flood Warning System - Eliminated

A flood warning system is not considered useful to address the concerns of this study area. Floods on the Missouri River are affected by conditions hundreds of miles upstream and take a considerable amount of time to develop. Adequate warning is available via television and other media outlets for Missouri River flood events.

Flood Proofing - Eliminated

The large number and diversity of structures, types, sizes, and construction of facilities would make it infeasible to modify these to a consistent level of flood damage reduction.

Permanent Evacuation – Eliminated

The size of the affected population and amount of development in the study area preclude consideration of permanent evacuation of the study area.

River Level Changes – Eliminated

The closest dam that could be operated for river level changes is 360 miles upstream. The complex Missouri River system is unable to be managed to the necessary level to measure effects at a single levee unit.

Channel Modification - Eliminated

The existing levees and the size and magnitude of flow of the Missouri River present significant limitations to modification. Furthermore, these types of features would have detrimental effects upon the aquatic, riparian, and woodland habitat in the river corridor. Channel modification could significantly change the stage frequency relationship downstream. The Federal government is currently under Congressional mandate to mitigate for impacts from past channel modification activities. Further channel modification would be counter to this mandate.

Levee Setback/Realignment - Eliminated

Two options are available for possible realignment of Unit R471-460. At approximately river mile 448 the levee moves closer to the river, narrowing the floodway and creating a constriction (or “pinch point”) during high flow events. This constriction could be reduced by realignment of the levee in this location, or the unit could be realigned further upstream to provide a wider floodway upstream of the narrow point for increased floodplain storage during high flow events.

Levee Setback

The narrow point in the levee alignment at approximately river mile 448 coincides with the river bend immediately upstream of Unit L-455. Setting back Unit R471-460 at this location would provide for a wider floodway during high flow events. This location also coincides with an active Union Pacific railroad bridge and the double-span bridge carrying US Highway 36. There is significant business development, including a large construction company, located between the two bridges immediately inside the protected area. Both bridges would likely require extensive modification and the existing businesses would have to be relocated to achieve significant levee setback. A levee setback in this location could lower the general water surface profile in this vicinity up to half a foot. This is not enough to offset the overtopping concern for the remainder of the unit. Bridge modification, real estate acquisition, business demolition and relocation, and new levee construction would all contribute to a significantly higher cost for this alternative.

Environmental benefits would be only marginally enhanced by the creation of a short reach of new riverside floodplain habitat relative to the currently existing resources in the area. The economic benefits of the alternative would be negatively impacted by the loss of businesses in the area and the increased cost. Based on preliminary analysis, the marginal hydraulic and environmental benefits of a levee setback in the vicinity of river mile 448 do not offset the significant adverse economic, engineering, transportation, and social impacts that would be incurred to the project. Levee setback options were not considered further in this area.

Levee Realignment in Upstream Portion of Unit R471-460

Upstream of the narrow point, consideration was given to methods to expand the floodway to provide storage during high flow events. In this area, the levee could be realigned toward the bluffs and existing levee alignment removed, providing increased floodplain volume and connectivity to the river. Alternatively, the old levee alignment could remain, and be allowed to overtop and fail during high flows, providing some increment of additional storage during large floods. In order to achieve levee certification for the communities and facilities in the study area, the new section of levee could be constructed north of Rosecrans Airport starting near river mile 452 to connect the existing levee with the bluff to the west. Requirements and anticipated impacts of this new levee are as follows:

- The existing levee cannot likely be removed without specific authorization from Congress. Removal of the remaining existing levee section would likely be politically and socially unacceptable. The remaining existing levee section would likely still be maintained in operation by the local entities. If maintained in accordance with the program, it would be eligible for flood disaster relief under the provision of Public Law 84-99. Future claims for Federal assistance for flood fighting and damage restoration would likely increase. With the existing levee section still in place, the incremental floodplain benefits associated with a realignment of the Federal project in the north would be marginal.
- The new alignment would cross the flight path in close proximity to the airport creating a right-of-way encroachment and safety issue that likely would not be acceptable to the Air Guard or the Federal Aviation Administration.
- Formulating an alternative that allows for the overtopping and failure of an existing levee does not meet the stated planning objectives of this study.
- Nearly three miles of new levee would be constructed, requiring significant real estate acquisition, additional material borrow sites, new drainage structures, and possible road closure structure at the tie-in to the bluff. This feature would involve a significant cost increase.
- There is no guarantee that real estate agreements would be easily reached with existing land owners and condemnation might be necessary. Such negotiations, and additional construction time, would likely cause a protracted delay that would prolong the exposure of residents to impacts and risk from the currently decertified levee.
- Approximately six miles of the existing levee downstream of river mile 452 would still be subject to an overtopping concern that would need to be addressed to restore FEMA certification.

- The introduction of a new levee section into an existing levee system will increase the annual operation and maintenance costs.
- The new alignment would permanently remove some agricultural ground from production due to construction and would allow significant additional acreage of productive agricultural property to remain subject to impact from lesser floods. Some existing benefits of the existing project would be lost by removing this property from the certified area.
- No additional environmental benefits would be realized if the existing levee stays in place and existing agricultural land remains in production. To realize any environmental benefits from realignment, the existing levee would have to be removed entirely and the land allowed to revert to a natural riparian state. This may require the government to buy out the existing agricultural property at considerable additional expense to the project.
- Significant political and public protest would result from any proposal to remove property from the protected area or physically remove any existing section of levee.
- Implementation of changes to existing levee alignment would require additional Congressional authorization

A point-by-point consideration of the cost impacts to construct a new levee section, including all aspects discussed herein, indicated that realignment options would be greater than the cost of other alternatives proposed in the same area. Due to anticipated higher costs, a decrease in existing project benefits, and serious concerns over the social impacts of the proposal to the area communities, the levee realignment alternative was not carried forward for additional analysis

Levee Raise – Retained

Raising the existing project to provide a higher reliability against overtopping is considered economically and technically feasible and is retained for further consideration.

E. Initial Plan Formulation and Screening Results

Based on the initial screening of alternatives, the non-structural alternatives were not found to be potentially effective to offset the magnitude of flooding expected in such a large study area. None of the proposed non-structural alternatives were retained for further analysis. Only the structural levee raise alternative was considered to meet the planning objectives and be economically, environmentally, and socially acceptable for continued analysis.

In addition to a series of levee raise alternatives, the no action plan was retained for continued evaluation.

1.0 No Action Alternative

The “No Action” alternative will not reduce existing flood damage potential. Flood-fighting and reliance on flood insurance will be the only recourse for the affected communities. The National Flood Insurance Program (NFIP) helps to minimize the creation of additional damages within the areas covered by flood insurance through continued compliance with the flood plain zoning ordinances. The NFIP can also help reduce financial losses incurred during a flood event through flood insurance payments for actual flood damages sustained. However, this measure in itself does not prevent flood damages nor does it present a long-term solution for flood damage reduction. Without increased flood damage reduction over the existing condition, Unit R471-460 will remain uncertified by FEMA. If restoration of the levee is not complete within ten years of an AR Zone designation the study area will be given an AE Zone designation, NFIP premiums will be raised, and limitations on future development will be imposed. These higher insurance costs and limitations will create significant economic hardship on the communities that have been developing in the protected areas. Plans for future expansion of the Air National Guard base and other industrial/business facilities near Rosecrans Airport will be jeopardized.

2.0 Structural Alternatives

Raise Existing Levee

Several potential design floods were analyzed for levee raise alternatives:

- 1% (100-yr) flood plus one and one-half feet (100+1.5)
- 1% flood plus three feet (100+3). This is minimum flood level needed for FEMA certification.
- The observed 1993 flood event
- 0.2% (500-yr) flood event (500+0)
- 0.2% flood event plus one and one-half feet (500+1.5)
- 0.2% flood event plus three feet (500+3)

The existing condition evaluation of each of the levee units determined that Unit R471-460 has a higher overtopping exceedance probability than Unit L-455. Therefore it was determined that for each alternative, necessary raises would be developed first for Unit R471-460 and then for Unit L-455 as needed to mitigate any potential across river induced damages or provide consistent level of performance for the system. Furthermore, geotechnical and structural features located within the horizontal limits of raise would be analyzed for probability of failure and would be improved concurrently as needed.

To establish a basis for comparison and screening, the nominal 1-percent flood event water surface profile plus three feet (100+3) was developed and used to establish the benchmark horizontal and vertical limits of raise that would be necessary for Unit R471-460. The additional three feet is the necessary amount to provide 90% reliability to pass the 1-percent event and regain certification of Unit R471-460. Within the determined horizontal limits, this profile is very close to the estimated level of the 1993 flood as determined by high water mark calibration.

Further, the differences between the modeled 100+3 and 500+0 profiles were determined to be insignificant. Thus, separate analysis of these flood profiles is not necessary and they can be eliminated.

Raises in the levee height will cause higher hydraulic pressures on the levee, its foundation, and drainage features. Modifications to the existing underseepage berms and pressure relief wells may be needed to counteract these additional forces. Consideration of expansion of the underseepage berms, additional relief well installation, or replacement of the existing wells, is required as part of each raise alternative analysis. Existing drainage structures, pipes, utilities, and manholes located in or near the levee will require evaluation to determine their ability withstand higher hydraulic and soil load pressures.

3.0 Summary of Initial Plan Screening

Five alternative plans are retained for further detailed analysis:

No Federal Action – It is required to retain this plan for comparison purposes throughout the screening process.

Structural Plans

Alternative 1. 100+3 – This plan would raise both units as needed to allow passage of the 1% flood (100 yr) event with minimum 90% reliability against failure.

Alternative 2. 500+1.5 – This plan would raise both units as needed to allow passage of the 0.2% flood (500 yr) event with approximately 50% reliability against failure

Alternative 3. 500+3.0 – This plan would raise both units as needed to allow passage of the 0.2% (500 yr) flood event with approximately 90% reliability against failure

Alternative 4. 100+1.5 – This plan would raise only unit R471-460 as needed to allow passage of the 1% flood (100 yr) event with approximately 75% reliability. No raise of Unit L-455 would be included.

F. Detailed Plan Formulation – Final Array of Plans

1.0 No Federal Action

No additional flood damage reduction would be provided under the “No Action” Alternative. Without modification to the existing flood damage reduction system, the study area would continue to be at risk from large flooding events; Unit R471-460 would remain decertified; and the affected communities would be faced with continuing economic decline. The problem would worsen with time if no action is taken because high flood-insurance rates will prevent new development and may force existing development out of the area.

2.0 Structural Plans

The structural plans consist of levee raises to different flood levels and modification to the underseepage and drainage control features as needed. These plans are all confined to the existing levee alignment.

Levee Raise

The limits of raise for the 100+3 alternative were previously determined for Unit R471-460. It was further determined that for the 100+3 event, to provide equal flood damage reduction benefits on the opposite bank, a short reach of Unit L455 would need a small increase in height for mitigation of hydraulic impact to maintain its reliability. The impacts of the raise to the structural and geotechnical features of the units were analyzed.

Screening analysis and cost estimating was performed on the two higher raise alternatives (500+1.5 and 500+3) for both levee units and the lower raise alternative (100+1.5) for unit R471-460. For the 100+1.5 alternative, no raise is required for unit L-455 since the levee is above this level under existing conditions. At the higher event levels, the raise required for Unit L-455 was no longer based on mitigation of the raise of Unit R471-460, but on the expected flood elevations of the river.

As each unit is raised, more drainage structures are affected. While some may require only a top platform raise at a lower raise, they may also require a complete replacement with a higher raise due to added hydraulic and soil pressures. Table 11 in the next section of this report summarizes the approximate horizontal and vertical impacts of each raise alternative and the number of affected drainage structures.

Underseepage Berms

An underseepage berm consists of a continuous strip of additional soil placed on the ground surface adjacent to the landside of the levee. Its purpose is to counteract the hydraulic pressures that will force water to seep underneath the levee during a high flow event and surface on the landside. The height of the raise to unit R471-460 will cause these hydraulic pressures to increase and thus requires extension of the existing berms within area that will be subjected to a height increase.

The minimal height raise proposed for L-455 in Alternative 1 (100+3) will not significantly alter the hydraulic pressures encountered during a high flow event and does not necessitate an extension of the existing berm. Furthermore, it should be noted that underseepage problems were not observed during the 1993 flood so the existing berms are considered to be in adequate condition. However, despite their observed successful performance during a significant flood event, the widths of the berms are not in accordance with current berm construction criteria now in use by the Corps of Engineers. Therefore, it is proposed that in the area subject to raise in unit

L-455 for Alternative 1, the underseepage berms will be extended as needed to comply with current construction criteria. Berms in other areas of the unit, where the levee is not being disturbed, will remain as is based on their past performance. For the 0.2% event raise alternatives, significant raises are proposed and underseepage berm extensions would be required relative to the increase in height.

R471-460 Relief Wells

The intended purpose of the wells is to relieve excessive uplift pressure during high river levels at the toe of the levee where the impervious blanket is thin and variable. The twenty original pressure relief wells located between levee stations 292+00 and 327+00 are 8-inch diameter assembled wood stave screens and risers wrapped with stainless steel wire. Current day pressure relief well construction materials no longer include wood assemblies and have been replaced with the more reliable and durable steel riser and screen assemblies. Wood stave well assemblies cannot withstand aggressive pressure relief well testing, development, and treatments. The pressure relief wells were installed in 1967, and all indications are that individual well efficiencies have decreased requiring development and treatment that the wood stave well assemblies may not be able to withstand. Throughout the pressure relief well field there will be a 2.5 feet minimum increase in differential hydrostatic head across the levee attributed to the top of levee raise. This will provide additional stress to the pressure relief well field with well assemblies of uncertain structural integrity.

L-455 Relief Wells

The existing relief well field is located upstream of the area of the proposed Alternative 1 (100+3) raise and will not be affected by this alternative. Due to the limited raise necessary for the 100+3 raise alternative, installation of new relief wells in the project area is not necessary. Implementation of the Alternative 2 (500+1.5) or Alternative 3 (500+3) alternatives will affect a greater length of levee and cause higher underseepage pressures.

3.0 Summary of Plan Features

Table 11 summarizes the features of the plans carried forward for detailed cost estimating and screening. All raise alternatives will require replacement of the R471-460 relief well field and extension of the underseepage berms in the area subject to raise.

TABLE 11 PLAN FEATURES FOR DETAILED PLAN SCREENING					
Alternative	Levee Unit	Horizontal Length of Levee	Maximum Height of Raise	Drainage Structures	
				Modify	Replace
No Action	NA	NA	NA	NA	NA
Alternative 1 Raise to 100 +3	R471-460	54,675 ft.	3.37 ft.	6	1
	L-455	8,929 ft.	< 1 ft.	NA	NA

Alternative 2	R471-460	70,240 ft.	5.0 ft.	3	5
Raise to 500+ 1.5	L-455	48,740 ft.	1.5 ft.	8	2
Alternative 3	R471-460	70,240 ft.	6.5 ft.	1	7
Raise to 500 + 3	L-455	58,441 ft.	3.0 ft.	8	2
Alternative 4	R471-460	41,850 ft.	1.2 ft.	6	1
Raise to 100 + 1.5	L-455	NA	NA	NA	NA

G. Economic Analysis and Screening of Plans

A more detailed discussion of the economic analysis process is presented in Appendix C.

The raise alternatives were evaluated in the economic screening analysis. All are different scales of levee raises focused on the R471-460 unit which currently is decertified by FEMA, and the alternatives include any L-455 raises necessary to achieve equal reliability on the left bank. All protect essentially the same land and properties:

The raises required for each alternative are described below in terms of the raise required at the economic index points. The exact amount of the raise will vary along different sections of the levee.

- Alternative 1 is a levee raise of about 2 and 2/3 feet for the R471-460 unit, bringing it up to a level 3 feet above the nominal 1%-chance flood elevation. Essentially no raise would be required for the L-455 at the economic index point. (This also coincides with the nominal 0.2%-chance profile plus zero overtopping margin.)
- Alternative 2 is a levee raise bringing R471-460 up to an elevation 1.5 feet above the nominal 0.2%-chance flood, requiring a raise of almost 5 feet. L-455 would be raised approximately 1.5 feet.
- Alternative 3, the largest in scale of the alternatives, raises R471-460 about 6.5 feet, with a 3 foot raise for L-455. The raise would bring the top of levee elevations to about 3 feet above the nominal 0.2%-chance flood.
- Alternative 4, the smallest alternative, raises R471-460 to a level 1.5 feet above the nominal 1%-chance flood elevation. A raise of about 1.2 feet is required. L-455 would not be modified in any way under this alternative.

For screening of plans, a detailed estimate was prepared and other estimates were parametrically proportioned based upon that. Alternative 1, the 100+3 plan, is the alternative closest to the existing site and levee conditions that still meets the sponsor's objectives and was therefore selected as the most logical benchmark for initial plan screening. Detailed analysis was conducted of the geotechnical, hydraulic, and structural aspects of Alternative 1 and a detailed cost estimate prepared using MCACES (Micro Computer Assisted Cost Estimating System). Based on this benchmark and using the modeled elevations of the design hydraulic profiles, the relative increase or decrease in project scope was calculated for the remaining three alternatives.

Factors included in this relativity analysis included the horizontal and vertical limits of raise, the number of impacted drainage structures and the degree of impact, and the quantities of material needed for the raise and underseepage berms. Based on the impacts associated with each alternative plan when compared to the selected benchmark, a parametric cost estimate was prepared for each alternative. This process is sufficient for screening of plans for this type of levee modification of low complexity and straightforward increase in size, with relatively small structural and utility components. There are very few utility, structural, or real estate issues that would tend to cause spikes in the cost estimate that would adversely affect the proportionality assumptions of quantities/unit pricing. This type of estimating for this project provides a good representation of the range of estimated costs of the alternatives for screening purposes. If the screening level economic analysis indicated that the NED plan was an alternative other than the selected benchmark, or if the plans were too close together in terms of net benefits to clearly identify the NED plan, additional detailed MCACES cost estimates would be prepared.

Interest during construction (IDC) was computed for these costs assuming a design and construction period ending in mid-2012 and the FY06 Federal interest rate of 5.125 percent. Costs including IDC were then annualized over a 50-year period of analysis. The annualized costs were compared with the benefits for each alternative emerging from HEC-FDA, and a benefit-cost ratio and net benefits were computed. All damages are expressed as equivalent annual damages that account for both base and future year conditions.

Operations, maintenance, repair, rehabilitation, and replacement (OMRR&R) costs are not included in this analysis. Geotechnical and Operations staff determined that no additional costs over and above present levels would be incurred for any of the alternatives under consideration (i.e., OMRR&R costs associated with any of the alternatives would continue at the current levels). Even if new OMRR&R costs did exist, they would be too small to affect economic justification and would not differ enough among alternatives to affect the rankings from this analysis.

The main results from the risk-based screening analysis are:

- The NED plan - the plan with the greatest net benefits - is Alternative 1, which consists of a raise of the R471-460 unit to 3 feet above the 0.1%-chance flood elevation. The screening level economic analysis indicates that this plan has estimated net benefits of \$4.11 million and a benefit-cost ratio of 3.2.
- The NED plan has a margin of superiority of 15% in net benefits over the second-ranking alternative, Alternative 4. Alternative 4, the smallest alternative, has net benefits of \$3.58 million. The NED plan has an 89% margin of superiority over Alternative 2 and a 391% margin over Alternative 3. These are the two largest alternatives. Therefore, Alternative 1, as the NED plan, is bracketed by both smaller and larger-scaled alternatives over which the NED plan has clear superiority in economic efficiency.

- All alternatives are economically justified. Benefit-cost ratios are strong for Alternatives 1 (3.2) and 4 (4.1), while the justification for Alternatives 2 and 3 would be more marginal with benefit-cost ratios of 1.4 and 1.1 respectively.
- Benefit-cost ratios for R471-460 by itself would be at least fairly strong in all four alternatives. In contrast, Alternative 1 is the only alternative that produces positive net benefits for the L-455 unit by itself.

Based on the screening analysis, the NED plan is Alternative 1, a raise to an elevation of 3.0 feet above the nominal 1% chance flood elevation. This plan is also the Locally Preferred Plan (LPP). A comparison of the resulting net benefits for each alternative is displayed in Figure 5 and the economic analysis calculations are summarized in Table 12.

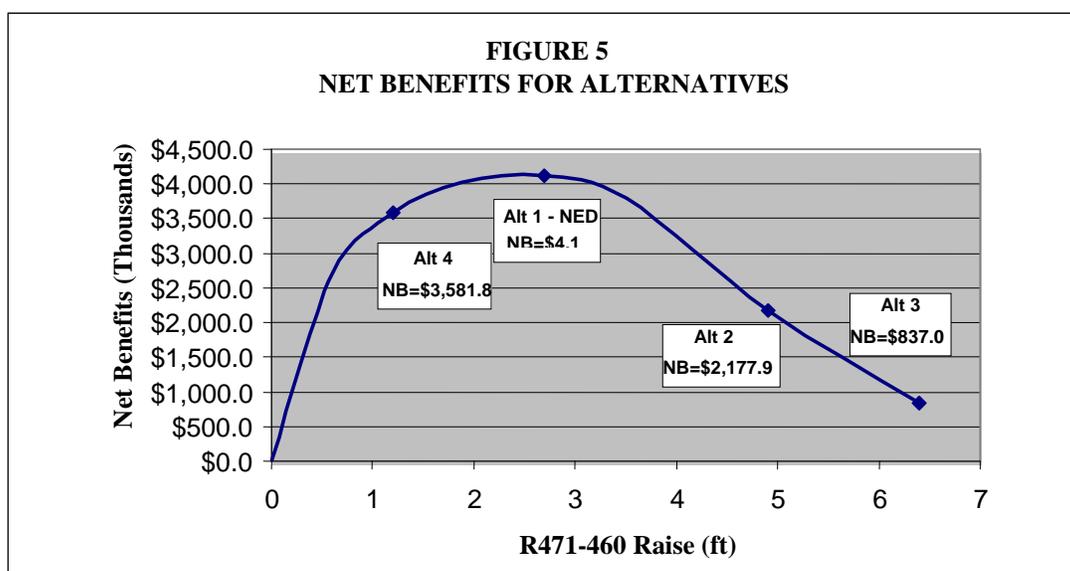


TABLE 12 NED SCREENING BENEFIT-COST DATA FOR ALTERNATIVES								
October 2005 prices; 5.125% interest rate								
In thousands of dollars								
Alternative	First Cost	Total Annual Costs	Total Annual Damages	Residual Annual Damage	Total Benefits	BCR	Net Benefits	Superiority of NED Plan
ALTERNATIVE 4 - R471 RAISE TO 1% EVENT + 1.5 FT.								
L455								
Reach 1			\$1,271.1	\$1,271.1				
Reach 2			\$803.4	\$803.4				
Total L455	\$0.0	\$0.0	\$2,074.5	\$2,074.5	\$0.0	0.0	\$0.0	
R460								
Reach 1			\$4,184.6	\$1,035.6				
Reach 2			\$2,193.6	\$593.8				
Total R460	\$18,917.6	\$1,167.0	\$6,378.3	\$1,629.4	\$4,748.9	4.1	\$3,581.9	
Total	\$18,917.6	\$1,167.0	\$8,452.8	\$3,703.9	\$4,748.8	4.1	\$3,581.8	14.8%

ALTERNATIVE 1 - R471 RAISE TO 1% EVENT + 3 FT.								
L455								
Reach 1			\$1,271.1	\$851.7				
Reach 2			\$803.4	\$803.4				
Total L455	\$3,051.9	\$187.2	\$2,074.5	\$1,655.1	\$419.4	2.2	\$232.2	
R460								
Reach 1			\$4,184.6	\$520.3				
Reach 2			\$2,193.6	\$268.1				
Total R460	\$27,793.7	\$1,709.4	\$6,378.3	\$788.4	\$5,589.8	3.3	\$3,880.4	
Total	\$30,845.6	\$1,896.6	\$8,452.8	\$2,443.5	\$6,009.2	3.2	\$4,112.6	*NED*
ALTERNATIVE 2 - R471 RAISE TO 0.2% EVENT + 1.5 FT.								
L455								
Reach 1			\$1,271.1	\$209.3				
Reach 2			\$803.4	\$185.6				
Total L455	\$44,389.9	\$2,719.2	\$2,074.5	\$394.8	\$1,679.6	0.6	-\$1,039.6	
R460								
Reach 1			\$4,184.6	\$76.3				
Reach 2			\$2,193.6	\$32.2				
Total R460	\$49,742.9	\$3,052.2	\$6,378.3	\$108.6	\$6,269.7	2.1	\$3,217.5	
Total	\$94,132.8	\$5,771.4	\$8,452.8	\$503.4	\$7,949.3	1.4	\$2,177.9	88.8%
ALTERNATIVE 3 - R471 RAISE TO 0.2% EVENT + 3 FT.								
L455								
Reach 1			\$1,271.1	\$19.4				
Reach 2			\$803.4	\$19.7				
Total L455	\$58,929.0	\$3,608.2	\$2,074.5	\$39.0	\$2,035.5	0.6	-\$1,572.7	
R460								
Reach 1			\$4,184.6	\$7.8				
Reach 2			\$2,193.6	\$3.4				
Total R460	\$65,075.0	\$3,957.4	\$6,378.3	\$11.1	\$6,367.1	1.6	\$2,409.7	391.3%
Total	\$124,004.0	\$7,565.6	\$8,452.8	\$50.1	\$8,402.6	1.1	\$837.0	

H. Environmental Considerations

1.0 No Federal Action

The “No Action” alternative would have no effect on fish and wildlife resources, the aquatic ecosystem, recreation, or floodplain values in the project area. Existing habitat conditions would continue as they currently exist.

2.0 Structural Alternatives

Raising the height of the existing levee will result in a widening of the levee toe and extensions to the landside underseepage berm, causing minimal intrusion into the adjacent natural

environment. Much of this adjacent area is already cleared for agricultural purposes or development, but there would be some additional clearing of terrestrial and woodland habitat. Birds and mammals would be temporarily affected by construction activities. The specific impacts are summarized in this report and discussed in more detail in the attached Environmental Assessment.

Alternative 1 (100 + 3). The raise of levee R471-460 will result in an increase of horizontal width impacting approximately 285 acres landward and approximately 77 acres riverward of the existing levee. The L-455 width increase will impact approximately 43 acres landward of the levee and approximately 54 acres riverward. Expanding the levees would result in the permanent removal of approximately 1.6 acres of secondary tree growth and 4.7 acres of shrubland landward of the levees and 5.4 acres of secondary growth trees and 8.0 acres of shrublands riverward of the levees. Modifying the two levees would also permanently impact a total of approximately 4.4 acres of emergent wetlands landward of the levees and approximately 0.5 acre of forested wetlands riverward of the two levees.

Alternative 2 (500 + 1.5). Increasing the height and width of R471-460 will impact approximately 385 acres landward of the levee and approximately 81 acres riverward of the existing levee. The L-455 width increase will impact approximately 46 acres landward of the levee and approximately 54 acres riverward. Expanding the levees would result in the permanent impact of approximately 2.2 acres of secondary tree growth and 6.4 acres of shrubland landward of the levees and approximately 5.4 acres of secondary growth trees and 8 acres of shrubland riverward of the levees. Modifying the two levees would also impact approximately 5.6 acres of wetlands and associated vegetation landward of the levees and 0.6 acre of wetlands associated vegetation riverward of the two levees.

Alternative 3 (500 + 3). The overall width increase of R471-460 will impact approximately 336 acres landward and approximately 81 acres riverward of the existing levee. The L-455 width increase will impact approximately 46 acres landward and approximately 54 acres riverward of the existing levee. The project boundary was set at no more than 500 feet from the center line of the existing levee. The impacts from the 500 + 3.0 feet alternative exceed this boundary, but are only reported to the boundary limit. Expanding the levees would result in the permanent impact of 2.7 acres of secondary tree growth and 8 acres of shrubland landward of the levees and 5.4 acres of secondary growth trees and 8 acres of shrubland riverward of the levees. Modifying the two levees would also impact approximately 6.7 acres of wetlands and associated vegetation landward of the levees and 0.6 acre of wetlands and associated vegetation riverward of the two levees.

Alternative 4 (100 + 1.5). The raise of levee R471-460 will result in an increase of horizontal width impacting approximately 229.5 acres landward and approximately 77 acres riverward of the existing levee. Expanding the levee would result in the permanent removal of approximately 1.3 acres of secondary tree growth and 4.5 acres of shrubland landward of the levees and 4.5 acres of secondary growth trees and 6.2 acres of shrublands riverward of the levees. Modifying the levee would also permanently impact a total of approximately 3.7 acres of emergent wetlands

landward of the levees and approximately 0.5 acre of forested wetlands riverward of the levee. There is no impact to unit L-455 from this alternative.

I. Hydraulic and Floodplain Considerations

Implementation of any right bank raise alternative would cause some limited amount of increased damages to L-455, located just across the river. The 100+3 alternative includes a small raise to the left bank that is sufficient to offset these impacts.

Water surface profiles will be affected upstream of St. Joseph and possibly as far downstream as Kansas City. Analysis was conducted to determine potential impacts to other levee units in those areas. It was determined that hydraulic effects of the 100+3 alternative raise are minimal upstream and downstream but do effect the L-455 unit across the River. The two higher levee raise alternatives will likely have significant impacts to other levee units upstream and downstream. These impacts were qualitatively considered in the alternative screening process.

J. HTRW Considerations

A HTRW site assessment of the study area was completed in September 1999. Conditions at the site since then have not likely changed relative to HTRW. Since the focus of the assessment was on the existing levee corridor and since that alignment is not proposed to be changed, the preliminary site assessment applies to all alternatives. The preliminary assessment addressed all potential contamination concerns. There are no known HTRW concerns within the project areas. The No Action plan would not involve any HTRW activity.

K. Engineering Considerations

There are no engineering features associated with the No Action plan. The structural plans have virtually the same engineering characteristics with minor variations. Other than different levels of raise requiring different amounts of materials and different levels of impacts to the same structures there are no major engineering differences between alternatives.

L. Plan Selection

Based upon consideration of all pertinent factors, the 100+3 structural alternative was selected as the recommended plan for implementation. It is both the NED plan and the Locally Preferred Plan (LPP), meeting the planning objectives, the National Economic objectives, and the local needs for levee certifications and affordability.

Implementation of the project will reestablish the design flood damage reduction to several local communities and significant economic investment. Negative impacts from the project would be minimal. Some disruption during construction could be expected, affecting traffic and agricultural activities. No relocation of homes or businesses is required. Induced damages are

expected to be minimal.

The evaluation results show strong economic justification for a project in the St. Joseph area. The existing project would be raised to 3 feet above the nominal 1 percent chance flood elevation, providing over 90% reliability against damages from the base flood.

Plans Considered and Eliminated

The 100+1.5, 500+1.5 and 500+3 plans were eliminated since they produce lower levels of net benefits over the period of analysis. Furthermore, the higher raises are not preferred by the local sponsor. Reliability against the 1% flood and FEMA re-certification are the sponsors' priorities and they are financially unable to participate in cost sharing for more detailed study or construction of higher levels of flood damage reduction. The "No Action" alternative would not resolve the continuing flooding problems to which the area is subject. The no action plan would have detrimental long term effects to the business and home owners in the area and to the economy of the protected communities.

X. Description of the Selected Plan

A. Selected Plan Components

Locations and details of the NED plan features are shown on plates R-01 thru R-11 and L-01 thru L-02, for the right and left banks respectively. These plates are located at the end of this report.

The NED plan will protect from the nominal one-percent chance discharge event with 91.6% reliability on Unit R471-460 and 94% reliability on Unit L-455. The plan includes a raise of Unit R471-460 starting near Station 93+00 and ending near station 640+00. Approximately 54,675 ft of levee will be raised with a maximum raise of 3.37 feet. The proposed raise of unit L-455 will begin near station 210+00 and end near station 300+00. Approximately 8,929 feet of levee will be raised with a maximum raise of 0.94 feet. Typical cross sections of a levee raise are provided in the drawing plates included in Appendix B.

Six existing drainage structures in the right bank levee will be modified by raising their top elevations. One existing drainage structure will be replaced and a temporary levee will be required during the excavation. Typical cross sections of drainage structure modification and a temporary levee are provided in the drawings located in Appendix B. No drainage structures are affected on the left bank L455 unit.

Existing underseepage berms will be extended in the reaches of the raise for both levee units. The average berm width increase on unit R471-460 is 141 feet with a maximum increase of 225 feet. The average berm width increase on unit L-455 is 95 feet with a maximum increase of 265 feet. The twenty existing pressure relief wells in unit R471-460 will be abandoned in-place and new relief wells installed. Typical cross sections of underseepage berm extensions and a relief well field layout are provided in the drawings located in Appendix B.

There are three utility crossings that will be affected by the proposed plan on the R471-460 unit only. The modifications to the L455 unit will not affect any utilities. One utility is a 16 inch water line located at station 300+00 running over the levee. This line will be relocated over the top of the raised levee affecting about 300 feet of line. There is an 8 inch gas line at approximate station 417+65 running over the top of the levee. This gas line will be relocated over the top of the raised levee, affecting about 288 feet of line. There is a telephone cable located at approximate station 418+15 buried in the levee about 3.5 feet deep. This line will be relocated over the top of the levee including an overbuild for cover of about 2 feet, affecting about 191 feet of line. More detailed information is included in the Civil Design section of the Appendix B, the locations of these are shown on the "R" plates at the end of this report.

B. Economic Performance and Risk of the Selected Plan

1.0 Economic Performance

Alternative 1 raises the R471-460 levee to an elevation three feet above the nominal 1% chance flood elevation. The L-455 levee also will undergo a small raise (< one foot) to maintain reliable flood damage reduction. Modifications to the underseepage and drainage control features are included in the selected plan for each respective unit. The selected plan is both the NED plan and the Locally Preferred Plan. . Table 13 displays the benefit-cost calculation.

TABLE 13			
BENEFIT-COST RATIO FOR NED PLAN			
In \$1,000s; Oct. 2005 prices; Equivalent annual damages			
BENEFITS	TOTAL	R471-460	L-455
EAD Without-Project	\$8,452.8	\$6,378.3	\$2,074.5
EAD With Project (Residual)	<u>\$2,443.5</u>	<u>\$788.4</u>	<u>\$1,655.1</u>
EAD Reduced	\$6,009.3	\$5,589.9	\$419.4
Emergency Cost Savings	\$540.8	\$503.1	\$37.7
Relocation and Reoccupation Cost Savings	\$78.0	\$61.3	\$16.7
Flood Insurance Administrative Cost Savings	<u>\$7.7</u>	<u>\$7.7</u>	<u>\$0.0</u>
TOTAL ANNUAL BENEFITS	\$6,635.8	\$6,162.0	\$473.8
% by unit		92.9%	7.1%
COSTS	TOTAL	R471-460	L-455
First Costs by Account			
01 Lands & Damages			
0101 Land Values	\$2,754.4	\$2,620.7	\$133.7
0102 Labor	\$182.4	\$108.6	\$73.7
02 Relocations	\$354.5	\$354.5	\$0.0
06 Fish & Wildlife Facilities			
0603 Wildlife Facilities & Sanctuaries	\$56.5	\$56.5	\$0.0
11 Levees & Floodwalls			
1101 Levees	\$25,126.4	\$22,684.7	\$2,441.7
1102 Floodwalls	\$0.0	\$0.0	\$0.0
13 Pumping Plants			
1300 Pumping Plants	\$0.0	\$0.0	\$0.0
30 Planning, Engineering & Design (PED)	\$2,553.6	\$2,309.6	\$244.0
31 Construction Management	\$1,658.0	\$1,498.9	\$159.1
Total PED	\$2,553.6	\$2,309.6	\$244.0
Total LERRD	\$3,291.3	\$3,083.8	\$207.5
Total E&D	\$1,658.0	\$1,498.9	\$159.1
Total Construction	<u>\$25,182.9</u>	<u>\$22,741.2</u>	<u>\$2,441.7</u>
Total First Costs	\$32,685.7	\$29,633.4	\$3,052.3
Annual costs			
First Costs	\$32,685.7	\$29,633.4	\$3,052.3
I.D.C.	<u>\$3,291.9</u>	<u>\$2,991.8</u>	<u>\$300.1</u>
Economic Costs	\$35,977.6	\$32,625.2	\$3,352.4
Interest & Amortization Factor	<u>0.05584</u>	<u>0.05584</u>	<u>0.05584</u>
Annual costs	\$2,008.9	\$1,821.7	\$187.2
Annual O & M Costs (increased)	<u>\$0.0</u>	<u>\$0.0</u>	<u>\$0.0</u>
TOTAL ANNUAL COSTS	\$2,008.9	\$1,821.7	\$187.2
% by unit		90.7%	9.3%
BENEFITS & COSTS	TOTAL	R471-460	L-455
TOTAL ANNUAL BENEFITS	\$6,635.8	\$6,162.0	\$473.8

TOTAL ANNUAL COSTS	\$2,008.9	\$1,821.7	\$187.2
BENEFIT-COST RATIO	3.3	3.4	2.5
NET BENEFITS	\$4,626.9	\$4,340.3	\$286.6
% by unit		93.8%	6.2%

The plan shows strong economic justification with a benefit-cost ratio of 3.3. The first cost of the plan is \$32,686,000 and the annualized cost is \$2,008,900. Annual benefits total \$6,635,800. This plan has net annual benefits exceeding \$4.6 million.

If the project is divided into two elements (i.e., R471-460 vs. L-455), both portions are economically justified (see Table 13). For R471-460, the resulting benefit-cost ratio is 3.4, while unit L-455 result in a benefit-cost ratio of 2.5. There is strong economic justification for each portion of the project as well as for the total project.

Table 14 shows a probabilistic assessment of NED benefits for the total project. The annual benefits produced by the risk analysis are \$6,009,200. There is a 75% probability that the true benefits exceed \$2,470,000, a 50% probability that they exceed \$4,550,000, and a 25% probability that they exceed \$7,576,000.

TABLE 14						
DAMAGE REDUCED FOR NED PLAN						
Damage in \$1,000's						
Damage Reach Name	Total Without Project	Total With Project	Damage Reduced	Probability Damage Reduced Exceeds Indicated Values		
				0.75	0.50	0.25
L-455						
Left Bank - Downstream	\$1,271.1	\$851.7	\$419.4	\$57.6	\$70.4	\$251.1
Left Bank - Upstream	\$803.4	\$803.4	\$0.0	\$0.0	\$0.0	\$0.0
L-455 Total	\$2,074.5	\$1,655.1	\$419.4	\$57.6	\$70.4	\$251.1
R471-460						
Right Bank - Downstream	\$4,184.6	\$520.3	\$3,664.3	\$1,572.5	\$2,932.3	\$4,811.5
Right Bank - Upstream	\$2,193.6	\$268.1	\$1,925.5	\$840.0	\$1,547.4	\$2,513.6
R471-460 Total	\$6,378.3	\$788.4	\$5,589.8	\$2,412.4	\$4,479.7	\$7,325.1
Total	\$8,452.8	\$2,443.5	\$6,009.2	\$2,470.1	\$4,550.1	\$7,576.2

2.0 Engineering Performance

The selected plan would restore a margin of at least three feet above the nominal 1% chance flood elevation for both levee units. Under future conditions of 2038, the nonexceedance probability for R471-460 would rise to 91.6% compared to its nonexceedance probability of 51.3% under existing condition without project. Table 15 describes the engineering performance

of the selected plan

**TABLE 15
ENGINEERING PERFORMANCE RATINGS FOR NED PLAN**

For future conditions (2038)						
	R471-460			L-455		
	OVERALL	downstream	upstream	OVERALL	downstream	upstream
Top of levee elevations						
Reference river mile		449.4	450.0		441.4	446.3
New TOL		824.8	825.5		816.0	821.2
Annual Exceedance Probability						
Median (as %)	0.30%	0.30%	0.30%	0.10%	0.10%	0.20%
Expected (as %)	0.30%	0.30%	0.30%	0.20%	0.20%	0.30%
Long-Term Risk (years)						
10 years						
Exceedance probability	3.32%	3.14%	3.32%	2.51%	2.26%	2.51%
Exceedance chance over period	1 in 30.1	1 in 31.9	1 in 30.1	1 in 39.8	1 in 44.3	1 in 39.8
25 years						
Exceedance probability	8.09%	7.67%	8.09%	6.15%	5.55%	6.15%
Exceedance chance over period	1 in 12.4	1 in 13.0	1 in 12.4	1 in 16.2	1 in 18.0	1 in 16.2
50 years						
Exceedance probability	15.53%	14.75%	15.53%	11.92%	10.80%	11.92%
Exceedance chance over period	1 in 6.4	1 in 6.8	1 in 6.4	1 in 8.4	1 in 9.3	1 in 8.4
1% Event Context						
Levee height margin						
Reference flood elevation		821.8	822.5		812.9	818.0
Margin (ft.)	3.0	3.0	3.0	3.1	3.1	3.2
Nonexceedance probability (as %)	91.6%	91.7%	91.6%	94.0%	94.1%	94.0%
0.2% Event Context						
Levee height margin						
Reference flood elevation		825.5	826.2		815.8	821.3
Margin (ft.)	-0.7	-0.7	-0.7	-0.1	0.2	-0.1

3.0 Induced Damages

Hydraulic investigations for this study concluded that the project is not expected to have any significant impact in terms of raising water surface profiles. The water surface profile for the 1%-chance event is not affected by the project. The profiles for events larger than the 1%-chance event would be somewhat increased downstream of the project area as well as across the river at the L-455 area. The purpose of the L-455 portion of the project is to offset the increases at that location. However, as discussed above, the L-455 portion of the project is economically

justified on its own independent terms - i.e., it is justified by the damages it would prevent within the L-455 area under without-project conditions, even without additional consideration of its efficacy in alleviating incremental damage potential contributed by the project. Downstream economic damages were not quantified for this analysis but would necessarily be minimal since the increased stages occur only in the most infrequent events and affect downstream areas with primarily agricultural impacts. Although minimal, the induced damages, if quantified, would be greater than zero and would serve to slightly reduce the estimated annual benefits for the project. Economic justification would not be affected.

4.0 Residual Risk

Although floodplain users and occupants may desire total protection from flooding, this is an unachievable goal. No flood damage reduction project can guarantee total elimination of flooding. The selected plan has substantial economic benefits and reduces equivalent annual damages in the study area by about 71% over without project conditions. But this means that there remains a significant residual equivalent annual damage in excess of \$2.4 million. There still would be a 10% to 16% chance of exceedance over a 50-year period under 2038 conditions (Table 15).

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 (Table 15). The probability and occurrence of flooding will be less frequent with the implementation of the recommended plan in the study area. However, during major flood events, residents and other floodplain occupants may still be ordered to evacuate and move to higher ground. And in very rare large events, the Federal levees could be overwhelmed, resulting in large flood depths inside the leveed areas. Because the areas within the levee units are relatively flat, most of the study area could be affected.

Floodplain tenants should not be led to believe that they have near-total protection against flooding and give up their flood insurance policies. They might find it advisable to keep their flood insurance policies, which are fairly inexpensive in areas with certified levees. Meanwhile, local leadership and emergency operations staff will need to design plans for these flood events which may be infrequent, but would hold the potential for catastrophe if they occurred. Effective emergency planning in advance is the best way to protect communities and minimize the damage from these rare flood events.

5.0 Regional Economic Development Impacts

The benefit evaluation process involves analysis of the economic losses to the subject study area from flooding as well as the potential gains to the study area from the successful prevention of flooding. Some impacts with and without a flood damage reduction 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 impacts are not included in determining the NED benefits and costs but do receive consideration in the decision-making process.

Construction of the selected plan would contribute to the long-term stability of both the R471-460 and L-455 areas and neighboring areas. 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 and new businesses and investment would be more easily attracted to the study area in the future if vacancies occur, retaining and possibly increasing 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 could 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.

C. Environmental and Cultural Considerations

1.0 Fish and Wildlife Resources

Construction of the NED plan would result in the raising of the existing levees up to 3.37 feet. This requires an increase to the levee toe width and an extension to the seepage berms associated with the levee. Borrow excavation is needed within approximately 1,139 acres riverward of R-471-460 and approximately 30 acres riverward of L-455. Expanding the levees would result in the permanent removal of approximately 1.6 acres of secondary tree growth and 4.7 acres of shrubland landward of the levees, and 5.4 acres of secondary growth trees and 8.0 acres of shrublands riverward of the levees. This habitat would be kept from growing on the levee areas through normal levee maintenance practices, and the habitat values they provide would be permanently lost. Therefore, measures to mitigate their loss would be required. A total of 7.0 acres of “in-kind” trees and 12.7 acres of shrubland vegetation will be planted on site immediately following construction activities.

Impacts within the 1,139 acres (R471-460) and 30 acres (L-455) of secondary tree growth and shrubland at the borrow sites would be considered temporary in nature and is expected to be less than significant. Additionally, steps will be taken in these borrow areas to minimize effects to this habitat. Minimization measures include but are not limited to varying bottom depths of excavated borrow sites, creating islands within the borrow site through avoidance of specified areas, spacing borrow areas apart from one another by approximately 500 feet to provide areas of no disturbance, and avoiding where possible any larger “old growth” trees.

Modifying the two levees would also permanently impact approximately 4.4 acres of emergent wetlands landward of the levees and approximately 0.5 acre of forested wetlands riverward of the two levees. These wetlands will be created on site and adjacent to the impacted wetlands concurrently with construction activities, resulting in no net loss to wetlands. Wetland impacts would be offset through the scraping and reshaping of the impacted areas to expand the existing wetland area equal to that which was lost. Some of the wetlands along both levees may consist of acreage enrolled in the Wetland Reserve Program. Wetland area impacts and mitigation have been coordinated with the NRCS, state agencies, and the USFWS. To the extent possible, these areas will be avoided and lands outside these protected areas will be used for borrow sites.

Impacts associated with the excavation of borrow material includes potential increases in erosion and sediment deposition in the Missouri River immediately downstream from the construction activities and temporary loss of wetland functions and values. Standard construction site erosion and sediment control practices will be employed to decrease this impact. Additionally, the riverward borrow areas impacted will likely revert to wetlands over time, thus offsetting construction related impacts and increasing water filtration and water quality in the project area.

Construction of the NED plan would result in temporary impacts to wildlife. These impacts would be caused by the increased human activity and noise associated with the construction efforts, and impacts to grassland, wetland vegetation, and terrestrial habitat resulting from the increased toe width of the levee, the increased width of seepage berms, and activities associated with obtaining borrow material. Construction activities would not be conducted along the entire length of the levee all at once, so wildlife would only avoid those areas where construction is occurring to the extent that they feel threatened. Where appropriate, revegetation through seeding of grasses, planting of trees, and reshaping of borrow areas would be done as soon as practical after completion of, or concurrent with, construction activities. This would minimize the length of time soils are exposed and area habitat is unusable. In time, these areas would revert to pre-construction conditions and area wildlife could once again feed, breed, and shelter in these areas.

Construction of the NED Plan is not expected to result in significant impacts to fisheries in the Missouri River because the levees under consideration are between $\frac{1}{4}$ to $\frac{1}{2}$ mile from the river, the proposed modification to the levee is not expected to alter the thalweg or any part of the river itself (including shallow water habitat), and the extensions to the levee toe and seepage berms would occur mainly on the landside of the levee

Detailed ecosystem mitigation is described in Chapter 4 of the attached environmental assessment. A mitigation plan has been prepared and is included in Appendix J of the attached environmental assessment. This plan has been coordinated with local and federal agencies including the U.S. Fish & Wildlife Service, Natural Resources Conservation Service, the Missouri Department of Conservation and the Kansas Department of Wildlife and Parks.

2.0 Cultural Resources

Literature reviews and background studies were performed for the project area on the left and right bank of the River. An accreted land study was also performed to determine any potential archeological sites. All cultural reviews in the project area in Kansas and Missouri have determined that there are no cultural, historic, or archeological sites of any significance that would be affected by the proposed project. A Section 106 review finding on November 6, 2001 by the State of Missouri SHPO states that the project area has a low potential for the occurrence of cultural resources. A cultural resource survey is not warranted. In a letter dated March 23, 2006, the State of Kansas SHPO concurs with our findings that there will be no effect of the proposed plan on historic properties and has no objection to the project. The potential extent of project features is the same at this time as presented to the agencies prior to the findings, and no changes in formulation of the project have occurred subsequently to affect these findings.

3.0 Cumulative Impacts

The Section entitled “Cumulative Impacts” of the Environmental Assessment provides a detailed assessment of potential cumulative impacts of the levee raises associated with the selected plan. Based on the analysis conducted, the recommended plan of constructing flood damage reduction reliability improvements within the St. Joseph metropolitan area will not result in substantial impacts to river reaches upstream or downstream of the project area. As such, cumulative impacts of the recommended plan are not considered significant.

4.0 Environmental Justice

Executive Order 12898 on Environmental Justice requires consideration of social equity issues, particularly any potential disproportionate impacts to minority or low-income groups. The study evaluated demographic and census data for the project area and analyzed the potential effects of the proposed project on minority and low-income groups. The proposed modifications to the levee systems will uniformly provide increased economic benefit to populations living and working behind the levee systems on both sides of the Missouri River in the project area. There are no significant induced hydraulic or other adverse impacts to the largely agricultural based levee systems located upstream and downstream of the project area that would result from the proposed plan. Public involvement processes will continue to reach out and provide information to the communities and populace affected by the proposed plan as implementation proceeds. Based upon the analysis, the proposed plan meets the intent of Executive Order 12898 and does not provide any imbalance or disproportionate affects to minority or low-income populations within the project area.

5.0 Environmental Operating Principles

Under the Environmental Operating Principles, the Corps of Engineers is mandated to be proactive in seeking and considering ways to improve and sustain the environment. Since the start of this study, the Kansas City District has been proactively considering several options to

bring significant environmental benefits to the project area including both the R471-460 and L-455 Units. This project under the Section 216 Authority and several other programs were considered as vehicles for environmental improvements.

After review of the options and consideration of the conditions in this project area, it was decided that several programs would be best suited to improve the environment of the project area. First, under the authority of this project the direct affects of this levee modification will be mitigated. Under the Missouri River Fish and Wildlife Mitigation Program, a significant area adjacent to unit R471-460 will be restored. The Missouri River Mitigation Program is currently planning a mitigation site to be located along the right over bank of the Missouri River between the approximate river miles of 442 to 448. The site would be located in the State of Kansas, between the towns of Elwood and Wathena, lying between the MO River and south of U.S. Hwy. 36, located on both sides of the federal levee. Currently this project is in the final real estate acquisition phase of purchasing four tracts of land from willing sellers in this area. This would create an initial site of approximately 1,000 acres. Future tracts in this area would be acquired on a willing seller basis as they become available. Restoration and mitigation activities that will be focused on will include creation of additional Missouri River shallow water habitat, wetland restoration, increases in forested areas, wet prairie restoration with native grass plantings, and food plot establishment for wildlife. The Kansas Department of Wildlife and Parks is the primary partner in this activity and will have management responsibilities for the area. Other river stakeholders will also be participating in this venture. This activity is also being coordinated with the levee districts that are the sponsors on the levee modification.

On the left bank behind Unit L-455, the Corps is initiating a project under Section 514 of the Water Resources Development Act (WRDA) of 1999, the Missouri and Upper Mississippi Rivers Enhancement Program, to bring environmental benefits to an oxbow lake; Lake Contrary. The Corps of Engineers and the non-Federal sponsor, the Buchanan County Commission, are proposing a diversity of restoration activities for Lake Contrary. These include, but may not be limited to: a) improvement of aquatic habitat by measures to improve water quality, bottom diversity, aquatic species spawning and rearing habitat; b) planting wetland vegetation to improve wetlands associated with the lake and to serve as a functional sediment filter; c) improving hydraulic connection between the lake and the Missouri River to provide periodic flushing and increased habitat connectivity; and d) restoring and re-connecting adjacent sloughs and Contrary Creek with the Lake and/or the Missouri River to enhance aquatic and terrestrial species and the habitats upon which they depend. This project may also assist the sponsors and other stakeholders in bringing additional compatible recreation opportunities to the area, and providing a linkage to comprehensive recreation master plans involving the City of St. Joseph and areas south to the Kansas City area.

D. Hydraulic and Flood Plain Considerations

Both existing levees currently pass the nominal 1% (100-year) chance of exceedance flood profile without overtopping; R471-460 with 53% reliability and L-455 with 92.8% reliability. Therefore, there are no impacts to the profile for the 1% (100-year) chance of exceedance event

for any raise alternative. This is an important designation as there are no impacts to the FEMA Base Flood Elevations along the Missouri River at any point as a result of any raise alternative. The impacts due to the proposed alternatives impact only profiles for events larger than the 1% (100-year) chance of exceedance event.

E. HTRW Considerations

There are no known HTRW considerations associated with the selected plan.

F. Engineering and Construction Considerations

There are no unusual engineering/design or construction issues associated with this project. Conventional construction methods will be used, and space is sufficient on site to provide for contractor mobilization and staging of construction.

G. Real Estate Considerations

The non-Federal Sponsors currently hold permanent easements sufficient for the existing levees and these are available for implementation of the selected alternative. Additional permanent easements will be acquired as needed for increases in levee to width in the areas affected by the levee raise. Temporary easements will be acquired and used for extension of the underseepage berms, borrow areas, equipment storage, access roads, construction vehicles, and staging areas. The width of the work area easements will vary along the levee, as additional lands are required.

A detailed description of the Lands, Easements, Relocations, Rights-of-Way, and Disposal (LERRD) requirements is outlined in the Real Estate Plan (Appendix D). This includes acreage, estate required, estimated land values, borrow areas, non-fed incidental costs and in-house government cost.

The proposed borrow areas are extensive in size and scope of soil removal and will be refined as the project moves into Pre-Construction Engineering and Design (PED). The areas have been reviewed by environmental staff to identify Wetland Reserve Program and Conservation Reserve Program lands within its reaches. Some borrow could come from land recently purchased by the Corps of Engineers under the authority of the Missouri River Fish and Wildlife Mitigation Program along the Elwood Gladden Levee Unit, saving on cost of proposed permanent easement.

H. Operations and Maintenance Considerations

No significant increase in operations and maintenance activities would occur with implementation of the preferred plan. Future O&M practices would remain the same as current operations including mowing, vegetation control, outfall cleaning, maintenance of wells, etc.

I. Value Engineering

A Value Engineering study appropriate to the feasibility phase, as required by Corps regulations, was conducted and completed in May 2006. This value engineering process identified two potentially beneficial improvements that might be implemented to realize significant cost savings for the project.

The first involves the potential use of dredged material from the Missouri River to use or supplement random fill for the levee modification. If there is sufficient suitable borrow material in the sediment from the River at the project location, and the impacts of sediment removal are not significant, then it will likely be a method to realize significant cost savings. The evaluation of sediment availability and the effects of dredging on the Missouri River are to some extent timing dependent. Also, further data and analysis is required on the environment and river degradation that were beyond the scope of this study. The determination on dredging will require additional surveys, sampling, testing, and analysis closer to the time of actual removal. Thus, the value engineering process must continue early in the design phase to reach a final conclusion. If dredging is deemed feasible; would result in a significant cost savings; and does not have significant environmental effects, the EA will be supplemented or revised and re-coordinated with the public and agencies.

The second value engineering opportunity identified is the potential avoidance of complete replacement of a large drainage structure. A filter drain installed under the structure's box could sufficiently reduce the hydrostatic pressures external to the box and eliminate the need for complete replacement of this structure. This would be a significant cost savings to the project. In order to come to a final conclusion on this potential recommendation, the structure will need to be thoroughly inspected and more detailed soil testing conducted. These activities are proposed to be conducted in conjunction with surveys and other on-site activities during the project design phase.

XI. Plan Implementation

A. Cost Sharing Requirements

The project cost allocation is 100% Flood Damage Reduction. The non-Federal cost share is determined according to the cost sharing prescribed in the Water Resources Development Act of 1986 (WRDA 86). In accordance with the typical allocation, the Federal government will be responsible for 65% of implementation costs and the Non-Federal sponsors for the remaining 35%. During the feasibility study, the three local sponsors provided their 50% cost share through the use of an inter-local agreement to which the Corps was not a party. It is anticipated that the 35% cost share for project implementation will be provided in the same manner. Table 16 presents the estimated project costs and cost sharing portions divided by levee. Future prices are inflated to the anticipated midpoint of construction (2011) using the current Federal interest rate of 5.125%. Detailed cost estimates are provided in Appendix F.

**TABLE 16
PROJECT COST SHARING**

In 1000's of dollars	October 2005 prices			Fully Funded		
NED Plan Feature Summary	R471-460	L-455	Total	R471-460	L-455	Total
Planning, Engineering, and Design (PED)	\$ 2,310	\$ 244	\$ 2,554	\$ 2,473	\$ 261	\$ 2,734
Construction	\$22,742	\$2,442	\$25,183	\$24,989	\$2,682	\$27,671
Construction Management	\$ 1,499	\$ 159	\$ 1,658	\$ 1,711	\$ 181	\$ 1,892
LERRD	\$ 3,084	\$ 208	\$ 3,290	\$ 3,284	\$ 220	\$ 3,504
Total NED Project Cost	\$29,634	\$ 3,052	\$32,686	\$32,457	\$3,344	\$35,801
NED Project Cost Sharing and Credit						
Non-Federal Share:						
Cash Contribution	\$ 7,677	\$ 883	\$ 8,560	\$ 8,502	\$ 974	\$ 9,476
LERRD	\$ 2,695	\$ 185	\$ 2,880	\$ 2,858	\$ 196	\$ 3,054
Total Non-Federal Share (35%)	\$10,372	\$1,068	\$11,440	\$11,360	\$1,170	\$12,530
Total Federal Share (65%)	\$19,262	\$1,984	\$21,246	\$21,097	\$2,174	\$23,271

B. Sponsor's Intent

The sponsor's intent to participate in the feasibility study was originally stated in several letters received after the Flood of 1993 requesting the initiation of the study. The sponsors committed to the study financially by signing the original Feasibility Cost Sharing Agreement (FCSA) in 1999. A revised FCSA was executed by all parties in April 2006, further reinforcing the sponsor involvement in the study and commitment to the project. The sponsors have shown every indication that they fully intend to progress into the design and construction phase of the project with the same support given to this Feasibility Study.

C. Project Financing and Sponsor Capability

The majority of the proposed work will occur on the right bank, unit R471-460. Costs of the

NED plan for R471 total \$29,634,000, or 90% of total project NED costs. The Elwood-Gladden Drainage District and the St. Joseph Airport Levee District will share in these costs. It is expected that the two districts will execute an inter-local agreement to allocate the funding between them. The South St. Joseph Levee District will be responsible for financing of the proposed work on the left bank. The L-455 share of total project costs is \$3,052,000, about 10% of total NED costs.

The project and local cost sharing requirements have been discussed with all three sponsors during the study. They are legally constituted bodies under State statutes with taxing authority, and the Corps' assessment indicates that they have the necessary financial basis to cost share a project of this magnitude. The districts, in conjunction with other local funding partners, have expressed their intent to fund the non-Federal share and are expected to issue general obligation bonds under authority granted them by the State. Financing of the L-455 project may involve a levy on property owners and/or additional contributions by selected large facilities in the protected area. Businesses and facilities in the L-455 area have estimated assets of \$1.2 billion. The sponsors have continually expressed very strong support for the project.

It is expected that the City of St. Joseph, Missouri will be a local funding partner for a portion of the local share, as they have been during feasibility phase. Their extensive infrastructure and property interests in both protected areas include the L-455 stockyards area with its city water treatment facility and many of the largest businesses in the region, as well as the R471-460 Rosecrans Airport area, including the 139th Airlift Wing of the Missouri Air National Guard. The ANG is one of the region's largest employers. Any issuance of general obligation bonds would be backed by a city budget currently approaching \$100 million. In addition, the city has a 5-year Capital Improvements Program supported by a half-cent sales tax, and the tax revenues often are used to attract matching grants from other state, local and Federal agencies. St. Joseph voters have consistently displayed their backing of the CIP in recent years when asked to vote on extensions of the sales tax. Increased CIP activity in recent years has helped bring about a 200% increase in grant funding received by the city from other agencies. The city's property tax base, which has benefited greatly in recent years from a growing regional concentration of life science businesses, also should be greatly enhanced by both the direct and indirect effects of the recent opening of Triumph Foods, a new pork processing facility that is one of the largest such facilities in the nation. The seventh-largest Missouri city has a range of possible options it could turn to in providing support of this project.

D. Summary of Coordination and Public Views

1.0 Study Coordination

The non-Federal sponsors strongly support the Recommended Plan. On a daily basis, each of the sponsors accomplish the numerous actions necessary for keeping the project in good condition as evidenced by recent annual inspection reports and by the evaluations undertaken in the feasibility study. The sponsors will continue to provide full cooperation and are prepared to meet the necessary financial obligation associated with the recommendations contained in the

Feasibility Report.

Extensive coordination with several State and Federal agencies took place during development and evaluation of the Recommended Plan and the Environmental Assessment. The following agencies were coordinated with and in some cases have provided comments or participated in the review of this project:

- Federal Emergency Management Agency
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- Natural Resources Conservation Service
- Missouri Air National Guard
- Missouri Department of Natural Resources
- Missouri State Historic Preservation Office
- Kansas Department of Wildlife & Parks
- Kansas Department of Health and Environment
- Kansas State Historic Preservation Office
- City of St. Joseph, Missouri
- City of Elwood, Kansas
- City of Wathena, Kansas
- Buchanan County, Missouri
- Doniphan County, Kansas

2.0 Public Involvement

The initial public involvement was conducted during the fall of 1995 and early 1996. It included meetings with local, state and Federal agencies, organizations and the general public. On October 29, 2002, the Corps and FEMA held a public meeting in Elwood, Kansas at the Elwood Community Center to explain to the residents the increased risk of flooding in the area. A similar meeting was held on October 30, 2002 in Wathena, Kansas, at the Wathena Community Center. These meetings also addressed the feasibility study process, alternatives, and likely outcomes as best understood at that time. Additional information regarding these meetings is included in Appendix A. The Corps' Notice of Intent (NOI) to prepare an Environmental Impact Statement (EIS) was published in the Federal Register on November 20, 2003. The Corps, in accordance with NEPA, actively solicited input on the project. No comments were received as a result of the NOI from either government agencies or the general public. Based on receiving no comments on the NOI and information resulting from an Internal Technical Review, a decision was made that the impacts of the proposed project were not significant and an EIS was not required. As such, the Corps reverted to preparing the included EA.

On August 1, 2006, a description of the proposed project was circulated to the public and resource agencies through Public Notice No. 200501489 issued jointly by the Corps and the Missouri Department of Natural Resources, Water Pollution Control Program and the Kansas

Department of Health and Environment. The public notice included a thirty-day comment period ending on August 31, 2006, and provided instructions for the public to provide comments on the proposed project. The public notice also included information on the Corps preliminary determination to prepare a Finding of No Significant Impact (FONSI) for the project and a draft Section 404(b)(1) Evaluation. The public notice was mailed to the non-Federal Sponsors, adjacent landowners and businesses, local, State, and Federal elected officials, and state and Federal agencies. A copy of the public notice and list of recipients can be found in the EA.

On August 28, 2006, a public meeting was held in Elwood, Kansas, to present the recommendations of the feasibility study and obtain public comment. The meeting was advertised in the St. Joseph, Missouri and Doniphan County, Kansas newspapers and notices of the meeting were sent to the mailing list found in the Environmental Assessment. The meeting was attended by members of the public, local elected officials, the local sponsors, representatives of the levee districts up and downstream of St. Joseph, and state resource agencies. Written comments were received during the meeting and following the meeting by mail. The comments and responses are included in Appendix A of this report.

XII. Conclusions

The Recommended Plan (NED Plan) reduces the risk of flooding through project improvements and remedies planned within the two units examined in this Feasibility Report. In general, the Recommended Plan would raise the top-of-levee elevation of Units R471-460 and L-455 and modify existing appurtenant drainage and underseepage control structures.

This plan helps to correct a design deficiency and restore a uniform level of flood damage reduction for the study area. The NED plan does not fully restore the system to pass the original authorized flow. To do so would require significant additional cost and have a much greater impact to the existing levee systems both upstream and downstream on the Missouri River. The NED plan will provide a project that functions in a safe, viable, and reliable manner, as was initially intended by its designers. It is not required as a result of changed conditions or inadequate maintenance, is generally limited to the existing features and does not change the scope or function of the authorized project. It is also economically justified.

There are no significant long-term social or environmental impacts. Design considerations of the plan include avoidance of environmental resources, cultural resources, and HTRW where possible. The long-term environmental and cultural consequences of plan implementation are positive as the increased reliability of the units act to guard the social and environmental fabric that has developed within the protected areas for the last 40 years. A minimal amount of wetlands would be lost and mitigation is planned accordingly.

The Recommended Plan carries no increase in OMRR&R. The sponsors have sufficiency to provide all real estate requirements.

XIII. Recommendation

Upon considering the economic, environmental, social, and engineering aspects of making improvements to the existing Missouri River Levee System Units R471-460 and L-455, it has been determined that a project to reduce the risk of flooding and correct design deficiencies is in the public interest. Accordingly, the Corps of Engineers recommends that the Recommended Plan, as described in this report, be authorized for implementation with such modifications as the Chief of Engineers may find advisable, and in accordance with existing cost sharing and financing requirements.

The estimated implementation cost of the Recommended Plan is \$21,246,000 Federal and \$11,440,000 Non-Federal for a total estimated cost of \$32,686,000 at October 2005 price levels. The NED benefits of the Recommended Plan are in excess of \$4.6 million. The average annual flood damage reduction benefits of the Recommended Plan exceed the average annual cost by a ratio of 3.3 to 1.

Implementation of the Recommended Plan will use existing project authority. All items included in the Recommended Plan are necessary to continue providing the flood damage reduction benefits as intended by Congress.

Federal implementation of the recommended project would be subject to the non-Federal sponsor agreeing to comply with applicable Federal laws and policies, including but not limited to:

- a. Provide a minimum of 35 percent, but not to exceed 50 percent of total project costs as further specified below:
 1. Provide 25 percent of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;
 2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs;
 3. Provide, during construction, a contribution of funds equal to 5 percent of total project costs;
 4. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the project;

5. Provide, during construction, any additional funds necessary to make its total contribution equal to at least 35 percent of total project costs;
- b. Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;
- c. Not less than once each year, inform affected interests of the extent of protection afforded by the project;
- d. Agree to participate in and comply with applicable Federal floodplain management and flood insurance programs;
- e. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires a non-Federal interest to prepare a floodplain management plan within one year after the date of signing a project cooperation agreement, and to implement such plan not later than one year after completion of construction of the project;
- f. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the project;
- g. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the level of protection the project affords, hinder operation and maintenance of the project, or interfere with the project's proper function;
- h. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;
- i. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

- j. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;
- k. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;
- l. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;
- m. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c *et seq.*);
- n. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;
- o. Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous

substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;

- p. Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and
- q. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

This recommendation is contingent upon such discretionary modifications as deemed necessary by the Chief of Engineers and funding requirements satisfactory to the Administration and Congress. The recommendations contained herein reflect the information available at the time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendation may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the project partner, the States, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

Michael A. Rossi (date)
Colonel, Corps of Engineers
District Engineer

End of Feasibility Report