Chapter 6
Environmental Consequences Associated with Study Alternatives

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CHAPTER 6:

ENVIRONMENTAL CONSEQUENCES ASSOCIATED WITH STUDY ALTERNATIVES

6.1 Introduction

The following discussion describes the potential environmental consequences of the identified study alternatives. The discussion is based on the information provided in Chapter 5 regarding the features and individual components that comprise the study. Based on the information provided in the component evaluations, in combination with economic information developed in the Feasibility Study, a series of decision alternatives were developed. These alternatives include combinations of components from the three project features that achieve, in varying degrees, the proposed action of the study.

6.1.1 Alternatives Development

A series of decision alternatives were developed to achieve the proposed action to different extents. These alternatives include combinations of the individual components previously discussed in Chapter 5. These alternatives are described and analyzed in the following pages.

6.1.1.1 Navigation Channel Depth Maintenance Features and Components

In Chapter 5, two action components were evaluated in detail. Based on 1) the ability to achieve the proposed action, 2) cost benefit analysis, and 3) environmental impacts, the Maintenance Dredged Material Disposal in New Disposal Sites Component was clearly the most favorable component among the Navigation Channel Depth Maintenance Features. This component attained the proposed action while having fewer adverse environmental impacts compared to the other component evaluated. Financially the two components were similar per the analysis in the Feasibility Study Report. Consequently this is the only component of the Navigation Channel Maintenance Features that was carried forward as a part of the decision alternatives analyses.

6.1.1.2 Flow Management Features and Components

In Chapter 5, three action components were evaluated in detail. Based on 1) the ability to achieve the proposed action, 2) cost benefit analysis, and 3) environmental impacts, the Operations Only Component was clearly the most favorable component among the Flow Management Features. This component attained the proposed action while achieving a positive cost benefit ratio and with minimal adverse environmental impacts. Consequently this is the only component of the Flow Management Features that was carried forward as a part of the decision alternatives analyses.

6.1.1.2.1 Navigation Channel Deepening Features and Components

The navigation channel deepening features evaluated in Chapter 5 included increased channel depths (10, 11, and 12 feet) within six river segments comprising the entire McClellan Kerr Arkansas River Navigation System (MKARNS). Based on 1) the ability to achieve the proposed action, 2) cost benefit analysis, and 3) environmental impacts the following was determined:

- Economic benefits of deepening the navigation channel are achieved primarily via deepening the entire system and not portions of the system. Seventy percent of the economic benefits of deepening the navigation channel are associated with channel deepening from the MKARNS mouth, at the confluence of the Mississippi River, upstream to the Port of Catoosa. Incremental deepening of the navigation channel on only lower portions of the MKARNS is not financially justified.
- Deepening the navigation channel to a depth of 10 feet is not financially justified since the cost benefit ratio for this component is below 1.0.
- Deepening the navigation channel to depths of 11 or 12 feet achieves the proposed action, is financially justified in that a positive cost benefit ratio is achieved, and there are no significant adverse impacts associated with either component. Consequently, these two components of the Navigation Channel Deepening Features are both included in the decision alternatives analyses.

6.2 Study Alternatives

Study alternatives were developed based on the analyses presented in Chapter 5 and highlighted in Chapter 6.1. Alternatives, including the No Action Alternative, were developed by combining components of the three features to achieve, in varying degrees, the proposed action. Table 6-1 summarizes the components used in the five alternatives selected for evaluation.

Table 6-1. Components of Decision Alternatives.

	Navigation Channel Maintenance*	Flow Management Operations Only	Navigation Channel Deepening 11 Ft.	Navigation Channel Deepening 12 Ft.
Alternative A No Action (Dredge disposal sites approved in 1974)	X			
Alternative B Maintenance Only (New dredge disposal sites)	X			
Alternative C Maintenance & Ops Only Flow Management	X	X		
Alternative D Maintenance & Ops Only Flow Management & 11 Foot Navigation Channel	X	X	X	
Alternative E Maintenance & Ops Only Flow Management & 12 Foot Navigation Channel	X	X		X

* Navigation channel maintenance activities will occur in the same manner under Alternatives B, C, D, and E. The navigation channel depth to be maintained will be 9 feet for Alternatives A, B and C, 11 feet for Alternative D, and 12 feet for Alternative E.
Source: USACE 2005

6.2.1 Alternative A - No Action

The No Action Alternative consists of maintaining the current MKARNS Operation System. No changes in existing river or reservoir operations would be made. The existing flow management plan would remain unchanged, the existing depth of the navigation channel would remain unchanged, and the existing navigation channel maintenance activities would remain unchanged.

Alternative A is based on measures that are currently in place and available for implementation with minimal additional administrative action. This alternative assumes that the existing 9-ft channel would be maintained throughout the period of analysis using dredging techniques and disposal areas described in the 1974 Operations and Maintenance Plan (O&M plan) for which an EIS was prepared and a ROD signed.

Subsequent to, and in accordance with, the 1974 O&M plan, in-river disposal of dredged materials has been used in Arkansas with the exception of the White River Entrance Channel, where terrestrial sites are utilized. Terrestrial disposal sites have also been acquired for use as needed in Oklahoma. These designated sites are sufficient to contain the dredged material

projected to be required through the 50-year period of analysis used in 1974. However, projections indicate that the currently used terrestrial sites in Oklahoma would not be adequate to meet disposal area needs through the 50-year period of analysis for the present study, i.e., 2010 through 2060. Additional currently unused disposal areas in Oklahoma that were approved in the 1974 O&M plan, would be needed to meet the projected dredged material disposal needs to maintain a 9-ft channel through 2060. Natural succession of habitats in these unused disposal sites has occurred for approximately three decades. These areas are now covered by substantial tracts of mature floodplain forests that are essential components to the region's complex mosaic of riparian, wetland, and floodplain habitats. Use of the sites would require additional coordination with Federal and State fish and wildlife management agencies because of the significant changes in the habitats of the dredged material disposal sites. Given the increased emphasis on the importance of high quality floodplain habitats since 1974, it is reasonable to assume that substantial mitigation would be necessary. In addition, under provisions of the Clean Water Act, the Oklahoma portion of the MKARNS has been designated an impaired stream. As a designated impaired stream, in-river dredged material disposal in the Oklahoma reach has been closely regulated by the State of Oklahoma, and rarely allowed to occur. Alternative A assumes that the impaired stream designation is not likely to be changed in the immediate future, and also assumes that in-river dredged material disposal in the Oklahoma reach of the MKARNS would not be allowed by the State of Oklahoma. This alternative also assumes that disposal of dredged material on the Arkansas portion of the MKARNS would continue in accordance with the 1974 O&M plan.

The following characterizes what would occur for each study feature/component under the No Action Alternative:

ALTERNATIVE A – NO ACTION

Navigation Channel Maintenance: Existing dredging and disposal to maintain the 9-foot navigation channel would continue. Dredged material would continue to be disposed of at existing active and inactive sites until they reached their holding capacity. The USACE would utilize only existing approved disposal sites and no new dredged material disposal sites would be developed.

Flow Management: The existing river flow management plan employing a taper operation of 40,000 cfs to 20,000 cfs and a 75,000 cfs flow "bench" at Van Buren would remain unchanged. (See Chapter 3 for details regarding the Taper and Bench operations).

Navigation Channel Depth: The current 9-foot navigation channel would be retained along the entire MKARNS. No sections of the navigation system would be deepened through dredging and new river training structures would not be constructed.

6.2.2 Alternative B - Navigation Channel Maintenance Only

Alternative B consists of adding new dredged material disposal sites in Oklahoma to supplement some current disposal sites along the MKARNS that will reach capacity within the next 10 years. The existing flow management plan would remain unchanged and the existing depth of the navigation channel would remain unchanged.

Alternative B includes consideration of all the measures included in Alternative A, except that it assumes that in-river disposal of dredged materials would be allowed in Oklahoma. Unused upland dredged material disposal sites, approved in the 1974 O&M plan, would not be utilized and the need to mitigate adverse effects to these now valuable sites would be avoided. Alternative B assumes that essentially all future disposal in Oklahoma would be in-river, in currently used terrestrial sites, or in newly identified terrestrial sites of low habitat value. Future disposal in Arkansas would continue to be instream except on the White River Entrance Channel where terrestrial sites are, and would continue to be utilized.

The following characterizes what would occur for each study feature/component under Alternative B:

ALTERNATIVE B

Navigation Channel Maintenance: Existing dredging and disposal to maintain the navigation channel would continue under this alternative. After currently utilized dredged material disposal sites reach their holding capacity, dredged material would be disposed of in new disposal sites designated in the 2003 Long-Term Dredged Material Disposal Plan (DMDP). Under this alternative, areas with high quality habitat such as bottomland hardwood forest or wetlands would be avoided wherever practical.

Navigation channel maintenance would include the construction of:

- 26 new dredged material disposal sites,
- 2 new and 50 modified river training structures, and
- 2 new and 4 modified revetments.

Flow Management: No change from the current flow management plan.

Navigation Channel Depth: No change from the current 9-foot navigation channel.

6.2.3 Alternative C - Navigation Channel Maintenance and Operations Only Flow Management

Alternative C consists of adding new dredged material disposal sites in Oklahoma to supplement disposal site capacity, which will reach capacity at some locations along the MKARNS within the next 10 years and replacing the existing flow management plan with the Operations Only Flow Management Plan. The existing depth of the navigation channel would remain unchanged.

The following characterizes what would occur for each study feature/component under Alternative C:

ALTERNATIVE C

Navigation Channel Maintenance: Existing dredging and disposal to maintain the navigation channel would continue under this alternative. After currently utilized dredged material disposal sites reach their holding capacity, dredged material would be disposed of in new disposal sites designated in the 2003 Long-Term DMDP. Under this alternative, areas with high quality habitat such as bottomland hardwood forest or wetlands would be avoided wherever practical.

Navigation channel maintenance would include the construction of:

- 26 new dredged material disposal sites,
- 2 new and 50 modified river training structures, and
- 2 new and 4 modified revetments.

Flow Management: The Operations Only Component entails modifying the current operations plan to better meet the objectives of the proposed action. The Operations Only Component is defined as the existing plan with a modified 60,000 cfs bench in place of the 75,000 cfs bench beginning at 3% lower system storage except during June 15 through October 1.

There are three primary differences between the Operations Only Component and the current operating plan. These three differences are: 1) a 14 day reduction above 61,000 cfs (a key level for farming interests in Arkansas and commercial navigation system wide), 2) an increase in days between 40,000 cfs and 60,000 cfs (key to scouring flows in the navigation system) and 3) accelerated evacuation of the storage projects when the system percent full exceeds 75%.

Navigation Channel Depth: No change from the current 9-foot navigation channel.

6.2.4 Alternative D - Navigation Channel Maintenance, Operations Only Flow Management, and 11 Foot Navigation Channel

Alternative D consists of 1) adding new dredged material disposal sites in Oklahoma to supplement some current disposal sites that will reach capacity within the next 10 years, 2) replacing the existing flow management plan with the Operations Only Flow Management Plan, and 3) increasing the depth of the navigation channel throughout the MKARNS from 9 feet to 11 feet.

The following characterizes what would occur for each study feature/component under Alternative D:

ALTERNATIVE D

Navigation Channel Maintenance: Existing dredging and disposal to maintain the navigation channel would continue under this alternative. After currently utilized dredged material disposal sites reach their holding capacity, dredged material would be disposed of in new disposal sites designated in the 2003 Long-Term DMDP. Under this alternative, areas with high quality habitat such as bottomland hardwood forest or wetlands would be avoided wherever practical.

Navigation channel maintenance would include the construction of:

- 26 new dredged material disposal sites,
- 2 new and 50 modified river training structures, and
- 2 new and 4 modified revetments.

Flow Management: The Operations Only Component entails modifying the current operations plan to better meet the objectives of the proposed action. The Operations Only Component is defined as the existing plan with a modified 60,000 cfs bench in place of the 75,000 cfs bench beginning at 3% lower system storage except during June 15 through October 1.

Navigation Channel Depth: The current 9-foot navigation channel would be deepened to an 11-foot navigation channel throughout the entire length of the MKARNS.

Navigation channel deepening to 11-foot would include the construction of:

- 41 new dredged material disposal sites,
- 89 new and 87 modified river training structures, and
- 1 new and 16 modified revetments.

6.2.5 Alternative E - Navigation Channel Maintenance, Operations Only Flow Management, and 12 Foot Navigation Channel

Alternative E consists of 1) adding new dredged material disposal sites in Oklahoma to supplement some current disposal sites that will reach capacity within the next 10 years, 2) replacing the existing flow management plan with the Operations Only Flow Management Plan, and 3) increasing the depth of the navigation channel throughout the MKARNS from 9 feet to 12 feet.

The following characterizes what would occur for each study feature/component under Alternative E:

ALTERNATIVE E

Navigation Channel Maintenance: Existing dredging and disposal to maintain the navigation channel would continue under this alternative. After currently utilized dredged material disposal sites reach their holding capacity, dredged material would be disposed of in new disposal sites designated in the 2003 Long-Term DMDP. Under this alternative, areas with high quality habitat such as bottomland hardwood forest or wetlands would be avoided wherever practical.

Navigation channel maintenance would include the construction of:

- 26 new dredged material disposal sites,
- 2 new and 50 modified river training structures, and
- 2 new and 4 modified revetments.

Flow Management: The Operations Only Component entails modifying the current operations plan to better meet the objectives of the proposed action. The Operations Only Component is defined as the existing plan with a modified 60,000 cfs bench in place of the 75,000 cfs bench beginning at 3% lower system storage except during June 15 through October 1.

Navigation Channel Depth: The current 9-foot navigation channel would be deepened to a 12-foot navigation channel throughout the entire length of the MKARNS.

Navigation channel deepening to 11-foot would include the construction of:

- 41 new dredged material disposal sites,
- 89 new and 87 modified river training structures, and
- 1 new and 16 modified revetments.

6.3 Alternatives Evaluation

The evaluation of the study alternatives is based on the detailed evaluation of the features and components in Chapter 5. Readers are encouraged to refer to the Chapter 5 evaluations to facilitate their understanding of the following discussions associated with the alternatives for the study.

In general the navigation channel maintenance component, flow management component, and the navigation channel deepening components of the action alternatives entail the following:

- **Navigation Channel Maintenance Component** of the action alternatives entail 1) maintaining the navigation channel via dredging and river training structures, 2) dredging sediment from the navigation channel in volumes consistent with current annual rates, 3) disposal of dredged material associated with navigation channel maintenance in existing and new disposal sites, and 4) the construction of river training structures and revetments.
- **Flow Management Component** of the action alternatives entails changes to the frequency of river flows below bank full at Van Buren (137,000 cfs). Additionally, the number of days the river flow is above 100,000 cfs at Van Buren is expected to increase by approximately 2 days annually. The number of days the river flow is above 60,000 cfs at Van Buren is expected to decrease by approximately 14 days annually.
- **Navigation Channel Deepening Components** of the action alternatives entails 1) the deepening of the navigation channel to a depth of 11 or 12 feet throughout the length of the

MKARNS, 2) disposal of dredged material associated with navigation channel deepening in existing and new disposal sites, and 3) the construction of river training structures and revetments to facilitate the maintenance of the navigation channel.

Table 6-2 presents a summary of the activities associated with each alternative that may influence the environmental impacts associated with each resource category.

The following discussion concentrates on resources that could potentially be affected by implementation of new activities on the MKARNS, including operational changes, construction projects on the MKARNS, or changes in utilization rates of the MKARNS associated with each of the alternatives.

Table 6-2. Decision Alternatives - Impact Quantification Summary

	Flow Management			Navigation Channel Maintenance and Navigation Channel Deepening																				
	River Flow (Change in Days)			Dredge Volume [1] (Cubic Yards 000s)			Dredge Area (Surface Acres)			Disposal Area Aquatic Habitat (Surface Acres)			Disposal Area Terrestrial Habitat (Surface Acres)			New River Training Structures (Number)			Modified River Training Structures (Number)			New Revetments (Number)			Modified Revetments (Number)		
DECISION ALTERNATIVES	at or above 60K	at or above 100K	at or above 137K	Maint	Deep	Total	Maint	Deep	Total	Maint Existing / Long Term DMDP [2]	Deep Existing / New	Total	Maint Existing / Long Term DMDP	Deep New	Total	Maint	Deep	Total	Maint	Deep	Total	Maint	Deep	Total	Maint	Deep	Total
Alternative A No Action	0	0	0	37,704	0	37,704	1,429	0	1,429	2,484 / 0	0 / 0	2,484	5,664 / 0	0	5,664	0	0	0	0	0	0	0	0	0	0	0	0
Alternative B Maintenance Only	0	0	0	37,704	0	37,704	1,429	0	1,429	2,484 / 165	0 / 0	2,649	5,664 / 569	0	6,233	2	0	2	50	0	50	2	0	2	4	0	4
Alternative C Maintenance & Ops Only Flow Management	-13.6	+1.7	0	37,704	0	37,704	1,429	0	1,429	2,484 / 165	0 / 0	2,649	5,664 / 569	0	6,233	2	0	2	50	0	50	2	0	2	4	0	4
Alternative D Maintenance & Ops Only Flow Management & 11 Ft Nav Channel	-13.6	+1.7	0	60,454	6,837	67,291	1,429	4,809	6,238	2,484 / 165	3,126 / 345	6,120[3]	5,664 / 569	927	7,160	2	89	91	50	87	137	2	1	3	4	16	20
Alternative E Maintenance & Ops Only Flow Management & 12 Ft Nav Channel	-13.6	+1.7	0	78,704	10,985	89,689	1,429	5,645	7,074	2,484 / 165	3,126 / 345	6,120	5,664 / 569	927	7,160	2	89	91	50	87	137	2	1	3	4	16	20

[1] Average Annual Maintenance Dredging Volume will vary on an annual basis based on rainfall and river flow conditions
[1] Average Annual Maintenance Dredging Volume (1995-2003) = 754,076 cubic yards.
[1] Maximum Annual Maintenance Dredging Volume (1995-2003) = 1,145,076 cubic yards (2002)
[1] Minimum Annual Maintenance Dredging Volume (1995-2003) = 378,721 cubic yards (2000)
[2] Long-Term DMDP =Long-Term Dredged Material Disposal Plan
[3] Assumption made that all disposal sites would be used and that all disposal sites would be completely impacted with implementation of either Alt D or Alt E.

Source: USACE 2005

6.4 Air Quality

The assessment of impacts on air quality addresses three major air quality concerns. These three concerns are:

- Sources of pollutants;
- Means of transport for pollutants; and
- Pollutant receptors.

Sources can be classified as emitting particulate and/or gases and vapors. The degree of pollutant transport is controlled by meteorological and topographic factors. Receptors may be living or non-living, ranging from plants and animals to exterior finishes on vehicles and buildings. Air quality issues considered as part of the air quality analysis include:

- Potential for increased emissions during dredging;
- Potential for increased industrial and/or recreational development (additional ports and/or marinas) and the creation of new point sources;
- National Ambient Air Quality Standards (NAAQS) attainment status; and
- Potential for modified highway, rail, and river traffic volumes and modified traffic patterns.

The purpose of the air quality impact analysis is to determine if the air emission sources associated with the Proposed Action Alternatives will cause an exceedance of the NAAQS. A significant adverse impact would occur if an action results in an exceedance of the NAAQS for a criterion pollutant.

As described in Chapter 4, the study area of the MKARNS contains six Air Quality Control Regions (AQCRs), all of which are in attainment of applicable air quality standards. No change to the AQCRs' attainment status is anticipated with the implementation of any of the alternatives. Although there would be slight increases in emissions due to construction, rock placement, and additional dredging, these increases would be short-term and minor. No changes in stationary emission sources would occur with the implementation of any of the alternatives.

Mobile emissions from the transportation of goods along the MKARNS are the main factor determining the proposed action's air quality impacts. According to predicted changes in transportation based on economic forecasting contained in the Feasibility Study, minor changes in transportation would occur with the implementation of any of the alternatives.

Implementation of the proposed action would improve navigation efficiencies that in combination with other economic factors could interact with changes in demand and transportation in the following three ways:

- If demand for goods stays the same and, due to increased efficiencies, there are fewer trips necessary to transport the same amount of goods, a decrease in waterway traffic would be produced;
- Demand for goods increases and there is an increase in waterway traffic; and
- Due to increased efficiencies and more competitive prices there is an increase in waterway transportation and a reduction in other forms of transportation, such as railways or trucks.

The economics analysis in the Feasibility Study (USACE 2005) predicted that no large increase in demand would occur, but that some small levels of increased demand in steel, dry fertilizers,

and specialty stone would occur. In addition, the forecast predicted that a 1% increase in waterway traffic could occur due to a shift from overland to waterway transport.

6.4.1 Environmental Consequences Associated with Alternative A - No Action Alternative

Under the No Action Alternative, navigation channel maintenance, river flow management, and navigation channel depth would remain unchanged from existing actions. Impacts to air quality associated with implementing the No Action Alternative would be similar to existing impacts.

Once current disposal site capacity has been reached, dredged material would be pumped to previously used but currently inactive disposal sites. Maintenance dredging and disposal on the MKARNS would be maintained.

Under the No Action Alternative, river levels on the MKARNS would continue to fluctuate at current levels and barge traffic would be restricted during high flows. The annual average number of high flow days (>100,000 cfs) would not be reduced and, therefore, the amount of barge traffic would not increase.

Under the No Action Alternative, transportation would not change because channel deepening would not occur. Without the channel deepening, the amount of barge traffic would not change.

6.4.2 Environmental Consequences Associated with Alternative B - Navigation Channel Maintenance Only Alternative

Under Alternative B, navigation channel maintenance would be sustained using new disposal sites. River flow management and navigation channel depth would remain unchanged from existing actions.

Impacts to air quality associated with implementing the Alternative B would be similar to existing impacts. Under Alternative B, once capacity has been reached at the existing disposal sites on the MKARNS, dredged material would be disposed of in new disposal sites designated in the 2003 Long-Term DMDP. The new sites would allow for continued maintenance dredging and disposal on the MKARNS. The current conditions for navigation would be maintained and there would be no changes in transportation levels. Air emissions from towboats, and other transportation sources, would remain at current levels and would not have a beneficial or adverse impact on air quality.

6.4.3 Environmental Consequences Associated with Alternative C - Navigation Channel Maintenance & Operations Only Flow Management Alternative

Under Alternative C, navigation channel maintenance would be sustained using new disposal sites and river flow management would change as defined by the Operations Only Plan. Navigation channel depth would remain unchanged from existing actions.

Air quality impacts associated with the continued maintenance dredging and disposal on the MKARNS would be similar to those described for Alternative B. The current conditions for navigation would be maintained and there would be no changes in transportation levels. Air

emissions from towboats, and other transportation sources, would remain at current levels and would not have a beneficial or adverse impact on air quality.

Implementation of Alternative C would result in an annual average of 2 additional days per year above 100,000 cfs, a level at which barge traffic would not be able to operate at maximum tow size. Conversely, commercial navigation would benefit from the efficiency associated with an annual average of 14 fewer days per year with river flows above 61,000 cfs. Given the relatively minor change in river transportation activity, emissions associated with other forms of transportation would not measurably change as a result of the implementation of this alternative. Therefore, implementation of this alternative would not impact air quality along the MKARNS.

6.4.4 Environmental Consequences Associated with Alternative D - Navigation Channel Maintenance & Operations Only Flow Management & 11-Ft Depth Navigation Channel Alternative

Under Alternative D, navigation channel maintenance would be sustained using new disposal sites, river flow management would change as defined by the Operations Only Plan, and navigation channel depth would be increased to 11 feet throughout the MKARNS.

The implementation of Alternative D would result in no net change of air emissions across the MKARNS study area because the benefits and disadvantages of the flow management and channel deepening components would cancel each other out. Sustained maintenance dredging and disposal would not result in any increases or decreases in emissions compared to existing conditions. Overall, the combined changes of implementing Alternative D would be too small to contribute to a measurable difference in air emissions from current levels.

Implementation of Alternative D would result in an annual average of 2 additional days per year above 100,000 cfs, a level at which barge traffic would not be able to operate at maximum tow size. Conversely, commercial navigation would benefit from the efficiency associated with an annual average of 14 fewer days per year with river flows above 61,000 cfs. Given the relatively minor change in river transportation activity, emissions associated with other forms of transportation would not measurably change as a result of the implementation of this alternative. Therefore, implementation of this alternative would not impact air quality along the MKARNS

Deepening the navigation channel to 11 feet would allow towboats to push heavier barges carrying more goods. However, the increased weight and draft of the barge would require towboats to use more horsepower producing an increase in emissions. If the demand for goods remains the same then the greater barge towing capacity may allow for fewer trips. According to the economic forecasting provided in the Feasibility Study, demand for goods may increase. However, under this alternative, the increase in demand would be accompanied by an increase in barge efficiencies that would result in no net change in air quality. Also, emissions associated with other forms of transportation would not measurably change as a result of the implementation of this alternative. Therefore, implementation of this alternative would not affect air quality in the region.

6.4.5 Environmental Consequences Associated with Alternative E - Navigation Channel Maintenance & Operations Only Flow Management & 12-Ft Depth Navigation Channel Alternative

Under Alternative E, navigation channel maintenance would be sustained using new disposal sites, river flow management would change as defined by the Operations Only Plan, and navigation channel depth would be increased to 12 feet throughout the MKARNS.

Air quality impacts associated with implementing the flow management and channel deepening components of Alternative E would be similar to those associated with Alternative D.

Deepening the navigation channel to 12 feet would allow towboats to push heavier barges carrying more goods. However, the increased weight and draft of the barge would require towboats to use more horsepower producing an increase in emissions. If the demand for goods remains the same then the greater barge towing capacity may allow for fewer trips. According to the economic forecasting provided in the Feasibility Study, demand for goods may increase. However, under this alternative, the increase in demand would be accompanied by an increase in barge efficiencies that would result in no net change in air quality. Also, emissions associated with other forms of transportation would not measurably change as a result of the implementation of this alternative. Therefore, implementation of this alternative would not affect air quality in the region.

6.5 Noise

As described in Chapter 5, noise impacts in the MKARNS study area include both stationary and mobile sources. Noise is created by vehicle engines, as well as by frictional contact of an object with the water, ground, and/or air. In general, land vehicles cause greater noise effects than waterway transportation. Horns and whistles of transportation vehicles generate the highest noise levels.

Smaller watercraft actually produce more noise than larger vessels such as barge tows. Small, recreational watercraft such as powerboats often accelerate and decelerate rapidly which produces higher noise levels than the slower barge tows. In addition, smaller recreational watercraft travel higher in the water than barge tows, which results in higher levels of engine noise relative to barge tows whose engine noise is dampened by the water.

6.5.1 Environmental Consequences Associated with Alternative A - No Action Alternative

Under the No Action Alternative, navigation channel maintenance, river flow management, and navigation channel depth would remain unchanged until dredge disposal sites reach capacity. The No Action Alternative would result in USACE Tulsa District exhausting the active terrestrial disposal sites for navigation channel maintenance dredging. In stream disposal was not approved by the Oklahoma Department of Environmental Quality when the MKARNS Operation and Maintenance Program 1974 EIS was approved. When active sites are full , disposal will move to approved sites that are currently not being used. Transportation would not change and, therefore, there would be no change in noise levels.

Under the No Action Alternative, river levels on the MKARNS would continue to fluctuate at current levels and restrict barge traffic during high flows. The annual average number of high flow days would not be reduced and, therefore, noise from barge traffic would not be impacted.

Under the No Action Alternative, transportation would not change because channel deepening would not occur. Without the channel deepening the amount of barge traffic would not change, and thus noise levels would not be impacted.

6.5.2 Environmental Consequences Associated with Alternative B - Navigation Channel Maintenance Only Alternative

Under Alternative B, navigation channel maintenance would be sustained using new disposal sites. River flow management and navigation channel depth would remain unchanged from existing actions.

Impacts to noise associated with implementing Alternative B would be similar to existing impacts. Under Alternative B, once capacity has been reached at the existing disposal sites on the MKARNS, dredged material would be disposed of in new disposal sites designated in the 2003 Long-Term DMDP. The new sites would allow for continued maintenance dredging and disposal on the MKARNS. The current conditions for navigation would be maintained and there would be no changes in transportation levels. Noise from towboats, recreational watercraft, and other transportation sources would remain at current levels and there would be no increase or decrease in noise levels in the region.

6.5.3 Environmental Consequences Associated with Alternative C - Navigation Channel Maintenance & Operations Only Flow Management Alternative

Under Alternative C, navigation channel maintenance would be sustained using new disposal sites and river flow management would change as defined by the Operations Only Plan. Navigation channel depth would remain unchanged from existing actions.

Impacts to noise associated with implementing Alternative C would be similar to those described for Alternative B.

Alternative C would result in an annual average of 2 additional days per year when barge traffic could not operate at maximum tow size. Conversely, commercial navigation would benefit from the efficiency associated with an annual average of 14 fewer days per year with river flows above 61,000 cfs. Therefore, barge traffic would remain at approximately current levels and would not have an effect on noise levels in the region.

6.5.4 Environmental Consequences Associated with Alternative D - Navigation Channel Maintenance & Operations Only Flow Management & 11-Ft Depth Navigation Channel Alternative

Under Alternative D, navigation channel maintenance would be sustained using new disposal sites, river flow management would change as defined by the Operations Only Plan, and navigation channel depth would be increased to 11 feet throughout the MKARNS.

Sustained maintenance dredging and disposal would not result in any increases or decreases in noise levels compared to existing conditions.

Impacts associated with flow management changes would be similar to those described for Alternative C, i.e., barge traffic would remain at approximately current levels and would not have an effect on noise levels in the region.

Deepening the channel to 11 feet would allow towboats to push heavier barges carrying more goods. However, the increased weight and draft of the barge would require towboats to use more horsepower producing a very slight increase in noise. If the demand for goods remains relatively constant, the greater barge towing capacity may allow for fewer trips and slightly less traffic and noise on the MKARNS. According to the economic forecasting provided in the Feasibility Report, demand for goods may increase slightly which, in combination with the increased efficiencies, would result in no net change in noise levels.

Implementing Alternative D would produce a short-term minor noise impact associated with deepening dredging operations.

6.5.5 Environmental Consequences Associated with Alternative E - Navigation Channel Maintenance & Operations Only Flow Management & 12-Ft Depth Navigation Channel Alternative

Under Alternative E, navigation channel maintenance would be sustained using new disposal sites, river flow management would change as defined by the Operations Only Plan, and navigation channel depth would be increased to 12 feet throughout the MKARNS.

Impacts associated with sustained maintenance dredging and disposal, flow management, and channel deepening would be similar to those described for Alternative D.

6.6 Geology and Soils

The hydrogeology of the MKARNS study area is strongly influenced by various alluvial and other aquifers. Most natural recharge to the aquifers occurs as precipitation that falls directly on the alluvial deposits, infiltration of runoff from adjacent slopes, and infiltration from the streams that cross the deposits, especially during higher flows. The shallow depth to ground-water and permeable materials result in alluvial aquifers being potentially vulnerable to contamination by pesticides used to control vegetation and insects in agricultural and urban areas.

On the Verdigris River, the alluvial sediment contains more silt, while the material dredged from the Arkansas River is primarily sand. Dredged material is most likely to be free of contaminants if the material is composed primarily of sand, gravel, or similar materials and is found in areas of high current or wave action.

Evaluation criteria for consideration of impacts to geologic features and soils are based on chemical constituent concentrations in the soil (relative to applicable laws and regulations) and on physical damage to soil and geologic features. Among the more important geological processes are stream and wind erosion, deposition, mass wasting (the down-slope movement of soil and rock by the force of gravity), and soil formation.

Geology and soil issues considered in the analysis include:

- Changes in the rate of erosion and deposition within the river channel or banks due to a change in river levels and/or flows;
- Soil types within the dredge sites and dredged material disposal areas; and
- Potential contaminants present in riverbed sediments at dredge sites.

6.6.1 Environmental Consequences Associated with Alternative A - No Action Alternative

Under the No Action Alternative, navigation channel maintenance, river flow management, and navigation channel depth would remain unchanged until dredge disposal sites reach capacity.

Under the No Action Alternative maintenance dredging and disposal will continue at the current rate at active sites until they have reached capacity. Disposal will then continue at previously used but currently inactive sites. In Arkansas, capacity exists for many more years of disposal. Upland dredged material disposal is anticipated to have a minor direct, long-term adverse effect on the soils and topography of the disposal sites. Erosion and compaction would occur from construction and dredged material disposal activities. Runoff and erosion would be minimized during disposal by the use of BMPs. Disposal material would be contained within a diked area at most of the upland disposal sites. The addition of dredged material to the disposal sites would serve to raise the elevation of the sites.

Under the No Action Alternative, the existing flow management policies and procedures for the MKARNS would remain in place. These management policies and procedures have contributed to the establishment of the existing conditions. Under the No Action Alternative, erosion and deposition would continue as they have historically and would continue to be influenced by the existence of river flow management procedures.

Since there would be no deepening dredging under Alternative A, no additional impacts to geology and soils would be expected within the MKARNS.

6.6.2 Environmental Consequences Associated with Alternative B - Navigation Channel Maintenance Only Alternative

Under Alternative B, navigation channel maintenance would be sustained using new disposal sites. River flow management and navigation channel depth would remain unchanged from existing conditions.

In addition to the impacts to geology and soils described for the No Action Alternative, minor adverse impacts would occur once currently utilized dredged material disposal sites reach their holding capacity. Dredged material would be disposed of in new disposal sites designated in the 2003 Long Term DMDP, which specifies the avoidance of high quality habitats where practical. Most of the impacts would be to agricultural lands, rather than to higher quality habitats such as wetlands, prairie, and bottomland forest. Quantitative evaluations of representative terrestrial and aquatic disposal sites were accomplished using the Habitat Evaluation Procedure (HEP), as developed by the U.S. Army Engineer Research and Development Center – Environmental Laboratory (ERDC-EL), and the results extrapolated to the remaining potential dredged material disposal sites (see Appendix C and Subsection 6.8).

Since there would be no deepening dredging under Alternative B, no additional impacts to geology and soils would be expected within the MKARNS.

6.6.3 Environmental Consequences Associated with Alternative C - Navigation Channel Maintenance & Operations Only Flow Management Alternative

Under Alternative C, navigation channel maintenance would be sustained using new disposal sites and river flow management would change as defined by the Operations Only Plan. Navigation channel depth would remain unchanged from existing actions.

Impacts to geology and soils associated with sustained maintenance dredging would be similar to those described for Alternative B.

Under FM-OPS, annual out-of-bank flows (≥ 137,000 cfs) at Van Buren would continue with the same frequency as the No Action Alternative. Thus, there would be no increase in erosion potential and no impacts to soils. Under FM-OPS, the average decrease of 14 flow days per year above 61,000 cfs may slightly increase agricultural production in the Arkansas River floodplain. This increase in cultivation may result in increased pesticide use that would cause very minor indirect adverse impacts to the quality of soils in the study area.

6.6.4 Environmental Consequences Associated with Alternative D - Navigation Channel Maintenance & Operations Only Flow Management & 11-Ft Depth Navigation Channel Alternative

Under Alternative D, navigation channel maintenance would be sustained using new disposal sites, river flow management would change as defined by the Operations Only Plan, and navigation channel depth would be increased to 11 feet throughout the MKARNS.

Impacts to geology and soils associated with sustained maintenance dredging and implementation of FM-OPS would be similar those described for Alternative C.

Under Alternative D, in order to achieve the 11 foot channel, a total of approximately 6,837,176 cubic yards (cy) of additional dredged material would be removed from the MKARNS. This would result in short-term adverse impacts to soils from sediment suspension, movement, and resettlement caused by dredging, and minor long-term impacts to soils due to an increase in barge traffic on the MKARNS after completion of dredging.

Upland dredged material disposal is anticipated to have a minor direct, long-term effect on the soils and topography of many of the disposal sites. Erosion and compaction would occur from construction and dredged material disposal activities. Runoff and erosion would be minimized during disposal by use of BMPs. Disposal material would be contained within a diked area at most of the upland disposal sites. The addition of dredged material to the disposal sites would serve to raise the elevation of the sites.

6.6.5 Environmental Consequences Associated with Alternative E - Navigation Channel Maintenance & Operations Only Flow Management & 12-Ft Depth Navigation Channel Alternative

Under Alternative E, navigation channel maintenance would be sustained using new disposal sites, river flow management would change as defined by the Operations Only Plan, and navigation channel depth would be increased to 12 feet throughout the MKARNS.

Impacts to geology and soils associated with sustained maintenance dredging and implementation of FM-OPS would be similar those described for Alternative C.

Under Alternative E to achieve the 12-foot channel, a total of approximately 10,985,340 cy of additional dredged material would be removed from the MKARNS. This would result in short-term adverse impacts to soils from sediment suspension, movement, and resettlement caused by dredging, and minor long term impacts to soils from a slight increase in barge traffic on the MKARNS after completion of dredging.

Impacts associated with upland dredged material disposal sites would be similar to those described for Alternative D.

6.7 Surface Waters

Potential environmental impacts of the proposed actions would occur primarily as a result of changes in the frequency and duration of reservoir elevation and river stage water levels, changes in water quality and/or designated water body uses, and/or changes in the quantity or quality of aquatic and shoreline habitat.

Additional dredging to deepen the channel in the MKARNS would have the potential to negatively affect water quality if contaminants exist within riverbed sediments. Increased sediment suspension (turbidity) during dredging and/or during disposal of dredged material in aquatic areas also may cause short-term impacts to surface waters. Maintenance dredging volumes would remain similar to historic patterns and would vary according to river flow conditions. Unexpected high flows may dictate when actual dredging is required for any given site. Changes to geomorphology, e.g. headcutting, would not occur because reservoir pool levels would be maintained and stream gradients would be unaffected. Therefore, the channel bottom would remain geomorphologically stable at tributary confluences.

In Arkansas, all water quality certification procedures will be adhered to for both terrestrial and aquatic dredge disposal sites. When the final location of the terrestrial sites has been determined, certification through the Arkansas Department of Environmental Quality (ADEQ) for storm water runoff would include a notice of intent to proceed, a storm water pollution prevention plan, certification from ADEQ, use of best management practices (BMPs), and an inspection schedule. For the aquatic disposal sites, Section 401 (Clean Water Act) authorization requires certification from ADEQ after the USACE has submitted their complete dredge disposal plans and insured ADEQ that they are complying with the Environmental Protection Agency's 404(b)(1) Guidelines. BMPs that would be implemented by USACE for open water dredge disposal would include using floating silt curtains at all disposal sites, dredging during low flow periods, and avoiding disposal in valuable aquatic areas such as the entrances to tributary streams and oxbow lakes.

6.7.1 Environmental Consequences Associated with Alternative A - No Action Alternative

The amount of maintenance dredging that would occur under the No Action Alternative would be approximately the same as historic maintenance dredging volumes. Quantities and locations dredged would continue to vary annually based on river flows and sediment deposition patterns

in the navigation channel. Maintenance dredging volumes for the entire MKARNS ranged from approximately 379,000 cy to 1,145,000 cy per year between 1995-2000.

Sediment sampling conducted in 2004 (see Appendix E) by USACE, Tulsa District along the Oklahoma portion of the MKARNS found that constituents were reported at low detection frequencies and concentrations throughout the sampled Oklahoma portion of the MKARNS and were generally below established Threshold Effects Concentration (TEC) values. According to the protocol outlined in the Inland Testing Manual, Tier II Analysis would be required for continued or new disposal of material dredged from contaminated sites. Disturbing contaminated sediments would negatively affect water quality within the MKARNS during dredging. Impacts associated with channel maintenance would remain at current levels.

The No Action Alternative would not affect surface waters and floodplains of the MKARNS. River, associated tributary, and reservoir levels would continue to fluctuate under the existing operation plan.

Under the No Action Alternative no additional dredging would be completed and therefore water quality and/or designated beneficial uses of the MKARNS and quality of surface water would remain at current levels.

6.7.2 Environmental Consequences Associated with Alternative B - Navigation Channel Maintenance Only Alternative

Under Alternative B, navigation channel maintenance would be sustained using new disposal sites. River flow management and navigation channel depth would remain unchanged from existing actions.

Impacts would be similar to those identified for the No Action Alternative. The amount of maintenance dredging that would occur under Alternative B would be approximately the same as historic maintenance dredging volumes. According to the protocol outlined in the Inland Testing Manual, Tier II Analysis would be required for continued or new disposal of material dredged from contaminated sites. Disturbing contaminated sediments would negatively affect water quality within the MKARNS during dredging.

The construction and modification of new river training structures would have a short-term minor adverse impact on surface water as sediment suspension may increase during construction.

6.7.3 Environmental Consequences Associated with Alternative C - Navigation Channel Maintenance & Operations Only Flow Management Alternative

Under Alternative C, navigation channel maintenance would be sustained using new disposal sites and river flow management would change as defined by the Operations Only Plan. Navigation channel depth would remain unchanged from existing actions.

Impacts to surface waters associated with maintenance dredging would be similar to those described for Alternative B.

Under Alternative C, flow above 61,000 cfs would be reduced by an average of 14 days per year, while changes in flow above 175,000 cfs would be negligible. A decrease in annual average flow days above 61,000 cfs would reduce the duration of floodplain inundation.

Under Alternative C, there would be no additional days in which Oklahoma reservoir pool elevations exceed 10 feet above conservation pool, similar to the No Action Alternative. However, an annual average increase in water storage in the reservoirs (below 10 feet above conservation pool) may cause increased inundation of adjacent vegetated areas, which could provide additional habitat for larval fish and organic material for primary consumers.

According to hydrologic modeling data, increases in pool elevation at all lakes are spread throughout the year, with no more than two additional days over 8 feet above conservation pool occurring in any two-month period. Other minor impacts of this water level fluctuation may include altering the littoral or shoreline zone of the reservoirs that provide important aquatic habitat. The USACE's modifications of flow rates would continue to remain compatible with the authorized operational plan of each reservoir.

Under Alternative C, no additional dredging would be completed and therefore, water quality and/or designated beneficial uses of the MKARNS, and quantity or quality of aquatic and shoreline habitat would remain at current levels.

6.7.4 Environmental Consequences Associated with Alternative D - Navigation Channel Maintenance & Operations Only Flow Management & 11-Ft Depth Navigation Channel Alternative

Under Alternative D, navigation channel maintenance would be sustained using new disposal sites, river flow management would change as defined by the Operations Only Plan, and navigation channel depth would be increased to 11 feet throughout the MKARNS.

Impacts to surface waters associated with maintenance dredging and flow changes would be similar to those described for Alternative C but at a slightly higher level given the proposed construction of 91 and modification of 137 river training structures, and the additional 3 and modification of 20 revetments.

Additional dredging to achieve an 11-foot channel, totaling approximately 6,837,176 cy above the maintenance dredging volume, would have the potential to negatively affect water quality within the MKARNS if any contaminants occurring within riverbed sediments are exposed. An Inland Testing Manual Tier I evaluation would be performed along watercourses before dredging is conducted. Increased sediment suspension (turbidity) during dredging and/or during disposal of dredged material in aquatic areas also would have the potential to negatively affect water quality. In addition, navigation traffic may increase along the MKARNS due to a reduction in water transportation costs that result from channel deepening. This also would cause a potential increase in sediment suspension, which would have a minor impact on surface water quality.

6.7.5 Environmental Consequences Associated with Alternative E - Navigation Channel Maintenance & Operations Only Flow Management & 12-Ft Depth Navigation Channel Alternative

Under Alternative E, navigation channel maintenance would be sustained using new disposal sites, river flow management would change as defined by the Operations Only Plan, and navigation channel depth would be increased to 12 feet throughout the MKARNS.

Impacts to surface waters associated with maintenance dredging and flow changes would be similar to those described for Alternative D.

Impacts associated with deepening dredging would be similar to D but to a greater degree as a larger volume of material will be disturbed. Dredging completed to achieve a 12-foot channel would require the removal of approximately 10,985,340 cy above the maintenance dredging volume, which would have the potential to negatively affect water quality within the MKARNS if any contaminants occur within riverbed sediments and are exposed. An Inland Testing Manual Tier I evaluation would be performed along watercourses before dredging is conducted. Increased sediment suspension (turbidity) during dredging and/or during disposal of dredged material in aquatic areas also would have the potential to negatively affect water quality. In addition, navigation traffic may increase along the MKARNS due to a reduction in water transportation costs that result from channel deepening. This also would cause a potential increase in sediment suspension.

6.8 Land Cover and Land Use

Potential direct and indirect adverse impacts to land cover and land use, if any, would occur primarily as a result of changes in the type and/or relative proportions of land cover and land use within the study area due to implementation of any of the alternatives. Table 6-3 shows the amount and type of existing land cover at potential new and pre-approved existing disposal sites within each segment of the study area.

Table 6-3. Existing Habitat in Acres at Potential New and Existing Deepening Disposal Sites and Maintenance Disposal Sites in Oklahoma and Arkansas.

New Deepening Disposal Sites - 36 sites (30 terrestrial, 6 aquatic)

	Terrestrial						Aquatic	
River Segment	**Bottom land Hardwood**	**Upland Forest**	**Open Field**	**Old Field**	**Agriculture**	**Barren/ Sand**	**River Channel**	**Total**
1 (AR) Mouth to Pine Bluff	0	0	0	0	308	0	0	308
2 (AR) Pine Bluff to Little Rock	0	0	0	0	0	0	33	33
3 (AR) Little Rock to Dardanelle	0	0	0	0	0	0	42	42
4 (AR) Dardanelle to Fort Smith	0	0	0	0	0	0	0	0
5 (OK) Fort Smith to Muskogee	8	44	137	48	86	40	270	633
6 (OK) Muskogee to Tulsa	0	2	99	50	105	0	0	256
sum	**8**	**46**	**236**	**98**	**499**	**40**	**345**	**1272**

New and Existing Long Term DMDP Sites - 26 sites (19 terrestrial, 7 aquatic)

River Segment	**Bottom land Hardwood**	**Upland Forest**	**Open Field**	**Old Field**	**Agriculture**	**Barren/Sand**	**River Channel**	**Total**
1 (AR) Mouth to Pine Bluff	0	0	0	0	0	0	0	0
2 (AR) Pine Bluff to Little Rock	0	0	0	0	0	0	0	0

Table 6-3. Existing Habitat in Acres at Potential New and Existing Deepening Disposal Sites and Maintenance Disposal Sites in Oklahoma and Arkansas.

3 (AR) Little Rock to Dardanelle	0	0	0	0	0	0	0	0
4 (AR) Dardanelle to Fort Smith	0	0	0	0	0	0	0	0
5 (OK) Fort Smith to Muskogee	7	54	51	165	105	0	165	547
6 (OK) Muskogee to Tulsa	0	19	89	69	10	0	0	187
sum	**7**	**73**	**140**	**234**	**115**	**0**	**165**	**734**

Existing Deepening Disposal Sites

River Segment	Terrestrial	Aquatic	Total
1 (AR) Mouth to Pine Bluff	0	330	330
2 (AR) Pine Bluff to Little Rock	0	148	148
3 (AR) Little Rock to Dardanelle	0	1981	1981
4 (AR) Dardanelle to Fort Smith	0	667	667
5 (OK) Fort Smith to Muskogee	0	0	0
6 (OK) Muskogee to Tulsa	0	0	0
sum	**0**	**3126**	**3126**

Existing Maintenance Disposal Sites

River Segment	Terrestrial	Aquatic	Total
1 (AR) Mouth to Pine Bluff	0	758	758
2 (AR) Pine Bluff to Little Rock	0	255	255
3 (AR) Little Rock to Dardanelle	0	405	405
4 (AR) Dardanelle to Fort Smith	0	790	790
5 (OK) Fort Smith to Muskogee	3848	276	4124
6 (OK) Muskogee to Tulsa	1816	0	1816
sum	**5664**	**2484**	**8148**

Source: USACE, Tulsa and Little Rock Districts, 2005.

6.8.1 Environmental Consequences Associated with Alternative A - No Action Alternative

The amount of dredging and disposal that would occur to maintain a 9-foot navigation channel would continue at historic rates and volumes. Dredged material would continue to be disposed of at existing sites until they reached their holding capacity. Dredged material would then be

disposed of at previously used but currently inactive disposal sites. Therefore, impacts to land cover and/or land use would be limited to those sites approved and assessed in the 1974 O&M EIS. As dredged material is deposited on these sites, impacts would occur gradually. Impacts would occur over the life of the use of the sites.

There would continue to be minor adverse impacts to agricultural cropland as a result of maintaining the current flow management plan. Farmland soils would continue to be saturated and ponded at times during the growing season. However, these impacts are not expected to bring about a change in land cover and land use.

Because no additional dredging would occur under the no action alternative, there will be no impacts to land cover and land use patterns within the study area.

6.8.2 Environmental Consequences Associated with Alternative B - Navigation Channel Maintenance Only Alternative

Under Alternative B, navigation channel maintenance would be sustained using new disposal sites. River flow management and navigation channel depth would remain unchanged from existing actions.

Land cover and land use impacts associated with dredging and disposal to maintain a 9-foot navigation channel would continue under this alternative. After currently utilized dredged material disposal sites reach their holding capacity, dredged material would be disposed of in new disposal sites designated in the 2003 Long-Term DMDP. According to GIS data compiled by USACE, Tulsa and Little Rock Districts, potential impacts to land cover and land use include a loss of approximately 2,484 acres of shallow water dike field habitat in Arkansas and Oklahoma (see Appendix A) and 5,664 acres of terrestrial habitat under all of the alternatives (existing pre-approved maintenance dredged material disposal sites), which represents approximately 2% of the aquatic habitat and approximately 1.3 % of the terrestrial habitat in the study area. Under Alternative B potential additional adverse impacts to land cover and land use in these areas include a loss of 734 acres of bottomland, upland, and aquatic habitat along the entire length of the MKARNS according to Geographic Information Systems (GIS) data compiled by USACE, Tulsa and Little Rock Districts. Land cover and land use impacts, in addition to current maintenance dredged material disposal, include a conversion of approximately 7 acres of bottomland hardwood forest and 73 acres of upland forest (0.05 % of forest in the study area), 140 acres of open field and 234 acres of old field (0.15 % of similar land cover in the study area), 115 acres of agriculture (0.04 % of agricultural land in the study area), and 165 acres of aquatic habitat (0.14% of aquatic habitat in the study area) to dredged material disposal along the MKARNS. Areas with high quality habitat such as bottomland forest or wetlands would be avoided wherever practical. Given the geographic scope of the MKARNS and the avoidance of high quality habitat, this would be a minor adverse impact on land cover and land use.

There would continue to be adverse impacts to agricultural cropland as a result of maintaining the current flow management plan. Farmland soils would continue to be saturated and ponded at times during the growing season. However, these impacts are not expected to bring about a change in land cover and land use.

6.8.3 Environmental Consequences Associated with Alternative C - Navigation Channel Maintenance & Operations Only Flow Management Alternative

Under Alternative C, navigation channel maintenance would be sustained using new disposal sites and river flow management would change as defined by the Operations Only Plan. Navigation channel depth would remain unchanged from existing actions.

Land cover and land use impacts associated with maintenance dredging and disposal would be similar to those described for Alternative B.

There would be an average of 14 fewer days per year with flows at or above 61,000 cfs under Alternative C. Therefore, minor beneficial impacts to agricultural cropland are expected as a result of implementing Alternative C. There would be less soil saturation and ponding of farmland during the growing season. Although impacts would vary over time and by location, these changes may result in a minor adverse impact in the long term since less inundation may encourage the cropping of additional land, thus potentially displacing native vegetation within the floodplain.

6.8.4 Environmental Consequences Associated with Alternative D - Navigation Channel Maintenance & Operations Only Flow Management & 11-Ft Depth Navigation Channel Alternative

Under Alternative D, navigation channel maintenance would be sustained using new disposal sites, river flow management would change as defined by the Operations Only Plan, and navigation channel depth would be increased to 11 feet throughout the MKARNS.

Land cover and land use impacts associated with maintenance dredging and disposal would be similar to those described for Alternative B. Impacts associated with river flow management would be the same as those described for Alternative C.

Deepening to 11 feet would require loss of habitat in addition to that described for Alternative B as an increased number of new dredged material disposal sites would be selected, developed, and used to accommodate increased dredge volumes. According to GIS data compiled by USACE, Tulsa and Little Rock Districts, potential impacts to land cover and land use include a loss of approximately 2,484 acres of shallow water dike field habitat in Arkansas and Oklahoma (see Appendix A) and 5,664 acres of terrestrial habitat under all of the alternatives (existing pre-approved maintenance dredged material disposal sites) which represents approximately 2% of the aquatic habitat and approximately 1.3 % of the terrestrial habitat in the study area. Under Alternative D, an additional 165 acres of aquatic habitat for maintenance dredging, and 3,471 acres of aquatic habitat in Arkansas and Oklahoma for deepening would be impacted by dredged material disposal, for a total of an additional 3,636 acres of aquatic habitat (approximately 3 % of aquatic habitat in the study area.). An additional 569 acres of terrestrial habitat for maintenance dredging and 927 acres of terrestrial habitat for deepening dredging would be impacted by dredge material disposal. This loss includes the conversion of approximately 15 acres of bottomland hardwood and 119 acres of upland forest (0.09% of forest land in the study area), 376 acres of open field and 332 acres of old field (0.3% of similar land cover in the study area), 614 acres of agriculture (0.25% of agriculture in the study area), and 40 acres of barren/sand area (0.4% of barren/sand area in the study area) to dredged material disposal. Areas with high

quality habitat such as bottomland forest or wetlands would be avoided wherever practical. Given the geographic scope of the MKARNS and the avoidance of high quality habitat, this would be a minor adverse impact on land cover and land use.

Additionally, improved navigation may spur increased development of ports and marinas along the MKARNS, resulting in a minor loss of farmland, open areas, or a conversion of one developed land cover and land use to another.

6.8.5 Environmental Consequences Associated with Alternative E - Navigation Channel Maintenance & Operations Only Flow Management & 12-Ft Depth Navigation Channel Alternative

Under Alternative E, navigation channel maintenance would be sustained using new disposal sites, river flow management would change as defined by the Operations Only Plan, and navigation channel depth would be increased to 12 feet throughout the MKARNS.

Land cover and land use impacts associated with maintenance and deepening dredging and disposal would be similar to those described for Alternative D. Impacts associated with river flow management would be the same as those described for Alternative C and D.

Under Alternative E the navigation channel would be deepened to 12 feet. It was assumed that changes in development of ports and marinas along the MKARNS that may result as navigation improves would occur approximately in proportion to the depth of dredging. Therefore, there may be slightly greater land cover and land use change under this alternative.

6.9 Infrastructure

The MKARNS is a 445-mile long navigation system consisting of a series of navigation pools that are connected by locks in order to overcome a 420-foot change in elevation. The MKARNS connects Oklahoma and Arkansas to the Mississippi River and the nation's inland waterway system and via the Gulf Intracoastal Waterway to international ports as well. There are five major publicly developed ports along the MKARNS including the Port of Catoosa, Port of Muskogee, Port of Fort Smith, Port of Little Rock, and Port of Pine Bluff. In addition, there are numerous privately developed ports as well.

The components of infrastructure examined in this impact analysis are:

- Commercial Navigation;
- MKARNS Operations and Maintenance;
- Locks and Dams;
- Other In-River Structures;
- Levees;
- Reservoirs;
- Hydroelectric Power and Energy; and
- Roadways and Railways.

6.9.1 Environmental Consequences Associated with Alternative A - No Action Alternative

Under the No Action Alternative, navigation channel maintenance, river flow management, and navigation channel depth would remain unchanged. Therefore, no additional impacts to infrastructure are anticipated during this time.

The No Action Alternative would result in USACE Tulsa District exhausting the active terrestrial disposal sites for navigation channel maintenance dredging. In stream disposal was not approved by the Oklahoma Department of Environmental Quality when the MKARNS Operation and Maintenance Program 1974 EIS was approved. Therefore, previously used but currently inactive terrestrial disposal sites would be used after the active terrestrial disposal sites are exhausted. This could lead to increased O&M costs. Since the No Action Alternative would result in continued restrictions on barge traffic on the MKARNS during high flows, the amount of barge traffic would not change. Together, these impacts result in a minor adverse impact on river transportation.

Implementation of the No Action Alternative would not impact levees, locks and dams, or other in-river structures along the MKARNS. Under this alternative there would also be no changes to reservoirs or hydroelectric power from their current operating conditions. Reservoir storage would remain the same and there would also be no changes to water supply, wastewater discharge, or water quality. In addition, there are no anticipated changes to railway or roadway transportation.

The No Action Alternative would not affect the function of the eleven upstream reservoirs or reservoir hydroelectric energy production. Hydropower on locks and dams is limited by this alternative. High peak releases (greater than 100,000 cfs) exceed powerhouse capacity, resulting in restricted power generation at these locations.

Under the No Action Alternative there would be no channel deepening and the MKARNS would remain at its current depth. Under this alternative there would be no improvements to navigation efficiencies or other benefits to the navigation industry.

6.9.2 Environmental Consequences Associated with Alternative B - Navigation Channel Maintenance Only Alternative

Under Alternative B, navigation channel maintenance would be sustained using new disposal sites. Once capacity has been reached at the existing disposal sites on the MKARNS, new disposal areas would be selected. The new sites would allow for continued maintenance dredging and disposal on the MKARNS. River flow management and navigation channel depth would remain unchanged from existing actions

Implementation of Alternative B would not impact levees or locks and dams along the MKARNS. Construction of additional river training structures to facilitate the maintenance of the 9-ft channel (primarily in Arkansas) would include:

- 2 new and 50 modified river training structures
- 2 new and 4 modified revetments

Given the number of existing structures on the MKARNS, there would be no impacts.

Impacts to infrastructure associated with river flow are the same as those described for the No Action Alternative.

6.9.3 Environmental Consequences Associated with Alternative C - Navigation Channel Maintenance & Operations Only Flow Management Alternative

Under Alternative C, navigation channel maintenance would be sustained using new disposal sites. River flow management and navigation channel depth would remain unchanged from existing actions.

Impacts associated with continued maintenance and dredging are similar to those described for Alternative B.

Under Alternative C, flows above 61,000 cfs would decrease by an average of 14 days per year compared to the current plan. Flows above 61,000 cfs restrict navigation at maximum tow size along the MKARNS. This increase in navigation efficiency would benefit the navigation industry by allowing commercial navigation to become more reliable throughout the system and would reduce river transportation costs for the region. This would be a minor beneficial impact, since this change would be relatively small (14 days per year). This reduction in flow above 61,000 cfs may also slightly reduce the impact on levees, locks and dams, and other in-river structures along the MKARNS.

Under Alternative C, duration in the extreme upper limits (>10 feet above conservation pool) of the reservoir pools would decrease. Conversely, annual average duration of storage between 0 and 10 feet above conservation pool would increase very slightly at some reservoirs under this alternative, but these minor increases would not impact reservoir functions. Since this alternative would increase annual average days of duration above conservation pool level in the reservoirs, reservoir water supply would not be impacted. Additionally, Alternative C would not affect wastewater treatment on the MKARNS.

Because reservoir storage would increase due to reduced average daily flow under this alternative, losses to reservoir hydropower energy production would increase slightly. On the contrary, losses to hydropower on the locks and dams would decrease. With lower peak releases, less flow exceeds the powerhouse capacity resulting in slightly higher power generation for run-of-river projects. According to Appendix B: Economics Analysis, included in the Feasibility Report (USACE 2005), total monetary hydropower benefits under the Operations Only Plan would increase by $466,000 per year over the No Action Alternative. Overall, this implementation of this alternative will have a minor beneficial impact on hydropower benefits.

Alternative C would result in an average of 14 fewer days of flow above 61,000 cfs per year along the MKARNS than the current plan. Local rural economies may be stimulated by this increase, since production in agricultural fields may slightly improve. This may create an indirect minor adverse impact as economic growth may result in higher traffic levels, requiring more roadway maintenance and repair.

Under Alternative C there would be no channel deepening and the MKARNS would remain at its current depth. Under this alternative there would be no improvements to navigation efficiencies or other benefits to the navigation industry associated with channel deepening.

6.9.4 Environmental Consequences Associated with Alternative D - Navigation Channel Maintenance & Operations Only Flow Management & 11-Ft Depth Navigation Channel Alternative

Under Alternative D, navigation channel maintenance would be sustained using new disposal sites, river flow management would change as defined by the Operations Only Plan, and navigation channel depth would be increased to 11 feet throughout the MKARNS.

Impacts associated with navigational channel maintenance and flow changes would be similar to those identified in Alternative C.

Dredging to a depth of 11 feet and maintenance of the channel would require the following approximate number of new river training structures and revetments.

- 91 new and 137 modified river training structures
- 3 new and 20 modified revetments

There are 1,314 existing river training structures and 295 revetments on the MKARNS. Under this alternative there would be an approximate 7% increase in the number of river training structures and an approximate 1% increase in the number of revetments throughout the system. Construction of these new structures would have a minor adverse impact.

Deepening the channel to 11 feet would create greater efficiencies in commercial navigation by allowing barge tows to carry larger loads. Larger towing capacities help reduce transportation costs for the region and provide benefits to the navigation industry. Channel deepening and flow changes described under the Operations Only Plan, would further improve the efficiency and reliability of commercial navigation which would have a minor beneficial impact for the navigation industry.

Implementation of this alternative would require minor engineering changes to locks and dams in order to accommodate deeper draft vessels. Levees, however, would not need to be altered because there would be no change in river elevation.

Traffic may be induced to shift onto the river system considering the reduction in water routing transportation costs that result from channel deepening. A long-term impact would be a minor reduction in utilization of railways and roads and associated decrease in maintenance costs. However, this reduction may be balanced out by an overall indirect increase in use of area roadways associated with economic growth.

6.9.5 Environmental Consequences Associated with Alternative E - Navigation Channel Maintenance & Operations Only Flow Management & 12-Ft Depth Navigation Channel Alternative

Under Alternative E, navigation channel maintenance would be sustained using new disposal sites, river flow management would change as defined by the Operations Only Plan, and navigation channel depth would be increased to 12 feet throughout the MKARNS. Impacts would be similar to those described for Alternative D.

6.10 Biological Resources

The MKARNS and its associated upstream reservoirs are hosts to a variety of biological resources including Federally threatened and endangered species, wetland habitat and biota, aquatic habitats and biota, and terrestrial habitats and biota. The principal direct and indirect adverse impacts to biological resources result from 1) direct contact between construction activities and biota; 2) direct degradation of biological habitats; and 3) indirect degradation of biological habitats.

6.10.1 Environmental Consequences Associated with Alternative A - No Action Alternative

The amount of maintenance dredging that would occur under the No Action Alternative would be approximately the same as historic maintenance dredging volumes.

6.10.1.1 Threatened and Endangered Species

Under the No Action Alternative, no changes to the navigation channel depth and river level fluctuations would occur. No new dredge location or disposal sites would be created and no additional training structures would be required. In the future, disposal may occur on currently inactive sites that may contain bald eagle and/or American burying beetle habitat. Any adverse impacts to bald eagle or American burying beetle habitat would be minor if protective measures recommended by the USFWS are incorporated into the proposed action and implemented. Despite the protective measures, some American burying beetles may be disturbed or killed during ground disturbing activities, but the effects are expected to be infrequent and of short duration.

6.10.1.2 Wetlands

The No Action Alternative has an average of only 1 day per year of flow above 175,000 cfs. Because floodwaters rarely reach this level under this alternative, wetland habitats that fall beyond the reach of this flow are influenced less frequently. Continued operation under this plan would maintain the existing conditions, including the hydrology and species composition of these areas.

Under this alternative, inactive sites that may contain wetlands may be used for dredged material disposal. Before disposal occurs, jurisdictional wetland determinations would be conducted and appropriate mitigation would be carried out.

6.10.1.3 Aquatic Resources

Under the No Action Alternative, current 9-foot navigation channel maintenance would continue under the existing plan. No additional dredging locations or new river training structures would be required. River and associated reservoir levels would continue to fluctuate under current flow rates. No direct or indirect impacts to aquatic resources differing from the baseline condition are anticipated.

6.10.1.4 Terrestrial Resources

Under the No Action Alternative, current 9-foot navigation channel maintenance would continue under the existing plan and no additional dredging locations or new river training structures would be required. River and associated reservoir levels would continue to fluctuate under current flow rates. Therefore, no direct or indirect impacts to terrestrial resources differing from the baseline condition would be anticipated while dredge disposal sites are available.

The No Action Alternative would result in USACE Tulsa District exhausting the active terrestrial disposal sites for navigation channel maintenance dredging. In stream disposal was not approved by the Oklahoma Department of Environmental Quality. Therefore, future dredged material would have to be deposited in inactive terrestrial sites identified and approved in the 1974 EIS and/or in existing sites in Arkansas until those locations reached capacity. Many of the Tulsa District terrestrial sites approved in the 1974 EIS have not been utilized since creation of the navigation channel and contain mature vegetation. Utilizing these sites would require site reworking and additional mitigation for terrestrial impacts and thus would have a major adverse impact on terrestrial resources.

6.10.2 Environmental Consequences Associated with Alternative B - Navigation Channel Maintenance Only Alternative

Under Alternative B, navigation channel maintenance would be sustained using new disposal sites. River flow management and navigation channel depth would remain unchanged from existing actions.

6.10.2.1 Threatened and Endangered Species

The USACE coordinated with the US Fish and Wildlife Service (USFWS) to prepare a Biological Assessment (BA) for the Arkansas River Navigation Study and related activities associated with the operation of the MKARNS and the upstream reservoirs that influence water flow on the MKARNS. The BA was prepared pursuant to the requirements of the Endangered Species Act (ESA), and it considered potential impacts to threatened and endangered species throughout the study area. While the BA addressed anticipated impacts to all Federally listed threatened and endangered species potentially influenced by the USACE study and activities, it focused on species such as the interior least tern that are known to be present in multiple locations in the study area and have potentially been influenced by USACE activities along the MKARNS.

The BA was submitted to the USFWS in October 2003. In response to the preparation of the BA, the USFWS issued a Biological Opinion (BO) (June 28, 2005). The findings of the BA and BO are included in Chapter 4 of this EIS. Sixteen federally listed species occur in or near the study area; however, existing information indicates that only the endangered interior least tern and American burying beetle are likely to be affected by the proposed action. The least tern and American burying beetle are the only species addressed in the BO (USFWS 2005). The BO emphasized the anticipated effects of the proposed action on the least tern, although the USFWS does anticipate that the American burying beetle may be affected by the proposed action as well.

The BO suggested Best Management Practices (BMPs) as well as Reasonable and Prudent Measures (RPMs) for the protection of threatened and endangered species and their habitat in the

study area. These BMPs and RPMs will be incorporated into the design features of the selected alternative for the proposed action. As a result of implementing the BMPs and RPMs, no impacts to threatened or endangered species would occur. The ivory-billed woodpecker was not included in the BA because it was not discovered until recently. However, the USFWS included consideration of the ivory-billed woodpecker in its June 28, 2005 BO. The USFWS determined that the proposed action would not adversely affect the endangered ivory-billed woodpecker.

Interior Least Tern

There would be no significant impacts to the federally endangered interior least tern under Alternative B. USACE, Tulsa District would continue to consult with the USFWS on least tern management and protective measures recommended by the USFWS would be incorporated into the proposed action and implemented.

American Burying Beetle

Mitigation measures were provided by the USFWS in the BO. Adverse impacts to American burying beetles would be minor if Alternative B, which includes those mitigation measures, is implemented as discussed in Chapter 8.

Other Federally Listed Species

No impacts would be expected for the piping plover (*Charadrius melodius*), whooping crane (*Grus americana*), ivory-billed woodpecker (*Campephilus principalis*), gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), Ozark big-eared bat (*Plecotus townsendii ingens*), bald eagle (*Haliaeetus leucocephalus*), Arkansas River shiner (*Notropis girardi*), pink mucket pearlymussel (*Lampsilis abrupta*), scaleshell mussel (*Leptodea leptodon*), American alligator (*Alligator mississippiensis*), pallid sturgeon (*Scaphirhynchus albus*), Geocarpon (*Geocarpon minimum*), western prairie fringed orchid (*Platanthera praeclara*), or harperella (*Ptilimnium nodosum*). Although these species may occur in the vicinity of the MKARNS, they are either unlikely to occur in the study area or their habitat would not be affected by Alternative B.

6.10.2.2 Wetlands

Existing dredging and disposal to maintain a 9-foot navigation channel would continue under this alternative. After currently utilized dredged material disposal sites reach their holding capacity, dredged material would be disposed of in new disposal sites designated in the 2003 Long Term Dredged Material Disposal Plan. Areas with high quality habitat such as bottomland hardwood forest or wetlands would be avoided for dredged material disposal wherever practical. Alternative B would maintain the existing conditions, including the hydrology and species composition of wetlands. Therefore, impacts would be similar to those under the No Action Alternative.

6.10.2.3 Aquatic Resources

Existing dredging and disposal to maintain a 9-foot navigation channel would continue under this alternative. After currently utilized dredged material disposal sites reach their holding capacity, dredged material would be disposed of in new disposal sites designated in the 2003 Long-Term DMDP. According to GIS data compiled by USACE, Tulsa and Little Rock Districts, potential impacts to aquatic habitat include a loss of approximately 2,484 acres of

shallow water dike field habitat in Arkansas and Oklahoma (see Appendix A) (existing pre-approved maintenance dredged material disposal sites). Under Alternative B potential additional adverse impacts to aquatic habitat in these areas include a loss of 165 acres of aquatic habitat (0.14% of aquatic habitat in the study area) to dredged material disposal along the MKARNS. In addition, channel maintenance would require the construction of 2 new and 50 modified river training structures and 2 new and 4 modified revetments. When considered within the geographic scope of the MKARNS, these aquatic impacts would be minor.

River and associated reservoir levels would not change and no additional dredging locations or river training structures are required. No additional direct or indirect impacts to aquatic resources are anticipated

6.10.2.4 Terrestrial Resources

After currently utilized dredged material disposal sites reach their holding capacity, dredged material would be disposed of in new disposal sites designated in the 2003 Long-Term DMDP. According to GIS data compiled by USACE, Tulsa and Little Rock Districts, potential impacts to terrestrial habitat include a loss of approximately 5,664 acres in Oklahoma under all of the alternatives (see Appendix A) (existing pre-approved maintenance dredged material disposal sites). Under Alternative B potential additional adverse impacts to terrestrial resources in these areas include a conversion of approximately 7 acres of bottomland hardwood forest and 73 acres of upland forest (0.05 % of forest in the study area), 140 acres of open field and 234 acres of old field (0.15 % of similar habitat in the study area), and 115 acres of agriculture (0.04 % of agricultural land in the study area) to dredged material disposal along the MKARNS. These dredge diposal sites were selected to avoid high quality habitat (see Appendix C). The majority of areas that would be impacted are agricultural croplands and old field habitats that are not of high quality. Therefore direct impacts to terrestrial habitats would be minor.

6.10.3 Environmental Consequences Associated with Alternative C - Navigation Channel Maintenance & Operations Only Flow Management Alternative

6.10.3.1 Threatened and Endangered Species

Refer to Section 6.8.2.1 for a discussion of the BA submitted by the USACE and the subsequent BO prepared by the USFWS. Section 6.8.2.1 also discusses potential impacts to federally listed species. Sixteen federally listed species occur in or near the Action Area; however, existing information indicates that only the endangered interior least tern and American burying beetle may be affected by the proposed action.

Interior Least Tern

The reduction in days of flow above 61,000 cfs (five fewer days than currently) occurs during the federally endangered interior least tern nesting season under Alternative C. This would have a minor beneficial impact since nesting success may improve due to decreased flooding of sand bars and islands used for nesting. Frequent flooding, or scouring flow, controls vegetation encroachment that may hamper tern nesting attempts. An annual average nine-day reduction in

the number of days of flow above 61,000 cfs during the non-nesting period would not impact the tern since there would still be 30 days per year of flow above 61,000 cfs during this period.

American Burying Beetle

Mitigation measures were provided by the USFWS in the BO. Adverse impacts to American burying beetles would be minor if Alternative C, which includes those mitigation measures, is implemented as discussed in Chapter 8.

Other Federally Listed Species

Alternative C would result in an average annual increase of two days in flow above 100,000 cfs and no change in flow above 175,000 cfs along the MKARNS compared with the current plan. Because the average number of high flow days per year would not change appreciably, the amount of barge traffic would not increase. Since existing information indicates that only the endangered interior least tern and American burying beetle may be affected by the proposed action, other federally threatened or endangered species would not be impacted by Alternative C.

6.10.3.2 Wetlands

Impacts to wetlands from maintenance dredging and disposal would be similar to those described for Alternative B.

Alternative C would have an average of only one day per year of flow above 175,000 cfs. Because floodwaters would rarely reach this level under this alternative, wetland habitats that fall beyond the reach of this flow would be influenced less frequently. Continued operation under this plan would maintain the existing conditions, including the hydrology and species composition of these areas.

6.10.3.3 Aquatic Resources

Potential impacts to aquatic habitat associated with the creation of new dredge disposal site to sustain maintenance dredging would be similar to those described for Alternative B.

6.10.3.4 Terrestrial Resources

Potential impacts to terrestrial resources associated with the creation of new dredge disposal sites to sustain maintenance dredging would be similar to those described for Alternative B.

6.10.4 Environmental Consequences Associated with Alternative D - Navigation Channel Maintenance & Operations Only Flow Management & 11-Ft Depth Navigation Channel Alternative

Under Alternative D, navigation channel maintenance would be sustained using new disposal sites, river flow management would change as defined by the Operations Only Plan, and navigation channel depth would be increased to 11 feet throughout the MKARNS.

6.10.4.1 Threatened and Endangered Species

Refer to Section 6.8.2.1 for a discussion of the BA submitted by the USACE and the subsequent BO prepared by the USFWS. Section 6.8.2.1 also discusses potential impacts to federally listed

species. Sixteen federally listed species occur in or near the Action Area; however, existing information indicates that only the endangered interior least tern and American burying beetle are likely to be affected by the proposed action.

Interior Least Tern

Impacts to the federally endangered least tern associated with flow changes would be similar to those described for Alternative C.

There would be no significant impacts to the federally endangered interior least tern from deepening the channel to 11 feet. USACE, Tulsa District would continue to consult with the USFWS on least tern management and protective measures recommended by the USFWS would be incorporated into the proposed action and implemented. Minor beneficial impacts to the least tern would include increased habitat due to the creation of islands from dredged material.

American Burying Beetle

Mitigation measures were provided by the USFWS in the BO. Adverse impacts to American burying beetles would be minor if Alternative D, which includes those mitigation measures, is implemented as discussed in Chapter 8.

Approximately 1,602 acres of additional terrestrial habitat disturbance is anticipated with the proposed action. Despite protective measures recommended by the USFWS, some American burying beetles may be disturbed or killed during dredged material disposal pit construction, dredged material disposal, or other ground disturbance activities, but most of the effects are expected to be infrequent and of short duration.

Other Federally Listed Species

Impacts to other federally listed species associated with flow changes would be similar to those described for Alternative C.

Although these species may occur in the vicinity of the MKARNS, they are either unlikely to occur in the study area or their habitat would not be affected by the 11 foot channel deepening.

6.10.4.2 Wetlands

Impact to wetlands associated with flow changes would be similar to those described for Alternative C.

Since there would be dredging of the channel and disposal of dredged material under Alternative D, National Wetland Inventory (NWI) maps were used to avoid wetland areas for the initial screening of potential dredged material disposal sites. The initial screening was followed by field visits to collect data for the HEP analysis. During these visits any sites in which wetland areas were observed were eliminated from the list of potential sites. No impacts to wetlands are expected with deepening the channel to 11 feet.

6.10.4.3 Aquatic Resources

No direct or indirect impacts to aquatic resources are expected from implementation of the changes in flow management under this alternative. River and associated reservoir levels would fluctuate similarly to current flow rates.

According to GIS data compiled by USACE, Tulsa and Little Rock Districts, potential impacts to aquatic habitat include a loss of approximately 2,484 acres of shallow water dike field habitat in Arkansas and Oklahoma (see Appendix A) (existing pre-approved maintenance dredged material disposal sites). Under Alternative D, an additional 165 acres of aquatic habitat in Oklahoma for maintenance dredging, 3,126 acres of aquatic habitat in Arkansas for deepening and 345 acres of aquatic habitat in Arkansas and Oklahoma for deepening would be impacted by dredged material disposal, for a total of 6,120 acres. Results from the aquatic habitat impacts analysis (Appendix C) illustrates a positive relationship between fish abundance and the depth of dike pools and the amount of gravel and sand/gravel mixture available. It implies that reducing water depth in a dike field through dredged material disposal and reducing the amount of gravel in the channel through dredging would have a major adverse impact to fishes. However, high quality habitat would be avoided, thereby minimizing the impact of this action.

Approximately 4,809 acres and 6,837,176 cy of navigation channel substrate would be dredged for deepening along the MKARNS for Alternative D. In addition, approximately 1,429 acres and 37,704,000 cy of substrate would be dredged for maintenance along the MKARNS for this alternative for a total of 6,238 acres and 44,541,000 cy. Because the main channel of the MKARNS has been degraded from the dredging activities associated with establishing and maintaining the navigation channel, prime aquatic substrate habitat loss due to maintaining and deepening the channel to 11 feet and adding river training structures would be minor.

Additional impacts for the Verdigris River were identified. The Verdigris River was straightened and channelized to provide a reliable navigation channel. The channel was shortened from cutoffs, high spoil banks were created on both sides for 50 miles, and the floodplain and associated backwaters became isolated from the river. Isolation of backwaters prevents transfer of organic matter and nutrients between river and floodplain and reduces important spawning and rearing areas for fishes. The navigation channel is 150 feet wide in the Verdigris River compared to a 250-foot channel in the Arkansas River. Therefore, impacts of navigation-related activities have been proportionally greater in the narrow, incised channel of the Verdigris River compared to the wider channel in the Arkansas River. To quantify this impact, the number of acres associated with the navigation channel in Verdigris River pools (i.e., 909.1 acres) was multiplied by an HSI of 0.1, indicating low habitat quality for existing conditions, to obtain impacts of 91 AAHUs for this alternative. The complete Aquatic Evaluation Report and HEP analysis are located in Appendix C.

Gravel surveys found 165 acres of gravel and 628 acres of sand/gravel mix substrate in dredging areas that would be impacted by the dredging associated with Alternative D. The goal of the mitigation is to have no net loss of pure gravel bars either by relocating gravel that is dredged to a nearby, suitable area or transporting dredged gravel to other sites within the project area.

Sites to receive relocated gravel beds would be selected based on modeling results and in coordination with natural resource agencies. The site selection process would focus on sites where the relocated gravel beds would remain in place and that have appropriate flow regimes to avoid the gravel becoming covered by fine sediments. Monitoring of the new sites will occur and gravel relocated as necessary to maintain the beds. Therefore, adverse impacts to gravel substrate would be short term and minor.

A 2004 Freshwater Mussel (Unionid) Survey conducted by Ecological Specialists, Inc. collected a total of 5,467 live unionids of 27 species at 43 sample sites encompassing dredging areas, disposal areas, and areas reported to harbor mussel beds along the MKARNS, and two additional species were found only as weathered shells. No threatened or endangered species were found in the mussel survey (see Appendix C). Of the 5,467 unionids collected in the study, 3,053 live unionids of 25 species were collected from Segment 1 of the MKARNS. Mussel populations would incur major adverse impacts at scattered areas throughout the MKARNS with more impacts occurring at higher density mussel areas that would be heavily dredged such as the Arkansas Post Canal in Segment 1. Mitigation measures have been established in coordination with natural resource agencies. Adverse impacts to mussels would be reduced if Alternative D, which includes those mitigation measures, is implemented as discussed in Chapter 8.

6.10.4.4 Terrestrial Resources

Potential impacts to terrestrial resources in association with the creation of new dredged material disposal sites for maintenance and deepening dredging include the conversion of approximately 569 acres of terrestrial habitat for maintenance dredging and 927acres of terrestrial habitat for deepening dredging. This loss includes the conversion of approximately 15 acres of bottomland hardwood and 119 acres of upland forest (0.09% of forest land in the study area), 376 acres of open field and 332 acres of old field (0.3% of similar land cover in the study area), 614 acres of agriculture (0.25% of agriculture in the study area), and 40 acres of barren/sand area (0.4% of barren/sand area in the study area) to dredged material disposal. These dredge disposal sites were selected to avoid high quality habitat (see Appendix C). The majority of areas that would be impacted are agricultural lands and open field/old field habitats that are not of high quality.

Habitat quality was evaluated by a multidisciplinary Multiagency Ecosystem Evaluation Team (MEET). The MEET determined that within the study area, bottomland hardwoods and mature forests were the highest quality wildlife habitats while old field, open field, and agricultural land were the lowest wildlife habitat quality (note that the MEET recognized that old field habitat is important to a variety of wildlife species but within the study area other habitats were more valuable). This habitat evaluation process enabled the Corps to avoid adverse impacts to high quality habitats by selecting dredged material disposal sites in areas of low quality habitat. Of the 1,496 acres that would be impacted, only 134 acres (9%) are high quality habitat, the remaining 1362 (91%) are low quality habitat. Consequently, impacts to terrestrial habitats were determined to be minor.

Although direct, site-specific impacts to high quality terrestrial habitats would be minor, since the total acreage potentially impacted under Alternative D is greater than under Alternatives A-C, the impact under Alternative D would be major. These losses would be in addition to the 5,664 acres of terrestrial habitat that constitutes the existing pre-approved maintenance dredged material disposal sites.

No direct or indirect impacts to terrestrial resources are expected from operations only flow management. River and associated reservoir levels would fluctuate similarly to current flow rates.

6.10.5 Environmental Consequences Associated with Alternative E - Navigation Channel Maintenance & Operations Only Flow Management & 12-Ft Depth Navigation Channel Alternative

Under Alternative E, navigation channel maintenance would be sustained using new disposal sites, river flow management would change as defined by the Operations Only Plan, and navigation channel depth would be increased to 12 feet throughout the MKARNS.

6.10.5.1 Threatened and Endangered Species

Refer to Section 6.8.2.1 for a discussion of the BA submitted by the USACE and the subsequent BO prepared by the USFWS. Section 6.8.2.1 also discusses potential impacts to federally listed species. Sixteen federally listed species occur in or near the Action Area; however, existing information indicates that only the endangered interior least tern and American burying beetle are likely to be affected by the proposed action.

Interior Least Tern

Impacts would be similar to those described for Alternative D.

American Burying Beetle

Impacts would be similar to those described for Alternative D.

Other Federally Listed Species

Impacts would be similar to those described for Alternative D.

6.10.5.2 Wetlands

Impacts would be similar to those described for Alternative D.

6.10.5.3 Aquatic Resources

Impacts to aquatic resources associated with Alternative E would be similar to those for Alternative D. According to GIS data compiled by USACE, Tulsa and Little Rock Districts, potential impacts to aquatic habitat include a loss of approximately 2,484 acres of shallow water dike field habitat in Arkansas and Oklahoma (see Appendix A) (existing pre-approved maintenance dredged material disposal sites). Under Alternative E, an additional 165 acres of aquatic habitat in Oklahoma for maintenance dredging, 3,126 acres of aquatic habitat in Arkansas for deepening, and 345 acres of aquatic habitat in Arkansas and Oklahoma for deepening would be impacted by dredged material disposal, for a total of 6,120 acres. Results from the aquatic habitat impacts analysis (Appendix C) illustrates a positive relationship between fish abundance and the depth of dike pools and the amount of gravel and sand/gravel mixture available. It implies that reducing water depth in a dike field through dredged material disposal and reducing the amount of gravel in the channel through dredging would have a major adverse impact to fishes. However, high quality habitat would be avoided, thereby minimizing the impact of this action.

Approximately 5,645 acres and 10,985,340 cy of navigation channel substrate would be dredged for deepening along the MKARNS for Alternative E. In addition, approximately 1,429 acres and

37,704,000 cy of substrate would be dredged for maintenance along the MKARNS for this alternative for a total of 7,074 acres and 44,541,000 cy. Because the main channel of the MKARNS has been degraded from the dredging activities associated with establishing and maintaining the navigation channel, prime aquatic substrate habitat loss due to maintaining and deepening the channel to 12 feet and adding river training structures would be minor.

Additional impacts for the Verdigris River were identified. The Verdigris River was straightened and channelized to provide a reliable navigation channel. The channel was shortened from cutoffs, high spoil banks were created on both sides for 50 miles, and the floodplain and associated backwaters became isolated from the river. Isolation of backwaters prevents transfer of organic matter and nutrients between river and floodplain and reduces important spawning and rearing areas for fishes. The navigation channel is 150 feet wide in the Verdigris River compared to a 250-foot channel in the Arkansas River. Therefore, impacts of navigation-related activities have been proportionally greater in the narrow, incised channel of the Verdigris River compared to the wider channel in the Arkansas River. To quantify this impact, the number of acres associated with the navigation channel in Verdigris River pools (i.e., 909.1 acres) was multiplied by an HSI of 0.1, indicating low habitat quality for existing conditions, to obtain impacts of 91 AAHUs for this alternative. The complete Aquatic Evaluation Report and HEP analysis are located in Appendix C.

Gravel surveys found 165 acres of gravel and 628 acres of sand/gravel mix substrate in dredging areas that would be impacted by the dredging associated with Alternative E. The goal of the mitigation is to have no net loss of pure gravel bars either by relocating gravel that is dredged to a nearby, suitable area or transporting dredged gravel to other sites within the project area. Therefore, adverse impacts to gravel substrate would be short term and minor.

Sites to receive relocated gravel beds would be selected based on modelling results and in coordination with natural resource agencies. The site selection process would focus on sites where the relocated gravel beds would remain in place and that have appropriate flow regimes to avoid the gravel becoming covered by fine sediments. Monitoring of the new sites will occur and gravel relocated as necessary to maintain the beds. Therefore, adverse impacts to gravel substrate would be short term and minor.

As discussed in section 6.10.4.3, no threatened or endangered species were found in the mussel survey (see Appendix C). Of the 5,467 unionids collected in the study, 3,053 live unionids of 25 species were collected from Segment 1 of the MKARNS. Mussel populations would incur major adverse impacts at scattered areas throughout the MKARNS with more impacts occurring at higher density mussel areas that would be heavily dredged such as the Arkansas Post Canal in Segment 1. Mitigation measures have been established in coordination with natural resource agencies. Adverse impacts to mussels would be reduced if Alternative E, which includes those mitigation measures, is implemented as discussed in Chapter 8.

Adverse impacts to mussels may be slightly higher for Alternative E than for Alternative D due to the increased amount of deepening dredging.

6.10.5.4 Terrestrial Resources

Impacts would be similar to those described for Alternative D. Although direct, site-specific impacts to high quality terrestrial habitats would be minor, since the total acreage potentially impacted under Alternative E is greater than under Alternatives A-C, the impact under Alternative E would be major. These losses would be in addition to the 5,664 acres of terrestrial habitat that constitutes the existing pre-approved maintenance dredged material disposal sites.

6.11 Recreation and Aesthetic Values

MKARNS and its associated upstream reservoirs offer numerous recreational and aesthetic opportunities to millions of people each year. Boating, fishing, wildlife viewing, hunting, and camping are just some of the recreational activities available. There are 26 recreational lakes and reservoirs found along the MKARNS that in 2002 had approximately 18.5 million visitors. These visitors have a positive economic impact on the local communities in these areas. Therefore impacts to these recreational resources would affect not only those who visit these areas, but also those who benefit from the economic effects of these areas.

6.11.1 Environmental Consequences Associated with Alternative A - No Action Alternative

Navigation channel maintenance, river flow management, and navigation channel depth would remain unchanged from existing conditions. The amount of maintenance dredging that would occur would be the same as historic maintenance dredging volumes. Unlike large commercial vessels, recreational watercraft can still operate on the river without maintenance dredging and disposal occurring.

River levels on the MKARNS would continue to fluctuate at current levels; USACE's modifications of flow rates are compatible with the authorized operational plan of each reservoir along the MKARNS. The USACE would continue to cooperate with state and Federal fish and wildlife agencies to develop plans for some lakes and to provide regular seasonal pool fluctuations. Appropriate seasonal pool variations help to improve fish spawn by maintaining or increasing water levels during spring months, improve water recreation by maintaining levels sufficient for recreation during summer months, and improve waterfowl food and hunting by fluctuating water levels to maximize waterfowl habitat and hunting opportunities during fall months. In general, potential impacts to recreation and aesthetic values would not change based on the No Action Alternative. During periods of maintenance dredging some recreational resources would not be accessible. However, these short-term minor adverse impacts would not change from current levels.

6.11.2 Environmental Consequences Associated with Alternative B - Navigation Channel Maintenance Only Alternative

Under Alternative B, navigation channel maintenance would be sustained using new disposal sites. River flow management and navigation channel depth would remain unchanged from existing actions.

The dredging process and construction of or modification of river training structures would provide a minor, short-term decrease in aesthetics along the MKARNS. The sustained

maintenance of the existing channel could produce short-term impacts to recreation and aesthetic values.

Unlike large commercial vessels, recreational watercraft can still operate on the river without maintenance dredging and disposal occurring. Any other impacts would be similar to those described for the No Action Alternative.

6.11.3 Environmental Consequences Associated with Alternative C - Navigation Channel Maintenance & Operations Only Flow Management Alternative

Under Alternative C, navigation channel maintenance would be sustained using new disposal sites and river flow management would change as defined by the Operations Only Plan. Navigation channel depth would remain unchanged from existing actions.

Impacts associated with sustained maintenance of the existing channel would be similar to those described for Alternative B.

An annual average of two fewer days of flow above 75,000 cfs at Van Buren would be enhance the safety of pleasure boaters and fisherman resulting in a minor beneficial impacts to recreation opportunities. Alterations in average flow above 137,000 cfs (channel capacity) and the number of days that reservoirs are expected to be above conservation pool level would be negligible. In addition, annual average flow above 175,00 cfs is similar to the No Action Alternative. Therefore, flow changes implemented under this alternative would have minor impacts on public recreation use along the MKARNS.

The alternative would not result in higher reservoir elevations or river stages than have been previously recorded. The expected differences in anticipated river flows in an average year are minor and are summarized in Tables 5-2 and 5-3. For these reasons, there would be no conflicts with the "no conversion" provisions of Section 6(f)3 of the Land and Water Conservation Fund Act (P.L. 88-578).

6.11.4 Environmental Consequences Associated with Alternative D - Navigation Channel Maintenance & Operations Only Flow Management & 11-Ft Depth Navigation Channel Alternative

Under Alternative D, navigation channel maintenance would be sustained using new disposal sites, river flow management would change as defined by the Operations Only Plan, and navigation channel depth would be increased to 11 feet throughout the MKARNS.

Impacts to recreation and aesthetic values associated with sustained maintenance and implementation of the flow management plan as outlined under this alternative would be similar to those identified for Alternatives B and C.

Channel deepening to 11 feet would produce minor short-term impacts to recreation and aesthetic values. Dredging activities may temporarily close boat ramps and boat basins and affect public recreation areas (swimming beaches) on a short-term basis during deepening dredging. In addition, the dredging process and construction of or modification of river training structures would provide a minor, short-term decrease in aesthetics along the MKARNS.

Minor long-term adverse impacts would be associated with dredged material disposal on areas used for hunting, fishing, or other recreational activities. However, given the number of recreational opportunities in the area, this would be a minor adverse impact. Once at capacity, dredged disposal would create wildlife habitat, which would have indirect beneficial effects on recreation if they enhanced hunting, fishing, or wildlife viewing opportunities.

6.11.5 Environmental Consequences Associated with Alternative E - Navigation Channel Maintenance & Operations Only Flow Management & 12-Ft Depth Navigation Channel Alternative

Under Alternative E, navigation channel maintenance would be sustained using new disposal sites, river flow management would change as defined by the Operations Only Plan, and navigation channel depth would be increased to 12 feet throughout the MKARNS.

Impacts to recreation and aesthetic values under this alternative would be similar to those identified for Alternative D. However, there would be slightly more impacts due to increased dredging area and volumes.

6.12 Cultural Resources

The Area of Potential Effect (APE) for archaeological resources is dependent on the project feature under consideration. The APE on the MKARNS encompasses lands within the existing operating levels. In the 11 lakes, the APE encompasses all lands within the existing operating level for each lake. The APE for the dredged material disposal sites for this component are the limits of each proposed disposal location including any access roads and staging areas.

An action is considered to have an effect on a historic property when the action may alter the qualities of a property that may qualify the property for inclusion in the National Register of Historic Places (NRHP). An effect is considered adverse when it diminishes the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Adverse impacts on historic properties (i.e., NRHP-listed or eligible resources) would include, but not be limited to:

- physical destruction, damage, or alteration of all or part of the property;
- isolation of the property from or alteration of the character of the property's setting when that character contributes to the property's qualification for the National Register of Historic Places;
- introduction of visual, audible, or atmospheric elements that are out of character with the property or alter its setting;
- neglect of a property resulting in its deterioration or destruction; and
- transfer, lease, or sale of the property (36 CFR 800.9[b]).

Any ground-disturbing action in the area of an NRHP-eligible or potentially eligible archaeological site, or modification to such a site, can affect the integrity of that cultural resource which may influence potential eligibility for inclusion in the NRHP.

For the purposes of this document, a significant impact under NEPA will be defined as an 'adverse effect' under Section 106 of the National Historic Preservation Act

6.12.1 Environmental Consequences Associated with Alternative A - No Action Alternative

Navigation channel maintenance, use of existing disposal locations, river flow management, and navigation channel depth would remain unchanged from existing conditions. Areas of the river bottom that have been previously dredged as part of regular maintenance would not contain intact cultural resources. No impacts to NRHP-eligible cultural resources are anticipated with maintenance dredging that would occur under the No Action Alternative

Existing conditions including ongoing erosion of archaeological sites or architectural resources, and vandalism of shoreline archaeological sites would continue. No additional cultural resources on the MKARNS or the lakes would be adversely affected as a result of implementing the No Action Alternative. Cultural resources would continue to be managed in accordance with Federal laws, regulations, and USACE policies and procedures, and under the scope of the existing MKARNS management plan.

6.12.2 Environmental Consequences Associated with Alternative B - Navigation Channel Maintenance Only Alternative

Potential adverse consequences of the proposed action on cultural resources would occur as a result of changes in the location of maintenance dredging disposal sites.

Potential minor adverse impacts to cultural resources include physical disturbance through maintenance dredging operations, construction and/or modification of dikes and revetments within the river channel and adjacent shorelines, use of new disposal locations, and vandalism from temporarily increased access during construction of shoreline revetments.

No disturbance of cultural resources at existing disposal locations would occur. Surface disturbance and ground preparation at areas designated as new disposal locations may have a minor adverse affect on cultural resources. Burial of cultural resources by dredged material may also occur. Such archaeological resources would essentially be sealed intact beneath the dredged materials; however, deeply buried sites would likely be unavailable for future research. Compaction of sites might result from burial, and contaminants in the dredged material have the potential to render some types of archaeological analysis ineffective if buried sites were excavated at some future time (e.g., fuel oil would hinder accurate radiocarbon dating of organic remains and make soil-phosphate analysis impossible). These types of physical disturbance would disturb or destroy the integrity of the archaeological sites and subsequently, their eligibility for the NRHP.

There are three archeological sites, potentially eligible or recommended eligible or with unevaluated NRHP status identified in the APE at proposed disposal locations.

The current 9-foot navigation channel would be maintained resulting in no impacts to submerged cultural resources from dredging activities. Construction of two new dikes and modification of 50 dikes may have a minor adverse affect on submerged archaeological sites. Ninety documented shipwrecks occur in the MKARNS system. Some of these may be impacted by the construction and/or modification of dikes and revetments. Construction of two new and modification of four existing revetments may adversely affect shoreline cultural resources. No construction-related ground disturbance through the creation of access roads, surface grading, or the use of heavy equipment would occur during the construction and/or modification of shoreline

revetments, because all construction and modification activities will take place from barges on the river

There are no NRHP-listed architectural resources within the APE of any proposed dredge disposal location within the project area.

6.12.3 Environmental Consequences Associated with Alternative C - Navigation Channel Maintenance & Operations Only Flow Management Alternative

In addition to impacts associated with sustaining maintenance dredging, potential impacts to cultural resources associated with Alternative C would occur primarily as a result of changes in the frequency and duration of reservoir elevation and river stage water levels.

Implementation of the flow management changes included under this alternative could result in changes to historic river flows and reservoir elevations. River flows would provide an average of 14 fewer days per year at or above 61,000 cfs, and result in an average of slightly less than two additional days per year at or above 100,000 cfs (note that changes in river flows are typically associated with changes in river stage elevations). The duration that reservoirs remain at flood level would be similar to existing conditions. It is anticipated that reservoir levels would be between 0 and 8 feet above conservation pool slightly more frequently than under existing conditions, and reservoir levels would be greater than 8 feet above conservation pool slightly less frequently than under existing conditions.

As a result, this change in river flows and reservoir levels would create additional opportunity for shoreline erosion exposing archaeological deposits, undercutting, slumping, and subsequent erosion of shoreline archaeological sites, and increasing the potential for vandalism of archaeological materials from temporarily increased access to sites during periods of lower water levels. These types of physical disturbance could disturb or destroy the integrity of the archaeological sites and subsequently, their eligibility for the NRHP. Known shoreline cultural resources and unidentified cultural resources occurring in unsurveyed areas may be located in the APEs. Some of these cultural resources may be considered NRHP-eligible and may also be disturbed or destroyed during fluctuations in lake flood pools and river levels. This alternative may result in an adverse effect to cultural resources.

Impacts to architectural resources include damage or destruction by erosion and flooding, and audio or visual intrusions to associated historic settings or cultural landscapes or alterations to viewsheds that form the cultural landscapes at these resources.

6.12.4 Environmental Consequences Associated with Alternative D - Navigation Channel Maintenance & Operations Only Flow Management & 11-Ft Depth Navigation Channel Alternative

In addition to impacts associated with changes in the frequency and duration of reservoir elevation and river stage water levels as outlined for Alternative C, potential impacts to cultural resources may include physical disturbance through channel deepening and dredging operations, and construction and/or modification of dikes and revetments within the river channel and on adjacent shorelines. River bottom dredging is unlikely to encounter intact cultural resources. Construction and/or modification of dikes may adversely affect submerged archaeological sites.

Construction and/or modification of revetments and increased access to shoreline areas may adversely affect both submerged and terrestrial archaeological sites. Shipwrecks and submerged cultural resources, including submerged terrestrial sites, may occur in the APE and would be identified during subsequent cultural resources investigations if this alternative is selected. Some of these archaeological sites may be considered NRHP-eligible and may be disturbed or destroyed during activities relating to the construction and/or modification of dikes and revetments.

This alternative may cause temporary audio intrusion of architectural resources during construction activities. Impacts to the visual landscape or viewshed of resources caused by changes in the appearance of the shoreline through addition of revetments would be minimal. There are 17 NRHP-listed, eligible or potentially eligible or unevaluated architectural resources within the APE of the MKARNS.

6.12.5 Environmental Consequences Associated with Alternative E - Navigation Channel Maintenance & Operations Only Flow Management & 12-Ft Depth Navigation Channel Alternative

Impacts to cultural resources will be similar to those described for Alternative D.

6.13 Sociological Environment

Direct and indirect adverse impacts to the sociological environment result from those activities that affect the regional or local community, including population, housing, community facilities and services, and infrastructure. These sociological changes can generally be directly or indirectly linked to new or expanded economic impacts.

6.13.1 Environmental Consequences Associated with Alternative A - No Action Alternative

Under the No Action Alternative the river channel would remain at its current depth, river levels on the MKARNS would continue to fluctuate at current levels and limit barge traffic during high flows. The average number of high flow days would not change and, therefore, the amount of barge traffic would not increase. Therefore, this alternative is anticipated to have no effects on regional population, employment, or income. Since navigational clearances and water surface profiles would be maintained and no changes in overall reservoir operations are proposed, this component is also expected to have little to no effect on MKARNS uses or users.

No changes in demographics, employment, housing, schools, and public or social services would be expected relative to baseline conditions. Therefore no effects on environmental justice issues are anticipated.

Although no impacts to Native Americans and other ethnic concerns are expected under this alternative, it is the USACE's policy to fully comply with Executive Order 13084.

Because the number of high flow days would not be reduced, flooding of farm fields would continue at the same rate. This may cause farmers to lose production in some fields, and thus may negatively affect the local economy.

6.13.2 Environmental Consequences Associated with Alternative B - Navigation Channel Maintenance Only Alternative

Sociological impacts would be similar to Alternative A.

6.13.3 Environmental Consequences Associated with Alternative C - Navigation Channel Maintenance & Operations Only Flow Management Alternative

An annual average 14-day decrease in flow days above 61,000 cfs produced by this alternative could result in more efficient barge transport. Navigation on the MKARNS provides the least expensive form of transportation for dozens of local industries that produce chemical fertilizer, sand, gravel and rock, wheat, soybeans, and other commodities. Based on analysis of the potential river operations projected under this alternative, there would be a minor long-term increase in employment within the study area.

The decrease in number of days of flows above 61,000 cfs would in a minor improvement in farming operations along the MKARNS, while there would be no significant increases in agricultural/structural or recreational damages within the system. Less frequent flooding of farm fields may stimulate agricultural production and thus the local economy and quality of life.

Operations Only Plan would have little or no impact on local housing, schools, and public or social services. Therefore there would not be a disproportionate impact on minority or low-income populations or children in the study area

Although no impacts to Native Americans and other ethnic concerns are expected under this alternative, it is the USACE's policy to fully comply with Executive Order 13084.

6.13.4 Environmental Consequences Associated with Alternative D - Navigation Channel Maintenance & Operations Only Flow Management & 11-Ft Depth Navigation Channel Alternative

Impacts to the sociological environment would be similar to those identified for Alternative C.

In addition, implementation of Alternative D would result in minimal long-term negative effect on the sociological environment as a result of channel deepening. There would be one displacement and relocation of a landowner or tenant as a result of dredging and disposal operations under this alternative. There would be no adverse disproportionate impacts on low-income or minority populations

6.13.5 Environmental Consequences Associated with Alternative E - Navigation Channel Maintenance & Operations Only Flow Management & 12-Ft Depth Navigation Channel Alternative

Impacts would be similar to Alternative D.

6.14 Economic Environment

6.14.1 Introduction to Economic Environment Impact Analysis

Direct and indirect impacts to the economic environment of the study area would result from the economic costs or benefits of each alternative to operations and maintenance of the navigation system, commercial navigation, agricultural and non-agricultural lands, hydropower facilities, and tourism/recreation. Analysis of the economic consequences includes the comparison of economic benefits and project costs that would occur with implementation of each alternative. Indirect benefits would include a potential increase in employment, labor force, income and business volume, and an expansion of new business and industry. Other potential indirect impacts include effects on community and regional growth, property values and tax revenues, and public facilities and services.

Contributions to the national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the Nation. The base economic benefit of a navigation project is the reduction in the value of resources required to transport commodities. The process of optimizing net benefits should be reasonable and practical in seeking to maximize net benefits. The best project may be defined as the plan that returns the greatest excess of benefits over costs, i.e., it is not possible to improve upon a plan producing maximum net benefits (total benefits less total costs). For all project purposes except ecosystem restoration, the alternative plan that reasonably maximizes net economic benefits consistent with protecting the Nation's environment, the NED plan, shall be selected.

Table 6-4 provides a summary of the incremental net economic benefits and costs associated with each of the alternatives. Alternative B represents the baseline against which the benefits and costs of Alternatives C, D and E are compared. The annual incremental benefits of Alternatives C and D include the benefits of Alternative B in addition to the benefits incurred under Alternative C and D respectively.

Table 6-4. Summary of Incremental Net Economic Benefits and Costs, Average Annual Values (July 2004 Prices), 5.375% Discount Rate, 50-year Economic Life.

	Increment Over Baseline				
	Alternative A	**Alternative B**	**Alternative C**	**Alternative D**	**Alternative E**
Incremental Costs					
Construction	-	-	-	7,973,100	9,649,100
O&M	-	-	-	2,234,100	2,823,700
Real Estate (potential)	-	-	-	-	-
Subtotal	-	-	-	**10,207,200**	**12,472,800**

Table 6-4. Summary of Incremental Net Economic Benefits and Costs, Average Annual Values (July 2004 Prices), 5.375% Discount Rate, 50-year Economic Life.					
	Increment Over Baseline				
	Alternative A	**Alternative B**	**Alternative C**	**Alternative D**	**Alternative E**
Non-Agricultural Property Damage (Includes Recreational Facilities)					
Oklahoma	-	-	(5,500)	(5,500)	(5,500)
Arkansas	-	-	(13,100)	(13,100)	(13,100)
Agricultural Property Damages					
Oklahoma	-	-	0	0	0
Arkansas	-	-	(18,800)	(18,800)	(18,800)
Subtotal	**-**	**-**	**(37,400)**	**(37,400)**	**(37, 400)**
Incremental Benefits					
Navigation	-	-	8,372,100	18,545,600	21,854,700
Recreation	-	-	0	0	0
Hydropower	-	-	466,000	466,000	466,000
Subtotal	**-**	**-**	**8,838,100**	**18,974,200**	**22,283, 300**
Annual Incremental Net Benefits	**-**	**-**	**8,800,700**	**8,767,000**	**9,810,500**
Source: USACE, Tulsa and Little Rock Districts, NWD, Parsons, 2005.					

6.14.1.1 Environmental Consequences Associated with Alternative A - No Action Alternative

Under this alternative, existing operations and maintenance activities accomplished by the USACE to maintain the existing MKARNS would continue at their current rate and frequency. These activities include the maintenance and repair of the existing locks, dams, levees, recreational structures, as well as the dredging of the river to maintain safe navigation depths. Implementation of this alternative would result in the continuation of existing beneficial and adverse direct and indirect economic impacts associated with operation and maintenance of the system.

Under the No Action Alternative, the current navigation conditions would continue in the short-term. Therefore, there would be no short-term beneficial or adverse economic impacts.

However, the limitations on commercial navigation during and after storm events that cause high flows reduces reliability of shipping on the MKARNS. The disparity between the navigation channel depths in the two river systems results in less efficient barge operations than could be achieved with a consistent 12-foot navigation channel throughout the MKARNS and Lower Mississippi River commercial navigation systems. Long-term differences in the economics of the navigation industry are expressed not as adverse impacts, but as foregone benefits. These differences would occur as a result of continuing the current condition of navigation days and navigation efficiencies.

Table 6-5 portrays the high, middle and low annual tow trip projections for a 9-foot channel for the No Action Alternative. The number of tows was estimated based on tonnage levels, number of barges per tow, and the number of tons per barge. Under existing conditions, there would be no decrease in tow trips as compared to the flow management and deepening components based on existing traffic and tow trips. Currently, the average MKARNS tow has 6.9 barges with an average of nearly 7,000 tons per tow.

Table 6-5. No Action Alternative: High, Middle and Low Annual Tow Trip Projections, 9′ Channel

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High 9′ forecast	1,805	3,274	4,859	5,272	5,683	6,129	6,615	2.3%
Middle 9′ forecast	1,805	2,183	2,430	2,636	2,841	3,065	3,307	1.1%
Low 9′ forecast	1,805	1,805	1,805	1,805	1,805	1,805	1,805	0.0%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

6.14.1.2 Environmental Consequences Associated with Alternative B - Navigation Channel Maintenance Only Alternative

There would be both beneficial and adverse economic impacts under Alternative B as a result of the requirement for new dredged material disposal sites. Some productive cropland will be acquired for these new sites, resulting in a long-term loss of cropland production and a reduction in land value and property tax revenues. However, the dredging operations would create additional employment, resulting in increased business volume and income for the local economy. In addition, the dredged materials can become a resource as a raw material for various construction and industrial related uses.

6.14.1.3 Environmental Consequences Associated with Alternative C - Navigation Channel Maintenance & Operations Only Flow Management Alternative

There will be both beneficial and adverse economic impacts under Alternative C as a result of the requirement for new dredged material disposal sites. Some productive cropland will be acquired for these new sites, resulting in a long-term loss of cropland production and a reduction in land value and property tax revenues. However, the dredging operations will create additional employment, resulting in increased business volume and income for the local economy. In

addition, the dredged materials can become a resource as a raw material for various construction and industrial related uses.

There will be some negative economic impacts as a result of implementation of the flow management component incorporated in Alternative C. These would include agricultural and non-agricultural damages, and loss of some recreation/tourism benefits. However, these adverse impacts would be minimal. As noted in Chapter 5, these adverse impacts are the lowest under the Operations Only Component incorporated in Alternative C. As indicated in Table 6-4, net incremental economic benefits are $8.8 million under the Operations Only Component incorporated in Alternative C. Approximately 95 percent of these benefits are associated with navigation, with the remaining benefits attributable to hydropower.

Table 6-6 portrays the high, middle and low annual tow trip projections for a 9-foot channel under the Channel Maintenance and Operations Only Flow Management Alternative. The number of tows was estimated based on tonnage levels, number of barges per tow, and the number of tons per barge. The result of the flow management changes was computed by adding the average number of barges per tow to the existing average tons per tow. The flow management changes are expected to result in one additional barge per tow and consequently fewer tows. As a result, there is an approximate 13 percent decrease in annual tow trips associated with the flow management changes compared to the existing conditions without the flow management changes. Annual forecasted tow trips with the proposed flow management changes range from a high of 5,755 to a low of 1,571 in the year 2060. The low forecast reflects the current 2003 tow trip level, which was held constant throughout the future.

Table 6-6. High, Middle and Low Annual Tow Trip Projections – Alternative C.

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High 9′ forecast	1,571	2,849	4,228	4,587	4,945	5,333	5,755	2.3
Middle 9′ forecast	1,571	1,899	2,114	2,294	2,472	2,666	2,878	1.1
Low 9′ forecast	1,571	1,571	1,571	1,571	1,571	1,571	1,571	0.0

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

6.14.1.4 Environmental Consequences Associated with Alternative D - Navigation Channel Maintenance & Operations Only Flow Management & 11-Ft Depth Navigation Channel Alternative

The beneficial and adverse economic impacts described under Alternative C will continue and be similar under Alternative D. However, channel deepening to 11 feet will result in additional direct and indirect positive impacts on commercial navigation, and impacts on operations and maintenance under Alternative D. Deepening the channel would allow a significant portion of barges to be more fully loaded than is currently possible, and potentially induce existing overland traffic to waterway transportation as a result of greater cost savings. As indicated in Table 6-4, the net annual benefits under Alternative D approximate an additional $530,000 over Alternative C.

The shipping costs for existing traffic for the 9' channel depth and Alternative D are portrayed in Table 6-7. At the year 2003 baseline the differential cost savings between the existing 9' channel and Alternative D is approximately $7.5 million, while the differential cost savings per ton under Alternative D is approximately $.64. In the year 2010 and thereafter the differential cost savings per ton approximates $.61. The savings per ton represent the savings on water transportation compared to overland transportation costs.

Table 6-7. Existing Traffic, Tonnage and Transportation Costs - Middle Forecasts, Alternative D ($000s except for savings/ton)

	2003	2010	2020	2030	2040	2050	2060
Tons (000s)	11,884	14,372	15,997	17,356	18,708	20,177	21,775
Water-Routed Transportation Costs for Existing Shipment							
9'	150,344.6	177,979.5	196,781.4	213,242.4	229,292.3	246,738.0	265,728.8
11'	142,798.0	169,065.2	186,930.2	202,562.0	217,814.0	234,394.8	252,443.0
Net Cost Reduction	7,546.6	8,914.3	9,851.2	10,680.4	11,478.3	12,343.2	13,285.8
Lock Processing Costs, Including Induced Traffic for 11' Channel							
9'	n.a.	631.7	741.4	760.0	960.3	1,217.5	1,788.0
11'	248.9	571.4	699.8	706.1	936.9	1,135.7	1,277.9
Overland Transportation Costs							
	266,230.2	277,660.1	315,212.6	348,329.8	377,392.3	405,865.8	436,843.6
Savings per Ton for Existing Shipments							
9'	$ 9.75	$ 9.55	$ 9.47	$ 9.46	$ 9.44	$ 9.42	$ 9.41
11'	$ 10.39	$10.17	$10.09	$10.07	$10.05	$10.03	$10.02
Net Savings	$ .64	$ .62	$ .62	$ .61	$ .61	$ .61	$ .61

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 6-8 displays high, middle and low induced traffic tonnage projections for Alternative D, and the transportation savings per ton under the middle forecast. The methodology and assumptions regarding induced traffic discussed in Chapter 5 also apply in Chapter 6. Induced traffic under this Alternative is projected to account for an approximate 5 percent increase in waterway transportation. The transportation savings for traffic potentially induced to waterway transportation is estimated at $.31 per ton.

Table 6-8. High, Middle and Low Annual Induced Traffic Projections – Alternative D (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0.0	528.2	1,567.7	1,700.9	1,833.3	1,977.3	2,134.0	2.8%
Middle	0.0	352.1	783.8	850.4	916.7	988.7	1,067.0	2.2%
Low	0.0	291.2	582.4	582.4	582.4	582.4	582.4	1.4%
Overland Transportation Costs of Potentially Induced Traffic Except Processing Costs ($000s Dollars)								
11' Middle	n.a.	7,722.7	17,068.2	18,492.2	19,887.4	21,405.4	23,059.4	n.a.
Transportation Costs per Ton for All Overland Transportation Mode								
11' Middle	n.a.	$21.93	$21.78	$21.75	$21.69	$21.65	$21.61	n.a.
Transportation Savings per Ton for Induced Traffic (Oct., 2003 Dollars)								
11' Middle	n.a.	$.31	$.31	$.31	$.31	$.31	$.31	n.a.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 6-9 portrays the projected annual tow trips under the high, middle and low forecasts for Alternative D. Deepening is expected to result in increased barge loadings, which in turn would further decrease the number of tows required to move the traffic. The effect of channel deepening on the number of tows was estimated using pro-rationing techniques keyed to the percent reduction in barge line-haul costs as discussed in Chapter 5. It is estimated that there would be an approximate 10 percent decrease in annual tow trips under this alternative as compared to Alternative C, and over a 20 decrease compared to the No Action Alternative.

Table 6-9. High, Middle and Low Annual Tow Trip Projections – Alternative D.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	1,402	2,543	3,773	4,094	4,413	4,759	5,136	2.3%
Middle	1,402	1,695	1,887	2,047	2,206	2,380	2,568	1.1%
Low	1,402	1,402	1,402	1,402	1,402	1,402	1,402	0.0%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 6-10 displays the projected high, middle and low induced annual tow trips for Alternative D. The induced tow trips represent approximately 5 percent of the total tow trips.

Table 6-10. High, Middle and Low Annual Induced Tow Trip Projections – Alternative D.

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	0	62	185	201	216	233	252	3.0%
Middle	0	42	92	100	108	117	126	2.4%
Low	0	34	69	69	69	69	69	1.5%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 6-11 reflects the high, middle and low projected average annual navigation benefits for Alternative D with and without induced traffic. These benefits reflect the annual average savings in water transportation costs versus overland transportation costs for the same volume and group of commodities. The results indicate that induced traffic has little effect on the overall benefits. This is true regardless of the channel depth or traffic forecasts. However, the benefits are sensitive to channel depth and to future traffic projections. For example, the benefits of induced traffic under the high forecast are almost 80 percent greater than the benefits under the middle forecast for Alternative D.

Table 6-11. High, Middle and Low Projected Average Annual Navigation Benefits – Alternative D (000s Dollars)[1].

	Without Induced Traffic	With Induced Traffic
High	16,684.26	8,158.14
Middle	10,013.92	10,173.53
Low	7,638.37	7,755.08

1 Reflects July 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year time period.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 6-12 provides a more detailed summary of the annualized navigation benefits under the middle forecast for Alternative D. The annualized benefits reflect a reduction in transportation costs as a result of more efficient use of existing equipment, reductions in transit time, and in the use of water transportation rather than alternative overland transit modes. The benefits are expressed as average annual equivalent values. Over 95 percent of the benefits are cost reduction benefits, with the induced traffic providing the remaining benefits. The small benefit from the induced traffic is due to the relatively small amount of this traffic and the marginal savings realized by these shipments.

Table 6-12. Summary of Annualized Navigation Benefits, Middle Forecast – Alternative D (000s Dollars)[1].	
Benefits With Induced Traffic	
Cost Reduction	9,959.53
Existing	10,066.64
Processing	(107.11)
Shift of Mode	214.00
Shift in Origin/Destination	0.0
New Movement	0.0
TOTAL	**10,173.53**
Benefits Without Induced Traffic	
Cost Reduction	10,013.92
Existing	10,066.64
Processing	(52.72)
Shift of Mode	0.0
Shift in Origin/Destination	0.0
New Movement	0.0
TOTAL	**10,013.92**

[1] Reflects July 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 6-13 provides a summary of the total project costs, annual costs and benefits, net benefits, and benefit-to-cost ratio for Alternative D. The benefit-to-cost ratio of 1.9 results in annual positive incremental net benefits of approximately $8.8 million.

Table 6-13. Summary of Total Costs and Navigation Benefits[1] – Alternative D.	
Middle Forecast	
Total Project Cost[2]	$137,512,900
Total Annual Costs[3]	$10,207,200
Annual Benefits	$18,974,200
Annual Incremental Net Benefits	$8,767,000
Benefit-to-Cost Ratio	1.9

[1] Reflects July 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

6.14.1.5 Environmental Consequences Associated with Alternative E - Navigation Channel Maintenance & Operations Only Flow Management & 12-Ft Depth Navigation Channel Alternative

The beneficial and adverse economic impacts described under Alternative C will continue and be similar under Alternative E. However, further channel deepening to 12 feet will result in additional direct and indirect impacts on commercial navigation, operations and maintenance. Additional beneficial impacts will accrue to the navigation industry in respect to navigation efficiency as a result of fewer tows and increased barge loadings as a result of channel deepening. In addition, some existing overland traffic is expected to be transferred to waterway transportation as the result of increase in the efficiencies of waterway transportation and consequential lower transportation costs. It is expected that this gain in efficiency could potentially result in some increase in navigation and port-related investments and employment, resulting in additional contributions to the local and regional economy in respect to business volume and income. As indicated in Table 6-4, the net annual benefits under Alternative E are approximately an additional $1.03 million over Alternative D.

The shipping costs for existing traffic for the 9' channel depth and the 12' channel depth are portrayed in Table 6-14. At the year 2003 base-level the costs savings between the existing 9' channel and the 12' channel is approximately $10.1 million, while the differential costs savings per ton under the 12' channel is approximately $.85. The savings per ton represent the savings on water transportation compared to overland transportation costs.

Table 6-14. Existing Traffic, Tonnage and Transportation Costs - Middle Forecasts – Alternative E (000s except for savings/ton).

	2003	2010	2020	2030	2040	2050	2060
Tons (000s)	11,884	14,372	15,997	17,356	18,708	20,177	21,775
Water-Routed Transportation Costs for Existing Shipment							
9'	150,344.6	177,979.5	196,781.4	213,242.4	229,292.3	246,738.0	265,728.8
12'	140,224.9	166,032.8	183,585.7	198,942.2	213,933.8	230,231.0	247,972.8
Net Savings	10,119.7	11,946.7	13,195.7	14.300.2	15.358.5	16,507.0	17,756.0
Lock Processing Costs, Including Induced Traffic for 12' Channel							
9'	n.a	631.7	741.4	760.0	960.3	1,217.5	1,788.0
12'	247.8	544.3	661.5	789.2	871.9	1,004.9	1,050.4
Overland Transportation Costs							
	266,230.2	277,660.1	315,212.6	348,329.8	377,392.3	405,865.8	436,843.6
Savings per Ton for Existing Shipments							
9'	$ 9.75	$ 9.55	$ 9.47	$ 9.46	$ 9.44	$ 9.42	$ 9.41
12'	$10.60	$10.38	$10.30	$10.28	$10.26	$10.24	$10.22
Net Savings	$ .85	$ .83	$ .83	$ .82	$ .82	$ .82	$ .81

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 6-15 displays high, middle and low induced traffic tonnage projections for Alternative E, and the transportation savings per ton under the middle forecast. The methodology and assumptions regarding induced traffic discussed in Chapter 5 also apply in Chapter 6. Induced traffic under this Alternative is also projected to account for an approximate 5 percent increase in waterway transportation. The transportation savings for traffic potentially induced to waterway transportation is estimated at $.38 per ton under this Alternative.

Table 6-15. High, Middle and Low Annual Induced Traffic Projections – Alternative E (000s tons).

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	0.0	603.6	1,791.6	1,943.9	2,095.2	2,259.8	2,438.8	2.8
Middle	0.0	402.4	895.8	971.9	1,047.6	1,129.9	1,219.4	2.2
Low	0.0	332.8	665.6	665.6	665.6	665.6	665.6	1.4
Overland Transportation Costs of Potentially Induced Traffic (000s Dollars)								
12' Middle	n.a.	9,270.8	20,513.9	22,224.8	23,909.8	25,742.6	25,742.6	n.a.
Transportation Costs per Ton for All Overland Transportation Mode								
12' Middle	n.a.	$23.04	$22.90	$22.87	$22.82	$22.78	$22.75	n.a.
Transportation Savings per Ton for Induced Traffic (Oct. 2003 Dollars)								
12' Middle	n.a.	$.38	$.37	$.37	$.37	$.37	$.37	n.a.

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 6-16 portrays the projected annual tow trips under the high, middle and low forecasts for Alternative E. Further deepening is expected to result in increased barge loadings, which in turn would further decrease the number of tows required to move the traffic. The effect of channel deepening on the number of tows was estimated using pro-rationing techniques keyed to the percent reduction in barge line-haul costs as discussed in Chapter 5. It is estimated that there would be an approximate 2 percent decrease in annual tow trips under this Alternative as compared to Alternative D, and a 23 decrease compared to the No Action Alternative.

Table 6-16. High, Middle and Low Annual Tow Trip Projections – Alternative E.

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	1,380	2,504	3,716	4,032	4,346	4,687	5,058	2.3%
Middle	1,380	1,669	1,858	2,016	2,173	2,343	2,529	1.1%
Low	1,380	1,380	1,380	1,380	1,380	1,380	1,380	0.0%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 6-17 displays the projected high, middle and low annual induced tow trips for Alternative E. The induced tow trips represent approximately 5 percent of the total tow trips as under Alternative D.

Table 6-17. High, Middle and Low Annual Induced Tow Trip Projections – Alternative E.

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	n.a.	70	208	226	243	263	283	3.0%
Middle	n.a.	47	104	113	122	131	142	2.4%
Low	n.a.	39	77	77	77	77	77	1.5%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 6-18 reflects the high, middle and low projected average annual navigation benefits for Alternative E with and without induced traffic. These benefits reflect the annual average savings in water transportation costs versus overland transportation costs for the same volume and group of commodities. The results indicate that induced traffic has little effect on the overall benefits. This is true regardless of the channel depth or traffic forecasts. However, the benefits are sensitive to channel depth and to future traffic projections. For example, the benefits of induced traffic under the high forecast are almost 80 percent greater than the benefits under the middle forecasts for Alternative E.

Table 6-18. High, Middle and Low Projected Average Annual Navigation Benefits – Alternative E (000s Dollars)[1].

Forecast	Without Induced Traffic	With Induced Traffic
High	22,370.29	21,033.13
Middle	13,252.68	13,482.55
Low	10,114.86	10,321.35

[1] Reflects July 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 6-19 provides a more detailed summary of the annualized navigation benefits under the middle forecast for Alternative E. The annualized benefits reflect a reduction in transportation costs as a result of more efficient use of existing equipment, reductions in transit time, and in the use of water transportation rather than alternative overland transit modes. The benefits are expressed as average annual equivalent values. Over 95 percent of the benefits are cost reduction benefits, with the induced traffic providing the remaining benefits. The small benefit from the induced traffic is due to the relatively small amount of this traffic and the marginal savings realized by these shipments.

Table 6-19. Summary of Annualized Navigation Benefits, Middle Forecast – Alternative E (000s Dollars)1.	
Benefits With Induced Traffic	
Cost Reduction	13,211.13
Existing	13,297.68
Processing	(86.54)
Shift of Mode	271.32
Shift in Origin/Destination	0.0
New Movement	0.0
TOTAL	**13,482.45**
Benefits Without Induced Traffic	
Cost Reduction	13,252.68
Existing	13,297.68
Processing	(44.99)
Shift of Mode	0.0
Shift in Origin/Destination	0.0
New Movement	0.0
TOTAL	**13,252.68**

1 Reflects July 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 6-20 provides a summary of the total project costs, annual costs and benefits, net benefits, and benefit-to-cost ratio for Alternative E. The benefit-to-cost ratio of 1.80 results in annual positive incremental net benefits of approximately $9.8 million.

Table 6-20. Summary of Total Costs and Benefits[1] – Alternative E.	
Middle Forecast	
Total Project Cost[2]	$166,418,500
Total Annual Costs[3]	12,472,800
Annual Benefits	22,283,300
Annual Incremental Net Benefits	9,810,500
Benefit-to-Cost Ratio	1.80

[1] Reflects July 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.