Draft

Supplemental Environmental Assessment

Arkansas River Navigation Study
Arkansas and Oklahoma

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Little Rock and Tulsa Districts

ARKANSAS RIVER NAVIGATION STUDY
ARKANSAS AND OKLAHOMA
SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT

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Acronyms

%	Percent
ABB	American Burying Beetle
ACHP	Advisory Council on Historic Preservation
ADEE	Arkansas Department of Energy and Environment
ADEQ	Arkansas Department of Environmental Quality
AGFC	Arkansas Game and Fish Commission
ANHC	Arkansas Natural Heritage Commission
AR	The State of Arkansas
ARNS	Arkansas River Navigation Study
BMP	Best Management Practice
BO	Biological Opinion
CAA	Clean Air Act
CEJST	Climate and Economic Justice Screening Tool
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CWA	Clean Water Act
cy	Cubic yards
DMMP	Dredge Material Management Plan
EF	Emissions Factors
EJ	Environmental Justice
EO	Executive Order
EPA	Environmental Protection Agency
ERDC	U.S. Army Engineer Research and Development Center
ESA	Endangered Species Act
FEIS	Final Environmental Impact Statement
FR	Feasibility Report
FY	Fiscal Year
GCM	General Circulation Models
GHG	Greenhouse Gas
GWP	Global Warming Potential
H&H	Hydrology and Hydraulics
HHV	High Heat Value
IIJA	Infrastructure Investment and Jobs Act
ILT	Interior Least Tern
IPaC	Information for Planning and Consultation
MKARNS	McClellan-Kerr Arkansas River Navigation System
NAAQS	National Ambient Air Quality Standards

NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NLAA	May Affect, Not Likely to Adversely Affect
NLCD	National Land Cover Database
NLEB	Northern Long-eared Bat
NO_2	Nitrogen Dioxide
N_2O	Nitrous Oxide
NRHP	National Register of Historic Places
O_3	Ozone
O&M	Operations and Maintenance
OAS	Oklahoma Archaeological Survey
ODEQ	Oklahoma Department of Environmental Quality
ODWC	Oklahoma Department of Wildlife Conservation
OK	The State of Oklahoma
PA	Programmatic Agreement
Pb	Lead
PBO	Programmatic Biological Opinion
PED	Pre-Construction Engineering and Design
PM	Particulate Matter
RPEC	Regional Planning and Environmental Center
SEA	Supplemental Environmental Assessment
SHPO	State Historic Preservation Officers
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
THPO	Tribal Historic Preservation Office
tpy	tons per year
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WRDA	Water Resources Development Act
ZOI	Zone of Influence

1 Introduction

The US Army Corps of Engineers (USACE) Little Rock and Tulsa Districts have prepared this Supplemental Environmental Assessment (SEA) to evaluate proposed changes to the McClellan-Kerr Arkansas River Navigation System project (MKARNS). This SEA analyzes the potential impacts to the human and natural environment from implementing proposed changes to the authorized project in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended (42 United States Code [USC] §4321 et seq.), the Council on Environmental Quality's (CEQ) Regulations Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations [CFR] Parts 1500 – 1508), and US Army Corps of Engineers (USACE) Engineering Regulation (ER) 200-2-2: Procedures for Implementing NEPA (33 CFR 230).

This SEA supplements the 2005 Final Environmental Impact Statement (FEIS) for the Arkansas River Navigation Study, Arkansas and Oklahoma (ARNS). This SEA will: 1) provide a concise summary of the history and status of the originally authorized ARNS Project; 2) document the changes and refinements made to the MKARNS 12-Foot Channel design during the Pre-Construction Engineering and Design (PED) and Construction phases, including mitigation; and, 3) evaluate the potential environmental effects of the updated construction and design plans that may have changed since the FEIS was completed.

1.1 Background

The MKARNS is part of the United States inland waterway system. Originating at the Port of Catoosa in Tulsa and running through Oklahoma and Arkansas to the Mississippi River, the MKARNS provides a minimum nine-foot-deep navigation channel and is considered a "high-use" system that sees 10-11 million tons of cargo each year.

In 1999, a reconnaissance study of flooding in unprotected areas outside the existing flood control levees at Fort Smith, Arkansas was initiated. As a result of the reconnaissance study, a Section 905(b) (WRDA 86) Analysis dated September 1999 was prepared and approved in January 2000. The analysis identified the current MKARNS operating plan as the cause of some of the flooding problems. Concurrently, the navigation industry was asking that the operating plan be re-evaluated to reduce the navigation losses due to high flows. The navigation industry also requested an investigation to increase the channel depth from 9 feet to 12 feet. Based on an initial assessment of possible benefits, the reconnaissance study recommended a feasibility study to improve navigation conditions while incidentally improving flood control, hydropower, recreation, and fish and wildlife.

In 2005, the Final Feasibility Report (FR) and FEIS for the ARNS, MKARNS (herein referred to as the 2005 ARNS FR/EIS) were completed. The FR and EIS were a combined effort of the Little Rock and Tulsa Districts and originally consisted of two phases. Phase I examined how to reduce flooding and expand the number of days that barges could operate on the MKARNS while balancing any changes against the needs of existing project purposes that include navigation, flood control, water supply, hydropower, water quality, recreation, and fish and wildlife habitat. Phase II investigated deepening the channel over the entire system and widening the Verdigris River in Oklahoma. Each phase was to have a separate FR and EIS. However, to properly address cumulative environmental impacts, it was subsequently determined that both phases as well as ongoing operations and maintenance of the existing 9-foot channel should be addressed in one FR and EIS.

The 2005 ARNS FR/EIS and Report of the Director of Civil Works (Director's Report), signed on 27 September 2005, recommended three broad components: 1) changes to the existing

MKARNS dredge material disposal plan (DMMP) for the existing 9-foot channel with new dredge material disposal sites; 2) replacing the existing flow management plan for the MKARNS with an Operations Only component to improve navigation and hydropower; and 3) deepening the navigation channel throughout the MKARNS from 9 feet to 12 feet (referred to as the 12-foot channel).

The MKARNS project was authorized to a 12-foot depth by Congress in the Energy and Water Development Appropriations Act of 2004 (Section 136 of Public Law 108-137). Congressional appropriations were received for the first two components of the plan, which were and continue to be implemented throughout the MKARNS.

The USACE received Operations and Maintenance (O&M) funds in the fiscal year (FY) 2005 Omnibus Bill to begin work on Component 3, deepening the channel. These funds were used to construct some rock revetments to induce self-scouring of sediment and naturally maintain channel depth as well as dike notching, thus marking the start of construction. Additional appropriations were received in the FY 2022 Infrastructure Investment and Jobs Act (IIJA), also known as the Bipartisan Infrastructure Law (BIL), to continue design and construction of the 12-foot channel, bringing us to the present day. To date, no channel deepening dredging or upland placement area construction has been initiated and all work has been focused on updating the designs based on current conditions.

1.2 Project Authority

1.2.1 MKARNS

The Rivers & Harbors Act of 1946 authorized the development of the Arkansas River and its tributaries for the purposes of navigation, flood control, hydropower, and recreation. Downstream of Little Rock, it was authorized for the purposes of navigation and irrigation. Public Law 91-649 stated that the project would be known as the McClellan-Kerr Arkansas River Navigation System (MKARNS) to honor Senators Robert S. Kerr, Oklahoma, and John L. McClellan, Arkansas, who pushed its authorizing legislation through Congress. Subsequent acts authorized water supply and fish and wildlife purposes. Construction of the project began in 1957 and was opened to navigation in 1971 at a total cost of $1.3 billion.

1.2.2 Channel Deepening

Funds were appropriated in the Energy and Water Development Appropriations Act of 1999, which provided $100,000 for the USACE to initiate and complete a reconnaissance study of flooding in unprotected areas outside the existing flood control levees at Fort Smith, Arkansas. As a result of the reconnaissance study, a Section 905(b) (WRDA 86) Analysis, dated September 1999 was prepared and approved in January 2000. The report recommended a navigation study that would incidentally help flood control and included a recommendation for a feasibility study with two phases. The first phase (Phase I) examined how to reduce flooding and expand the number of days that barges could operate on the river. The second phase (Phase II) investigated deepening the channel over its entire length and widening the Verdigris River in Oklahoma.

Additional language was included in Section 136 of the Energy and Water Development Appropriations Act of 2004, which authorized a project depth of twelve feet. Section 136 of Public Law 108-137 states:

> *"The McClellan-Kerr Arkansas River navigation project, authorized under the comprehensive plan for the Arkansas River Basin by Section 3 of the Act entitled "An Act authorizing the construction of certain public works on rivers and harbors for flood control, and for other purposes", approved June 28, 1938 (52 Stat.1218)*

and Section 10 of the Flood Control Act of 1946 (60 Stat. 647) and wherever applicable the provisions of the River and Harbor Act of 1946 (60 Stat. 634) and modifications by Section 108 of the Energy and Water Development Appropriations Act, 1988 (101 Stat. 1329-112), is further modified to authorize a project depth of 12 feet."

Funding for changing the DMMP and flow management plan were appropriated and were, and continue to be, implemented. In 2018, both the USACE Tulsa District (SWT) and Little Rock District (SWL) produced new DMMPs for their respective segments of the MKARNS, and these two plans closely mirror the dredge material disposal plans established in the 2005 FR/EIS. No action has been taken to construct the new disposal sites identified in the two 2018 DMMPs. The USACE received $7,000,000 in the FY05 Omnibus Bill to begin work on deepening the channel; however, the Act incorrectly cited Public Law 108-357. Congress has since passed a technical correction citing the correct Public Law (P.L. 108-137). These funds were used to complete some PED equivalent work by constructing some rock revetments and dike notching, thus marking the start of construction. Additional congressional appropriations were received in the FY22 Bipartisan Infrastructure Law (BIL) to update NEPA compliance, Economics, Costs, Hydrology and Hydraulics (H&H) modeling and designs and begin construction of the 12-ft channel.

1.3 NEPA Compliance and Scope of the SEA

Since the signing of the Director's Report and Record of Decision (ROD) for the 2005 ARNS FR/EIS on 27 September 2005, and authorization to construct the project, detailed engineering, technical studies, and design needed to begin construction have been completed. In response to additional technical studies and the collection of site-specific data, several modifications to the approved 12-ft channel deepening plan have been identified and incorporated into construction designs.

Any change to a previously analyzed and approved project must comply with NEPA. The CEQ NEPA regulations direct agencies to prepare a supplement to either a draft or final EIS if the "agency makes substantial changes in the proposed action that are relevant to environmental concerns" or there are "significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts." (40 CFR 1502.9(d)(1)(i)–(ii)).

While the recommended plan design changes may be considered substantial in scope, no significant changes to the plans themselves have been made; instead, the original design has been further refined and locations of design features have been modified. The changes do not introduce any new significant impacts that were not already considered and addressed in the 2005 ARNS EIS. Additionally, the amount of unavoidable adverse impacts disclosed have decreased, resulting in less mitigation need. The main change is related to how much and where the impact is occurring. As a result, an SEA is appropriate over preparing a supplemental EIS.

This SEA identifies and evaluates potential direct (those resulting from the alternatives and occurring at the same time and place) and indirect effects (those distant or occurring at a future date) to the human and natural environment associated with third component of the Proposed Action, as identified in Chapter 2. Since components 1 and 2 are already in place, this SEA will focus only on the 12-foot channel deepening and associated DMMP revisions. Chapter 2 describes the alternatives considered, compares them, and identifies the Preferred Alternative. Chapter 3 describes the existing conditions that fall within the scope of this SEA. Next, Chapter 4 discloses the environmental consequences anticipated as a result of implementing the Proposed Action. The SEA focuses on the impact of the new project work not identified in the 2005 FEIS.

The 2005 ARNS FR/EIS is incorporated by reference throughout the SEA to reduce duplication of information and to focus on the new information in line with CEQ guidance (40 CFR 1501.12). When incorporation by reference is used, a brief summary of the information being incorporated is provided followed by the reference.

This SEA is being developed during the construction phase as more detailed H&H analyses refining dredge quantities and locations are ongoing, or have been completed, and real estate locations have been tentatively identified for new upland dredge disposal locations. The SEA includes detailed environmental analyses to evaluate the impact of the new project work not identified in the 2005 FEIS. Future NEPA analyses may be required should subsequent analyses result in changes to quantities or locations of project features.

1.4 Project Area

The MKARNS 12-Foot Channel Project Area includes the entire length of the MKARNS from the Port of Catoosa near Tulsa, Oklahoma, downstream to the confluence of the Mississippi River in southeastern Arkansas including:

- A 50-mile reach of the Verdigris River from the Port of Catoosa to Muskogee (navigation miles 445-394).
- Lower Arkansas River, which comprises 375 miles of the MKARNS (navigation miles 394 to 19).
- The Arkansas Post canal, a 9-mile canal connecting the Arkansas River to the lower portion of the White River (navigation miles 19 to 10).
- The lower 10 miles of the White River (navigation miles 10 to 0).

The project area also includes all dredged material disposal locations being considered, which includes areas of terrestrial land adjacent to the channel and in-water locations.

1.5 Description of the Authorized Project

The MKARNS system (Figure 1-1) is approximately 445 miles in length and consists of a series of 18 locks and dams (Table 1-1). USACE's Tulsa and Little Rock Districts cooperatively control flows in the Arkansas River system in Kansas, Oklahoma, and Arkansas. However, the Little Rock District's operational flexibility in controlling flows is very limited.

Channel widths and the depth of the navigation channel vary throughout the system. While the navigation channel is currently maintained to a minimum of 9 feet, the majority of the system is naturally at a depth of 12 feet or greater.

Figure 1-1. McClellan-Kerr Arkansas River Navigation System

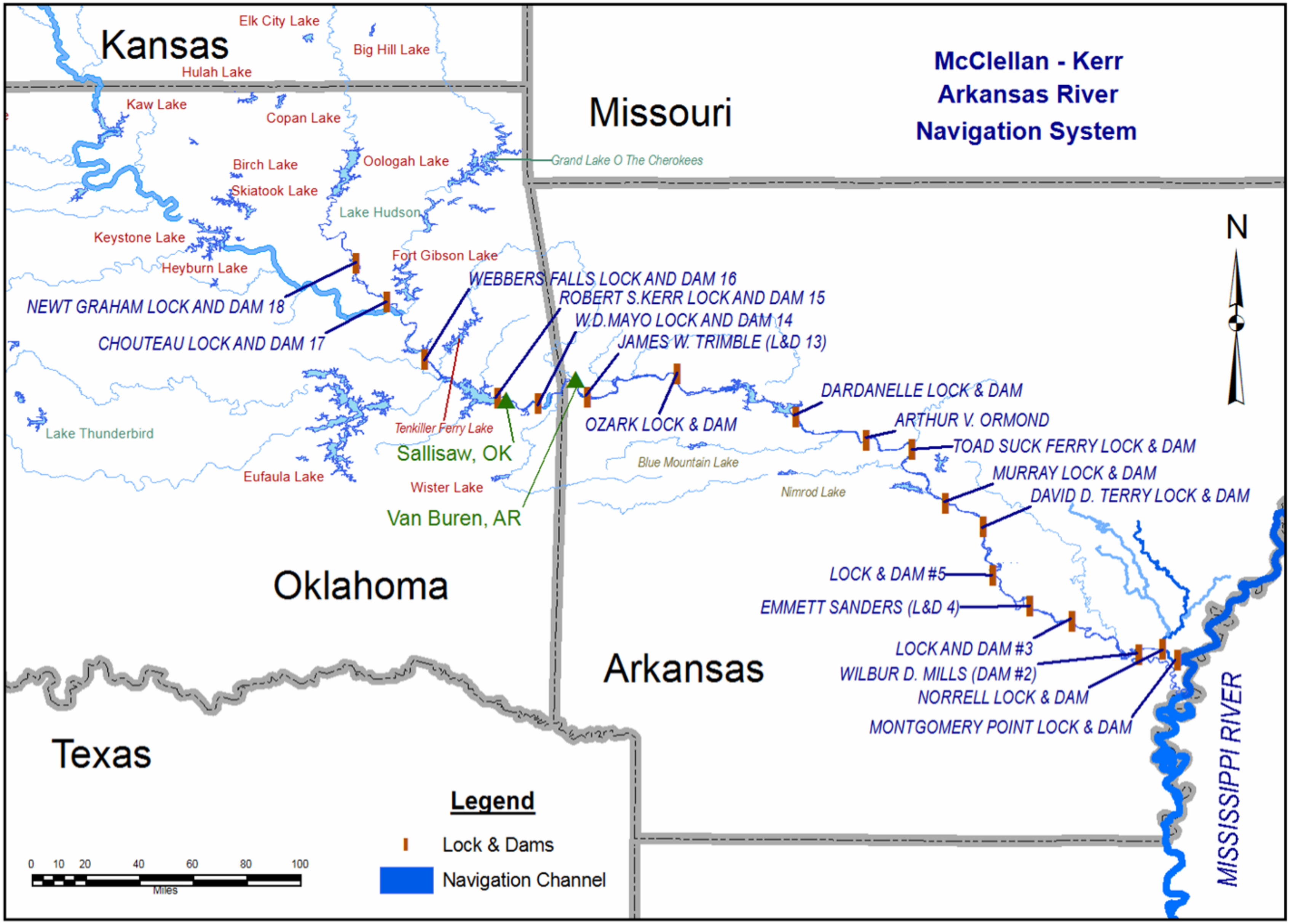


Table 1-1. Lock and Dam Structures on the MKARNS

Lock and Dam (L & D)	Construction Dates	Navigation Mile[1]	Elevation[2]
Oklahoma Lock & Dams			
Newt Graham L & D (No. 18)*	1966 to 1970	421.6	532 to 511
Chouteau L & D (No. 17)*	1966 to 1970	401.4	511 to 490
Webbers Falls L & D (No. 16)	1965 to 1970	368.9	490 to 460
Robert S. Kerr L & D (No. 15)	1964 to 1970	336.2	460 to 412
W. D. Mayo L & D (No. 14)	1966 to 1970	319.6	412 to 392
Arkansas Lock & Dams			
J. W. Trimble L & D No. 13	1966 to 1969	292.8	392 to 372
Ozark-Jeta Taylor L & D (No. 12)	1964 to 1969	256.8	372 to 338
Dardanelle L & D (No. 10)	1957 to 1969	205.5	338 to 284
Arthur V. Ormond L & D (No. 9)	1966 to 1969	176.9	284 to 265
Toad Suck Ferry L & D (No. 8)	1965 to 1969	155.9	265 to 249
Murray L & D (No. 7)	1965 to 1969	125.4	249 to 231
David D. Terry L & D (No. 6)	1965 to 1968	108.1	231 to 213
L & D No. 5	1965 to 1968	86.3	213 to 196
Emmett Sanders L & D No. 4	1964 to 1968	66.0	196 to 182
Joe Hardin L & D (No. 3)	1964 to 1967	50.2	182 to 162
Wilbur D. Mills Dam	1963 to 1968	40.5[3]	162 to AR
Lock No. 2**	1963 to 1967	13.3	162 to 142
Norrell L & D (No. 1)**	1963 to 1967	10.2	142 to ~115
Montgomery Point L & D	1998 to 2004	0.6[4]	~115

1) Navigation miles upstream from the mouth of the White River (WR); 2) Elevation in feet above mean sea level (msl) from upper pool to lower pool; 3) Miles upstream from the mouth of the Arkansas River (AR) at the Mississippi River (MR); 4) Navigation miles 0.6 of the White River Entrance Channel; * Verdigris River ; ** Arkansas Post Canal.

2 Alternatives Considered

Alternatives for achieving flow management, channel depth and widening, and navigation channel maintenance objectives along the Arkansas River were evaluated in Chapter 4 of the 2005 ARNS Feasibility Study. The 2005 ARNS Feasibility Study and FEIS are incorporated by reference and should be consulted for detailed information on the alternative formulation and evaluation process, as well as the other alternatives evaluated but not selected as the proposed action.

Under this SEA, the only alternatives evaluated will be the No Action Alternative and the MKARNS 12-Foot Deepening Component of the 2005 ARNS recommended plan. Features include design changes in dredging quantities; upland and in-water disposal acreages and locations; and the number, rock volumes, and locations of training structures. This section describes the 2005 12-foot Channel Deepening Project to provide a baseline for comparison of changes.

2.1 No Action

The No Action Alternative conditions and repercussions remain the same as outlined in the 2005 FEIS, modified to incorporate the implementation of the new flow management plan and DMMPs. The following statements characterize what would occur for each study feature/component under the No Action Alternative.

Navigation Channel Maintenance: Existing dredging and disposal to maintain the 9' navigation channel would continue. Dredged material would continue to be disposed of at existing sites until they reached their holding capacity. Only disposal sites approved in the 2018 SWT and SWL DMMPs would be used, and new sites identified in the 2018 DMMPs may need to be constructed and mitigated for.

Flow Management: The existing river flow management plan, implemented after the finalization of the 2005 ARNS, would be used.

Navigation Channel Depth: The current 9' navigation channel would be retained along the entire MKARNS.

In-water disposal was not approved by the Oklahoma Department of Environmental Quality in Oklahoma when the 1974 Operation and Maintenance Program EIS was approved. Therefore, future dredge material would have to be deposited in inactive terrestrial sites identified and approved in the 1974 EIS. Many of the terrestrial sites approved in the 1974 EIS have not been utilized since creation of the navigation channel, thus habitat characteristics on many of these sites have changed. Utilizing these sites would require significant re-working and additional mitigation for terrestrial impacts. Additionally, cultural resources investigations would be required for those previously approved locations and for any terrestrial mitigation areas, just as they would for the 12-foot channel.

2.2 MKARNS 12-Foot Channel Deepening

Alternative E – Navigation Channel Maintenance, Operations Only Flow Management, and 12-Foot Navigation Channel from the 2005 ARNS FR/EIS. This alternative was selected after careful analysis through the plan formulation process during the drafting of the feasibility study.

Since the 2005 FR/FEIS, river condition changes and new survey data have warranted modifications to the design of the MKARNS 12-Foot Channel. No significant changes to the plans themselves have been made; instead, the original design has been further refined and locations of design features have been modified. The MKARNS 12-Foot Channel design outlined in the 2005 FR/FEIS remains the proposed action with the following design changes.

2.2.1 Proposed River Training Structures

Approximately 85-90% of the Arkansas River is currently at a 12-foot depth or greater. Sustaining that depth and alignment for hundreds of miles requires construction of river training structures inside and outside of the remaining 10-15% footprint that is not currently at twelve feet of depth. The river training structures use the river's energy to naturally self-scour areas of built-up sediments overtime as well as support maintenance operations to keep the river to stay at a navigable depth. There are currently 1,314 existing dikes and weirs and 295 revetments on the MKARNS.

Some river training structures identified in the 2005 ARNS have already been constructed as funding was made available. Six structures have been built thus far: four in Pool 2 and two in Pool 7. The four constructed in Pool 2 still require additional work and are therefore included in the current list of proposed structures for modification. The two in Pool 7 have been completed and removed from the total in Table 2-1 below.

New training structures would need to be constructed in a similar manner as those constructed in the past throughout the life span of the MKARNS. Additionally, some of the existing training structures may require modification (e.g. reconstructing or lengthening) to perform as intended with a deeper channel. Proposed structures within the MKARNS system are considered either dikes or revetments. Both structures are constructed of rock and stone placed perpendicular to the river extending from the shoreline. The height, length, and width of structures vary depending on location and design needs. By evaluating historic dredging records and updated data collected, multidimensional models were created to determine river training structure needs, top elevations, lengths, and alignments, then the resulting rock quantity estimates. Average length is roughly 890 feet but ranges from 180 to 7,000 feet. Top width ranges between 10 to 20 feet. Slope on either side of the structure is typically 1.25 but up to 2.00. A typical design plan for these structures can be found in Appendix J, Additional Maps and Information.

The structures would be constructed entirely from the river, which limits the need for access roads along the river. The rock would be placed via hopper barges and then construction equipment, such as excavators, stationed on a separate flat-top barge would be used to place the rock more precisely creating the intended slope and dimensions of the structure.

For new structures, a section of the bank would need to be excavated to key the structures into the shoreline to prevent erosion and the river flanking the structure. Additionally, the bank line is paved with stone for a few hundred feet upstream and downstream of the key to also protect from flanking.

Table 2-1 below compares the quantity of new and modified river training structures, including dikes and revetments, proposed in the 2005 FR/EIS to those in the 2023 12-foot channel design. River training structures under the MKARNS 12-Foot Channel within the Tulsa District area of responsibility have not changed from the original feasibility plans at this time, however future survey and modeling efforts may result in changes. Changes have been made solely to those structures under the Little Rock District area of responsibility.

Table 2-1. Proposed River Training Structures and Revetments (2005 and 2023)

	2005		2023	
	New	Modification	New	Modification
Arkansas	85	98	18	84
Oklahoma	5	5	5	5
MKARNS 12-Foot Channel	**90**	**103**	**23**	**89**
Total New or Modified Training Structures	**193**		**112**	

2.2.2 Twelve-foot Channel Dredging

In order to deepen the navigation channel, underwater excavation ("dredging") is necessary. The initial excavation involves the removal of previously undisturbed materials and is referred to as “new work material.” After the initial excavation establishes a channel to the authorized depth, 12 feet in the case of the MKARNS, periodic or "maintenance" dredging must be done to keep the channel clear and safe for navigation. Maintenance dredging operations involve the repetitive removal of naturally recurring deposited bottom sediment such as sand, silt, and clays in an existing navigation channel. Once sediments are dredged from the waterway, they are referred to as "dredged material." The dredged material is then placed at a disposal location that has been identified in an authorized Dredged Material Management Plan (DMMP). The removal or excavation, transport, and placement of dredged sediments are the primary components of the “dredging process.”

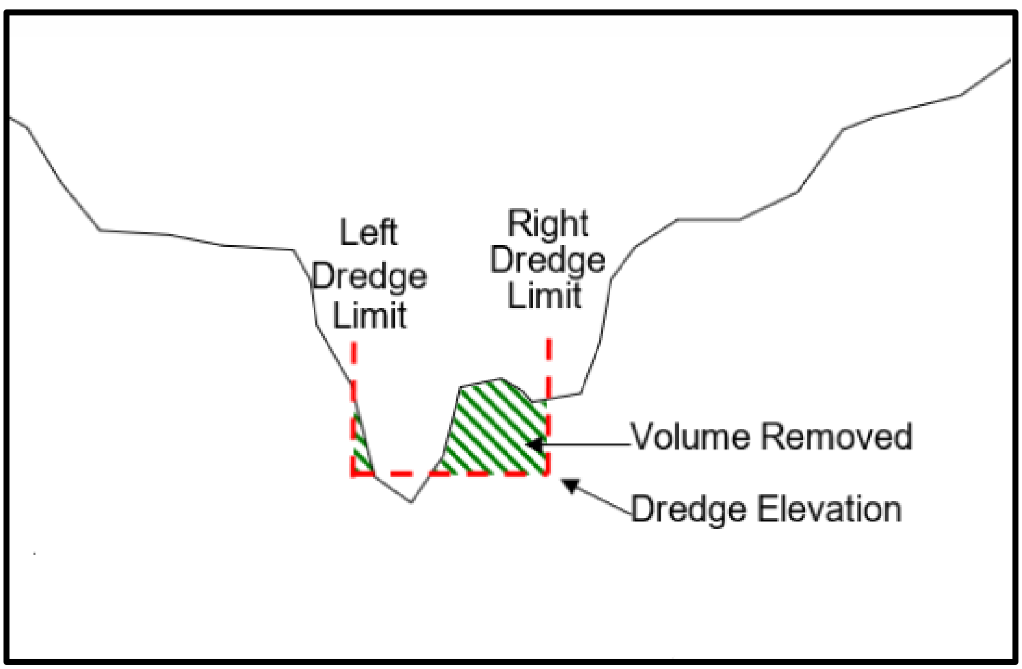
The MKARNS 12-Foot Channel alternative provides for the improvement of the Arkansas River and its tributaries by select modifications to dikes/revetments/jetties to promote navigation channel maintenance. The work includes bank stabilization; dikes, jetties, and revetments; dredging and disposal of material; land acquisition for dredge disposal sites; and environmental mitigation. The proposed project is divided into three separate components. The first will include the construction or modification of training structures that will allow the river to continue to self-scour naturally over time, minimizing the total amount of mechanical dredging that is required. The second component of the proposed project will include river dredging in Arkansas and Oklahoma. The final component addresses the disposal locations for the dredged material. Included with this SEA is the draft “MKARNS Dredge Material Management Plan” dated January 2024 that outlines the dredging process and problem areas for the MKARNS and includes descriptions of authorized disposal sites (Appendix K). This new DMMP encompasses the entire project area and would serve to update the existing SWT and SWL DMMPs dated 2018. While the new DMMP would replace those from 2018, the majority of the disposal sites identified in the 2024 DMMP overlap with those identified in the 2018 documents, which were developed in line with disposal sites identified in the 2005 FR/EIS. This project will include the use of both upland and in-water disposal locations that will be used for the deposition of dredge materials.

2.2.2.1 *Dredging (Excavation of Material)*

Dredging is the process of removing sediment from the bottom of the river within the navigation channel and placing it elsewhere outside the channel to maintain a navigable depth for industry. There are many different types of dredges as well as many mitigation strategies to lessen the amount of dredging needed or to provide utility of the dredge disposal material. Neither sedimentation nor the physical act of dredging are exact sciences or procedures. Hydrographic survey data of the river bottom is essential to estimating quantities; however, the riverbed of alluvial systems, such as the Arkansas River, are constantly changing.

Under this alternative, the current 9-foot navigation channel would be deepened to a 12-foot navigation channel throughout the entire length of the MKARNS. To reach a depth of 12 feet, mechanical and hydraulic dredging will be used to remove material throughout the length of the river where and when necessary. Figure 2-1 below depicts a typical dredge cross-section.

Figure 2-1. Typical Dredge Cross-Section



Mechanical and hydraulic dredging operations would take place in all areas where river training structures were unsuccessful or unable to maintain the required depth without dredging. The action does not include channel widening. No dredging would occur outside the currently authorized navigation widths of 250 feet on the Arkansas, 300 feet on the White, 150 feet on the Verdigris, and 225 feet on the Sans Bois, as authorized, which includes tapering for the lock approaches.

Dredging will be accomplished by two different mechanisms:

- Hydraulic dredging—Removal of loosely compacted materials by cutterheads, dustpans, hoppers, hydraulic pipeline plain suction, and sidecasters, usually for maintenance dredging projects.
- Mechanical dredging—Removal of loose or hard, compacted materials by clamshell, dipper, or ladder dredges, either for maintenance or new-work projects.

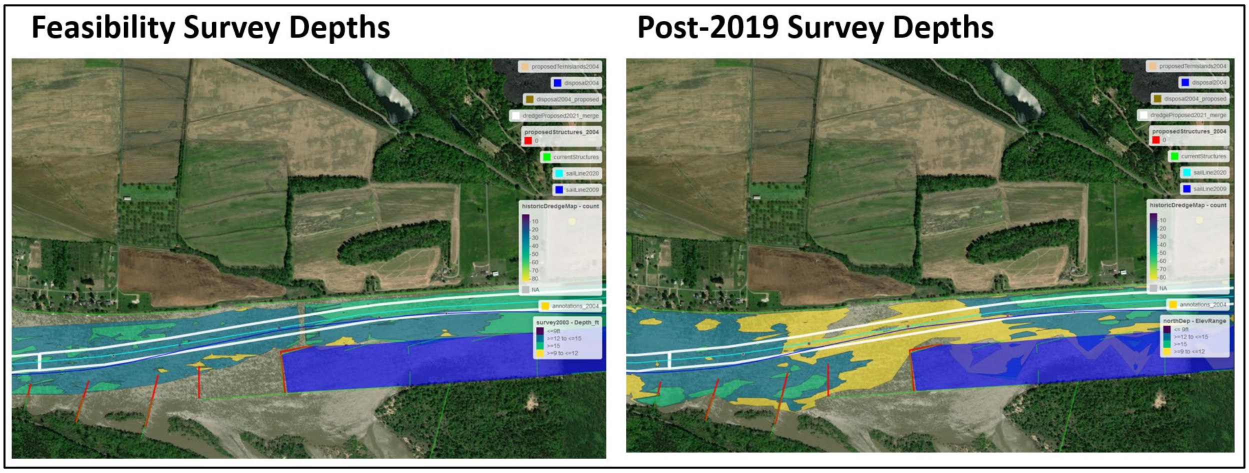
Mechanical dredges remove bottom sediment through the direct application of mechanical force to dislodge and excavate the material at almost in situ densities. Backhoe, bucket (such as clamshell, orange-peel, and dragline), bucket ladder, bucket wheel, and dipper dredges are types of mechanical dredges. Sediments excavated with a mechanical dredge are generally placed into a barge or scow for transportation to the disposal site.

Hydraulic dredges remove and transport sediment in liquid slurry form. They are usually barge mounted and carry diesel or electric-powered centrifugal pumps with discharge pipes ranging from 6 to 48 inches in diameter. The pump produces a vacuum on its intake side, and atmospheric pressure forces water and sediments through the suction pipe. The slurry is transported by pipeline to a disposal area. Hopper dredges are included in the category of hydraulic dredges for this SEA even though the dredged material is simply pumped into the self-contained hopper on the dredge rather than through a pipeline. It is often advantageous to overflow hopper dredges to increase the load; however, this may not always be acceptable due to water quality concerns near the dredging site.

Proposed locations for dredging have changed since the completion of the 2005 FEIS in response to river condition changes and new data warranting updated plans, as well as new technologies for hydrographic surveying. Due to the record flood of Spring 2019, among other flooding events, the expected locations and quantities of dredging identified in the original feasibility design are different.

The side-by-side images in Figure 2-2 below show the different sets of hydrographic surveys and other river features at a crossing in Pool 7 as an example of the differences that needed to be addressed through project design changes. In the images, the dark blue polygons represent existing disposal sites and red lines depict proposed structures. The color scheme ranging from yellow to teal represents the surveyed depths of the river during feasibility and after the 2019 flood. Yellow indicates water depths between nine and 12 feet, teal indicates depths between 12 and 15 feet, and green indicates areas greater than 15 feet in depth. This depiction showcases how water depth decreased in certain locations along the Arkansas River as a result of the 2019 flooding events.

Figure 2-2. Feasibility vs. Post-2019 Flooding Survey Depths at Pool 7



While the MKARNS system will continue to change, the current quantity of proposed dredge sites by state compared to those proposed in 2005 is depicted in Table 2-2.

Table 2-2. Proposed Dredge Sites

Location	2005 Proposed Dredge Sites	2023 Proposed Dredge Sites
Oklahoma	45	45
Arkansas	28	51
Total	**73**	**96**

Detailed analyses of recent bathymetric and lidar survey data conducted by the SWT and SWL H&H Divisions determined an approximate 46.6 percent (%) reduction in total proposed dredge quantity (5,791,099 M cubic yards [cy]) from the 2005 FR/EIS estimated quantity of 10,840,245 M cy.

The SWT current proposed dredging needs (2.86 M cy) decreased to approximately 45% from the 2005 estimate (6,320,552 M cy). While the estimated quantity of dredge material has decreased, the locations of dredging needs – coupled with available capacity in existing dredge disposal sites has identified the need for 37 new upland disposal sites for future dredging needs to deepen and maintain a twelve-foot navigation channel. The locations for these proposed upland dredge disposal sites have been identified and preliminary reviews have been conducted for environmental and cultural compliance. Some of the proposed upland disposal sites identified in the 2005 FR/EIS have been retained, while others have been either relocated or eliminated. One notable change from the 2005 FR/EIS is that aquatic disposal sites in Oklahoma, excluding sites proposed for creation of sandbar islands, are not being considered as part of the MKARNS 12-Foot Channel Project at this time. A detailed discussion of the environmental and cultural reviews and required compensatory mitigation are discussed elsewhere in this SEA and appendices.

The SWL H&H Division analyses determined a total of 51 sites that will need dredging to facilitate a 12-foot navigation channel. Current dredge quantities estimated (2.93 M cy) is approximately 35.2% less than that proposed in the 2005 FR/EIS (4,664,787 M cy). Due to changes in riverbed conditions that have occurred since 2005, 26 sites identified for dredging in 2005 do not require dredging at this time, while 9 new sites will require dredging. Existing and proposed dredge disposal sites identified in the 2005 FR/EIS for the Arkansas portion of the

MKARNS is anticipated to be sufficient for the updated dredge quantities.

Table 2-3 compares the dredging quantities by river segment required for the 12-foot channel deepening in 2005 and 2023. Depicted in the table, the quantity of dredge material to achieve the 12-foot channel has reduced by more than half compared to the quantities identified in the 2005 FR/EIS. Additional information on the updated dredging quantities can be found in the data tables provided in Appendix A and maps in Appendix B.

Table 2-3. 2005 vs. 2023 Proposed Dredging Quantities by River Segment

Location	2005 Proposed Dredging Quantity (CY)	2023 Proposed Dredging Quantity (CY)
Mouth to Pine Bluff	2,066,867	938,431
Pine Bluff to Little Rock	445,995	46,933
Little Rock to Dardanelle	925,439	757,654
Dardanelle to Fort Smith	1,226,500	1,358,277
Fort Smith to Muskogee	3,256,749	2,334,785
Muskogee to Catoosa	3,063,790	355,019
Total	**10,985,339**	**5,791,099**

Maintenance dredging is anticipated to occur on an as-needed basis to maintain the 12-foot channel depth, typically on an annual basis. Quantities dredged and disposed of vary annually based on river flows and sediment depositional patterns in the navigation channel. Between 1995 and 2003, the annual maintenance dredging volumes on the MKARNS ranged from approximately 378,000 cy to 1,145,000 cy. Table 2-4 depicts projected annual maintenance dredging quantities identified in the 2005 FR/EIS and the most up-to-date quantities calculated in 2021.

Table 2-4. Projected Annual Maintenance Dredging by Quantities by State

	Feasibility (million CY)	2021 Update (million CY)
Arkansas	1.48	2.31
Oklahoma	0.32	0.14
MKARNS	1.80	2.45

2.2.2.2 *Disposal of Dredged Materials*

After the sediment has been excavated, it is transported from the dredging site to the designated disposal area, as identified in the DMMP. This transport operation can be accomplished by the dredge itself or by using additional equipment such as barges or pipelines with booster pumps.

For the MKARNS 12-foot Channel Deepening Project, the collected and transported dredged material is placed in upland sites or in-water disposal sites. It is anticipated that up to 37 new upland sites will be needed throughout the Oklahoma section of the project and 2 new sites within Arkansas. Additionally, this project is anticipated to use up to 170 in-water sites (129 existing; 41 proposed new), all of which are within in the Arkansas section of the river. These sites have been identified for use and are assumed to be the worst-case scenario, but as surveys continue and the final quantities of dredged materials are known, only those needed will be constructed.

USACE has developed a Sediment Testing Protocol for the purpose of evaluating sediments prior to disposal into any site. As part of the dredging process, a determination of the potential for contaminant-related impacts associated with the discharge of dredged material in waters regulated under Section 404 of the Clean Water Act must be performed. The USACE utilizes the technical guidance presented in the EPA and USACE Evaluation of Dredged Material proposed for Discharge in waters of the U.S. Testing Manual, commonly referred to as the Inland Testing Manual (EPA/USACE 1998), and EPA regulation 40 CFR Part 230, (Guidelines for Specification of Disposal Sites for Dredged or Fill Material) and the USACE operation and maintenance regulations 33 CFR Part 335-338 when determining the need for sediment analysis. Further information on the feasibility-level HTRW analysis involving records review database queries conducted as part of this SEA is included in Appendix G.

2.2.2.2.1 Proposed Upland Disposal Sites

Upland Disposal is the placement of a dredged material into a secure area where the sediment is physically contained. These sites are diked structures that have been built for the disposal of dredged material where in-water placement and beneficial use are not feasible or environmentally acceptable. The size, shape, design and level of complexity of these facilities will vary widely depending on dredging quantities, methods of disposal, sediment contamination levels, state and local requirements and site characteristics.

For the MKARNS, the disposal sites are located on land as close as possible to areas along the navigation channel that are expected to require dredging. This will allow the dredged materials to be effectively piped directly from the barges and minimize pumping distances or the need for multiple booster pumps.

To prepare the upland sites for use, they are first surveyed for natural and cultural resources and redesigned to minimize impacts if possible. Following surveys, the usable section of the disposal property is cleared of all vegetation and a containment dike is constructed around the site. The material needed to construct the dike is often excavated from existing clay sediments on site (in-situ), but if the sediments on site are insufficient in quantity or quality/type, commercial material may be brought in or material from the channel may be used, if appropriate. After the dike is constructed, appropriate dewatering structures or outlets are constructed and will remain part of the structure over the long-term. Temporary access roads and staging areas will be constructed to facilitate in the construction and filling of the placement area.

Once the disposal site is constructed, the material can be placed therein. The material settles over time and liquids are released out of the containment area back into the channel through the dewatering or outlet structure. Once the sediments are sufficiently dewatered, the materials are stabilized using heavy equipment to create appropriate slopes and compaction to avoid erosion and create enough space in the site for future use during maintenance dredging operations. The dikes will be regularly inspected to ensure the integrity of the structure and conduct repairs if necessary. Vegetation may grow within the site but will be removed and/or covered up when maintenance material is placed at the site.

These sites will remain in use until full or until maintenance dredging is no longer necessary. The method for closure is highly dependent on the quantity of material, type of material, and duration on the landscape. The site and all material will simply remain on the landscape and allowed to revegetate.

The locations of proposed upland disposal sites have changed slightly from those identified in the 2005 FEIS in response to the changes in location and quantity of dredging. Table 2-5 identifies the 39 proposed new upland disposal sites by state, area permanently disturbed, and area temporarily disturbed. Permanently disturbed areas are those areas that will hold dredged material in perpetuity. Temporarily disturbed areas are those that may be used for access, staging, or other short-term purposes to facilitate the creation and/or use of the upland disposal sites, but will not be permanently utilized. Estimated acreages particularly for temporarily disturbed area are extremely conservative, and these acreages will likely decrease as engineering and design plans are further refined. These sites have been identified to avoid productive habitat to the greatest extent practicable; however, for those locations in which permanent adverse impacts cannot be avoided, habitat mitigation will be implemented to alleviate impacts to forested and emergent wetland habitats. Temporarily disturbed areas will be restored or allowed to revegetate over time after construction is completed, thus mitigation is not required. For more detailed information on the proposed upland disposal sites, see the data tables in Appendix A and maps in Appendix B.

Table 2-5. Proposed New Upland Disposal Sites

	2005 Upland Disposal Sites		2023 Upland Disposal Sites	
	Maintenance	Deepening	Maintenance & Deepening	
			Oklahoma	Arkansas
Number of Sites	14	41	37	2
Permanently Disturbed Area (acres)	Not available	915.00	666.45	142.00
Temporarily Disturbed Area (acres)	Not Available	Not Available	2,159.46	55.50

2.2.2.2.2 Proposed In-Water Disposal Sites

Open water placement on the MKARNS involves the discharge of dredged material directly into the river. Hydraulically dredged material may be discharged by pipeline into the site while mechanically dredged material may be placed in bottom-dump barges or scows and towed to the disposal sites. Discharged dredged material settles through the water column and deposits on the bottom at the disposal site. The dredged material may remain in a mound at the site or disperse depending on the material's physical properties and the hydrodynamics of the disposal site.

The disposal locations are typically located along the edges of the river, in areas where it is unlikely the sediments will end up back in the navigation channel. Additionally, most are placed behind hardened structures such as dikes, training structures, or containment structures built to further prevent materials from re-entering the channel. The areas used for in-water disposal sites are first surveyed and any containment structures are constructed prior to filling.

All proposed new and existing in-water dredge material disposal sites are located within the State of Arkansas. Two of the proposed sites included in the 2005 FEIS are no longer viable for use due to permitting issues. In-water disposal sites proposed to be constructed under the 2023 DMMP have been selected based on proximity to the updated dredging locations. Table 2-6 below depicts the quantity and area of in-water disposal sites planned for the use of dredged material disposal under the 2005 authorized plan compared to those proposed in the MKARNS 12-foot Channel Deepening Project, both existing and new. Note that the 2005 plans did not differentiate between existing in-water disposal sites and those that would be new construction. Further information on new in-water disposal sites can be found in Appendix A. Existing disposal sites are those that have preexisting permits, while proposed new in-water disposal sites are those for which permitting will need to be obtained.

Table 2-6. Arkansas Existing and Proposed New In-Water Disposal Sites

	2005 In-Water Disposal Sites		2023 In-Water Disposal Sites	
	Quantity	Total Area (Acres)	Quantity	Total Area (Acres)
Existing Disposal Sites*	Not available	Not available	129	11,328.26
Proposed New Disposal Sites	31	6,451.0**	41	1,280.01
Total	**31**	**6,451.0**	**170**	**12,608.27**

* Existing in-water disposal sites proposed for use under the 2005 proposed action were not identified clearly in the 2005 FR/EIS, therefore they are not available for comparison in this table.
**Four in-water disposal sites identified in 2005 were not calculated for acreage and therefore not included in the total area summation. These four sites were located in the Robert S. Kerr pool.

2.2.2.2.3 Beneficial Use of Dredge Material

In an effort to beneficially use dredged material, 30 sites have been selected for development into sandbar island habitats. These locations are depicted in the maps in Appendix B and did not change from those planned in the 2005 FR/EIS. Islands created with dredged material can provide quality stopover habitats during migration for many bird species, including piping plover and red knots, which are both federally listed and protected species.

The construction of the islands uses a combination of in-water and confined disposal in which the slurry of water and dredged material exiting the outflow pipe is channeled to the desired location via small, temporary berms. The berms are constructed prior to initiation of dredging and usually surround most of the disposal area. A bulldozer or other earth shaping equipment is used to direct the effluent, eventually guiding it to an open area within the berm, avoiding areas of high environmental concern. The temporary berms are then graded to the desired slope when the pumping of dredged material has been completed and the template profile of the island has been achieved. Shoreline stabilization is generally not needed or recommended for the berms.

A dredged material island is rarely a perfect, inverted cone-shaped feature. Most often it consists of a lower drift ridge and swale, an upper drift ridge and swale, a steeper slope leading to the dome, and the dome itself. The size, shape, and elevation of the island is dependent on the quantity and quality of material available, desired location, and any other permitting requirements, but is generally modeled after natural islands in the area. A typical sandbar island made from dredge material is shown in Figure 2-3 below.

Figure 2-3. Typical Dredge Material Sandbar Island

Periodic nourishment of an island is usually needed every three to seven years to maintain its size and appropriate seral stage which will be supported by maintenance dredging. Islands constructed in open water where an island or emergent shoal did not previously exist may also require periodic nourishment to repair or offset erosion of the island.

2.2.3 Location Priorities

2.2.3.1 *Oklahoma*

Construction of the proposed upland disposal sites in Oklahoma have been organized by phase in relation to existing river depths and therefore urgency (Table 2-7). Sites included in Phase 1 are for shallower, heavily trafficked areas of the MKARNS, thus necessitating more urgent dredging, while disposal locations in Phase 4 are related to dredging locations of greater depth and therefore less urgency.

Table 2-7. Oklahoma Upland Disposal Sites by Phase

SWT Upland Disposal Sites			
Phase 1	**Phase 2**	**Phase 3**	**Phase 4**
11	18	0	1
21	13	6	2
27	15	10	20
28	24	14	7
34	29	16	12
Alt 4	31a	32	33a
	Alt 20	35	36a
	22	38	37
	30	41	1a
		40	4a
		39	18a

2.2.3.2 *Arkansas*

The Little Rock District is focusing first on implementing rock river training structures. The new and modified training structures would be implemented by pool priority, and the sequence of their construction would be dependent on the success determined by monitoring and modeling existing training structures. This tiered approach is by dike field within each pool and will change by individual dike as additional information is gathered and design plans are narrowed down.

Tiers will be updated as conditions change, consistent with larger scale inland navigation O&M and the original MKARNS 12-foot channel design and construction plans. Currently, Pools 5, 8, and 10 are being prioritized as they are of low risk but high benefit to the system.

Table 2-8. Arkansas Training Structures by Tier

Tier	Components
Tier 0	Construction to 12-foot channel design with previous earmark, noting for record.
Tier 1	Construction in locations of high risk of shoaling. Existing depths are nine to 12 feet, or required downstream protection feature.
Tier 2	Construction in locations of moderate risk of shoaling. Existing depths are roughly 15 feet or greater, or downstream protection feature.
Tier 3	Construction in locations of low risk of shoaling. Existing depths are roughly 15 feet or greater, or downstream protection feature.
Tier 4	Construction in locations of potential risk of shoaling after other tiers. Existing depths are 12-15 feet, or downstream protection feature.
Tier 5	Construction in locations of potential risk of shoaling after other tiers. Existing depths are roughly 15 feet or greater, or downstream protection feature.

The two proposed upland disposal sites in Arkansas are located adjacent to the Arkansas Post Canal and would be built as needed after the first few tiers have been constructed and monitored as dredging quantity needs may change. The proposed upland disposal site locations were selected to avoid, wherever possible, mature upland forest, bottomland hardwood forest, and wetlands. Where sites could not be located outside these habitat types, the design of the pit will be configured to minimize impacts as much as possible. Priority was given to sites on USACE owned land. If suitable USACE land was not available, the team looked for private agricultural lands and possible in-water disposal locations where there was the potential for beneficial use of the dredged material (Arkansas only). This ultimately reduced the acreage of land needed for mitigation. The construction of upland disposal sites in Oklahoma will be constructed in four phases. The final location of disposal sites will be determined as each phase is funded and detailed design begins. Thus, the potential exists to further minimize adverse impacts to significant natural resources (i.e., bottomland forest and aquatic sites). The two sites identified for upland sites in Arkansas would be constructed on current agricultural land, which will avoid impacts to significant resources.

3 Affected Environment

This chapter presents the existing conditions of the project area and is organized by resource topic, including the status of the affected environment described. Potential effects of each alternative on those resources are analyzed in Chapter 4. The geographic scope of analysis includes the entirety of the MKARNS from the Port of Catoosa to its confluence with the Mississippi River. Chapter 4 – Existing Conditions – of the 2005 ARNS FEIS is hereby incorporated by reference to describe the affected environment for many of the resource areas.

3.1 Resources Analyzed and Resources Excluded from Detailed Analysis

USACE revisited the 2005 EIS to determine which resource areas have differing existing conditions since the initial evaluation or will experience different impacts from the updated design, therefore requiring updated analysis in this SEA. Some resource topics were eliminated from further analysis in this SEA because effects attributable solely to the proposed action would be negligible, or the design refinements described in the proposed action would not create additional impacts on these resources beyond the scope of those evaluated in the 2005 FEIS. The list of resources and rationale for level of analysis is located in Table 3-1.

Table 3-1. Resources Analyzed and Resources Excluded from Detailed Analysis

Resource	Have the existing conditions measurably changed in the study area since the 2005 EIS?	Will the 2023 design update have impacts greater than those considered in the 2005 EIS?	Detailed analysis included in SEA?
Air Quality	No Change	Implementation of the updated design may affect emissions regulated under the National Ambient Air Quality Standards.	Yes
Climate Change and Greenhouse Gas	Yes – new EOs and regulations have been issued requiring analysis.	Yes – this resource was not evaluated in the 2005 EIS.	Yes
Noise	No Change	No – Dredging need has been reduced since 2005 resulting in less impacts than originally described. Equipment and methodologies have not changed that would cause more noise disturbance.	No
Geology and Soils	Yes – Changes in river morphology and sediment load have occurred over time due to flooding and natural river movement.	Yes – Updated dredging quantities and disposal site locations may result in impacts differing from the 2005 ARNS EIS.	Yes
Surface Waters	Yes – Flooding, droughts, and natural river morphology have affected where surface waters are present. As well, the Clean Water Act has revised regulations since 2005.	Yes – additional placement areas are being considered and could affect the resource.	Yes
Land Cover and Land Use	No Change	Yes – Updated locations for upland disposal sites will alter land use where new placement sites have been proposed.	Yes
Infrastructure	No Change	No – The proposed design updates do not require	No

Resource	Have the existing conditions measurably changed in the study area since the 2005 EIS?	Will the 2023 design update have impacts greater than those considered in the 2005 EIS?	Detailed analysis included in SEA?
		modification of existing infrastructure such as locks, dams, reservoirs, buildings, roadways, etc. Note: river training structures were included as an infrastructure consideration in 2005 but has since been included as a consideration for multiple resources since they are project features and would not exist on the landscape if it were not for this project.	
Transportation	Yes – Considered as part of the infrastructure category but not thoroughly analyzed.	Yes – Impacts were not fully analyzed in 2005.	Yes
Biological Resources	Yes – New species have been listed under the ESA	Yes – Additional placement areas are being considered and could affect the various habitats and species and result in different unavoidable impacts and mitigation requirements.	Yes
Recreation and Aesthetic Values	No Change	No – The additional placement areas and changes in dredging location would not impact recreation or aesthetic values differently.	No
Cultural Resources	Yes – Additional placement areas affects the Area of Potential Effect (APE), and these new areas must be considered for the presence of cultural resources.	Yes – Additional placement areas affects the APE, and these new areas must be considered for the presence of cultural resources.	Yes
Socio-economics and Environmental Justice	Yes – The socioeconomic condition of the study area has likely changed since 2005 as urbanization and development have occurred, and these changes are expected to be minimal; however, new Environmental Justice regulations and policies have been implemented in the meantime, warranting reevaluation in this SEA.	No – No significant changes in impacts to socioeconomics from the 2005 ARNS EIS. Dredging quantities have decreased from 2005 and placement areas remain in rural, uninhabited areas and impacts are not expected to differ significantly from those identified in 2005.	Yes

3.2 Air Quality

The Clean Air Act (CAA) of 1970 is the comprehensive federal law that regulates air emissions from stationary and mobile sources. Among other things, this law authorizes the Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS) to protect public health and welfare and to regulate emissions of hazardous air pollutants. NAAQS define the maximum permissible concentrations of six pollutants, known as criteria pollutants. The criteria pollutants include Carbon Monoxide (CO), Lead (Pb), Nitrogen Dioxide (NO_2), Ozone (O_3), Particulate Matter (PM_{10} and $PM_{2.5}$), and Sulfur Dioxide (SO_2). Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

The EPA directs states to develop state implementation plans (SIPs), applicable to appropriate industrial sources in the state, in order to achieve these standards. Oklahoma and Arkansas have both developed Air Divisions that are responsible for facilitating the departments' responsibilities for NAAQS attainment issues, air emissions permitting, and development and enforcement of air regulations and initiatives.

The Oklahoma Department of Environmental Quality (ODEQ) Air Data Report 2022 represents the most current data available on the state's compliance with NAAQS. The report states that the State of Oklahoma is in attainment for all criteria pollutants. Several Oklahoma monitoring sites have not surpassed but are close to exceeding the acceptable primary and secondary standards for ozone, specifically in the Oklahoma City area, but are still within attainment (ODEQ 2022a). Prevailing winds are from the south to southeast throughout most of the state from the spring to autumn months, and the winter regime is roughly split between southerly and northerly winds. Because Oklahoma City is to the east of the study area, prevailing winds are not expected to carry any potential air contaminants from the project area to areas nearing nonattainment.

The Arkansas Department of Energy and Environment (ADEE), Office of Air Quality, works to meet Arkansas' federal obligations under the CAA. All counties within the State of Arkansas encompassing the MKARNS are in attainment for all NAAQS criteria pollutants (EPA 2023a).

Although there are some metropolitan areas located along the MKARNS, there are no major emission sources located on the waterway. Sources on the waterway are either stationary such as fossil fuel power plants located along the system, or mobile sources including towboat engines and recreational powerboat engines or recreation area traffic.

3.2.1 Stationary Emissions Sources

The primary pollutants produced through non-mobile sources that occur within the MKARNS study area are nitrous oxides, SO_2, and CO. Primary stationary emission sources along the MKARNS include power plants, pulp mills, sawmills, petroleum refining, cement factories, soybean oil mills, nitrogenous fertilizer factories, limestone and gypsum companies, and industrial inorganic chemical plants.

3.2.2 Mobile Emissions Sources

The primary pollutants produced through mobile emission sources are CO, nitrous oxides, hydrocarbons, and PM. Emissions produced in utilizing barges for transportation are generally much lower than those produced by to truck or rail transportation. The Texas Transportation Institute evaluated the emissions produced by three modes of transportation: truck (highway), rail (train), and inland towing (barge). Depicted in Table 3-2 below, the impact on air quality from the use of barges through inland navigation towing is significantly less than other modes of transportation, resulting in the utilization of less fossil fuels and production and release of fewer air pollutants.

Table 3-2. Fuel Efficiency and Emissions of Transportation Modes

Transportation Mode	Ton-Miles/Gallon of Fuel	Emissions (tons-emissions/10^6 ton-miles)
Truck	155	71.61
Rail	413	26.88
Inland Towing	576	19.27

In 2005, the inland waterways logged an estimated 274.4 billion ton-miles of activity. Given the above calculations, if this inland waterway activity occurred on the railroads an additional 2.1 million tons of emissions would have been produced, and on highways an additional 14.4 million tons (Texas Transportation Institute 2009).

3.3 Climate Change and Greenhouse Gas Emissions

Greenhouse gases (GHGs) are those gases that trap heat in the atmosphere, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases. While some GHGs are produced through natural processes, anthropogenic sources of GHG emissions include the burning of fossil fuels, solid waste, and biological materials; certain chemical reactions, such as cement production; livestock and other agricultural practices; land use; decaying of organic waste; industrial activities; and various household, commercial, and industrial applications and processes. CO_2 emissions make up almost 80% of national GHG emissions, and 35% of CO_2 emissions are related to transportation (EPA 2023b). Although natural processes like plant photosynthesis can absorb some anthropogenic GHG emissions, current production rates are causing a continued increase in atmospheric concentrations of GHGs, which may raise the average surface temperature of earth over time. Rising temperatures can produce changes in precipitation patterns, storm severity, and sea level. These impacts are collectively referred to as climate change.

Similar to the NAAQS sources listed above, significant sources of GHGs in the study area include industrial sources such as power plants, petroleum refining, and other product plants utilizing chemicals; transportation, primarily by road and rail; and agricultural practices.

3.4 Geology and Soils

The existing condition of geology and soils to include topography, geology, soils, alluvial sediment, and hydrogeology, has not changed significantly since the 2005 ARNS FEIS. More detailed information on geology and soil resources can be found in Section 4.4, Geology and Soils, of the 2005 ARNS FEIS.

The difference in elevation from the beginning of the MKARNS at the Port of Catoosa to the confluence with the Mississippi River is 410 feet. The study area traverses many physiographic regions in Arkansas and Oklahoma, including the Ouachita Province, the Ozark Plateau Province, and the Mississippi Alluvial Plain.

3.4.1 Geology

The rocks that underly the Ouachita and Ozark Provinces are Paleozoic (Cambrian to Pennsylvanian) in age. The Ouachita Province bedrock is fractured, faulted, and folded shale, sandstone, limestone and cherty-novaculite rocks, whereas the Ozark Province consists of well-consolidated, flat-lying to south dipping, fractured carbonate and clastic rocks. The Mississippi Alluvial Plain consists of alluvial deposition with underlying material similar to the Coastal Plain - Mesozoic to Cenozoic (Jurassic to Quaternary) in age (ADEE 2005).

3.4.2 Soils

Within the MKARNS, deposition and down-cutting by major rivers and streams were extensive from the end of the Tertiary period to the Quaternary Period. This on-going pattern of erosion and deposition left a series of alluvial depositions as the streams progressively lowered their beds. The more recent alluvial terraces are only a few feet above the current floodplain. The alluvium is the most recent depositional material within the confines of the current floodplain.

In Oklahoma, the Arkansas River from the Port of Catoosa down to Fort Smith lies within the Central Irregular Plains, Boston Mountains, and Arkansas Valley ecoregions. The length from Tulsa to Muskogee is characterized by irregular to undulating plains that are broken by low hills and cuestas, or hills with a steep face on one side and gentle slope on the other. Here, the soil is deep, loamy, and moderately acidic with gentle to steep slopes. The predominant soil complex in this area is the *Hector-Endsaw* which appears to the south and sometimes north bank of the river where soil is loamy, rocky, and well drained on steep slopes. The north bank of the river sees *Kamie-Larton-Porum* soils intermittently, characterized by very deep, loamy soils on gentle slopes (Carter and Gregory 2008).

From Muskogee onto the northwestern portion of Arkansas where the Arkansas River enters the state through Sebastian County, the Arkansas River valley is characterized by rolling flat-topped hills, long narrow ridges and broad valleys. The hilltops and ridges are mostly underlain by shale. The mountaintops and hilltops are generally *Mountainburg-Linker* soils, which are well drained, gently sloping to steep, deep, loamy soils. *Enders-Mountainburg* soils are well drained, gently sloping to steep, deep and shallow, loamy soils on narrow ridges. The fertile bottomlands of the valleys are generally *Leadvale-Taft*, which are moderately well drained to somewhat poorly drained, level to sloping, deep, loamy soils with a fragipan, with the *Wrightsville* association is on old stream terraces. The Arkansas River floodplain soils include the *Crevasse* association, which is excessively drained, level and nearly level, deep soils that are sandy throughout, and the *Severn-Iberia Norwood* association, which is well-drained to poorly drained, dominantly level, deep, loamy and clayey soils. These two associations frequently run parallel and adjoining each other, with the Crevasse association typically found to the north of the other (NRCS 1975).

The southeastern portion of the study area within the State of Arkansas is represented by Desha County (NRCS 1972a) and limited southern portions of Arkansas County (NRCS 1972b), which includes the area of the confluence of both the Arkansas and White Rivers with the Mississippi River. Soil types range from loamy soils along bayou ridgetops to predominantly clay in lower elevations. In this area, the *Herbert-Rilla-McGee* association is level and nearly level, somewhat poorly drained to well-drained, loamy soils found along ridgetops of the bayous. The *Sharkey-Commerce-Coushatta* and *the Perry-Rilla-Portland* associations are generally level bottomlands along the Arkansas River, which are poorly drained to well-drained, clayey and loamy soils. The *Sharkey-Desha* association is level and gently undulating, poorly drained to somewhat poorly drained, predominantly clayey soils on lower broad floodplain terraces.

The transition from the mountainous physiography of northwestern Arkansas to the deltaic characteristics of the southeastern portion of the MKARNS occurs gradually along its southeasterly progress through the State of Arkansas, but it is most pronounced through the Little Rock area.

3.4.3 Alluvial Sediment

During periods of high river flows, water velocities cause river sediments in the form of silt and sand, to be carried in suspension. As river flow decreases and velocities slow, the heavier suspended materials are dropped, and shoals develop in eddies and slower moving water. When these shoals occur in the navigation channel, they are removed by cutter head suction dredges to maintain the MKARNS navigation channel to authorized depths and dimensions. Dredged materials are disposed of in designated disposal areas on shore adjacent to the river or behind bank stabilization and channel alignment structures. On the Verdigris River, the dredged sediment is suitable for tilling and planting with grasses, as has been done in the past. The material dredged from the Arkansas River is sand and is not suitable for planting. Dredged material is historically free of contaminants where the material is composed primarily of sand, gravel, or similar materials and is found in areas of high current or wave action. Maintenance dredged material from the Arkansas River is primarily composed of sand and relatively free of pollutants (USACE 2003).

3.4.4 Prime and Unique Farmlands

The Farmland Protection Policy Act (FPPA), part of the 1981 Farm Bill, is intended to limit federal activities that contribute to the unnecessary conversion of farmland to other uses. The law applies to construction projects funded by the federal government such as highways, airports, and dams, and to the management of federal lands.

As part of the implementation of this law, the Natural Resources Conservation Service (NRCS) identified high quality agricultural soils as prime farmland, unique farmland, and land of statewide or local importance. Farmlands are extremely importance to meet the Nation's short- and long-range needs for food and fiber.

Prime farmland, as defined by the USDA, is land that has the best combination of physical and chemical characteristics to produce food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pastureland, forestland, or other land, but it is not urban or built-up land or water areas. The soil quality, growing season, and moisture needed for the soil to economically produce and sustain high yields of crops.

To determine prime farmland in and around the study area, the area within a width of two miles on either side of the Arkansas River centerline was evaluated. Within this area, a significant portion (494,362 acres) has soils with prime farmland characteristics (Table 3-3). However, most of the identified acreage is not currently being farmed and is not likely to be farmed due to the need for specialized farming practices (e.g., regular dewatering), current land use, and ownership priorities. This radius also includes private lands outside of the immediate study area. Prime farmland soils occur outside riverbanks, behind levees, and in areas that are not subjected to frequent flooding or ponding and have less than an eight percent slope. Lands not classified as Prime Farmlands includes open water areas, levees, developed areas, existing upland placement areas, pits and borrows, river wash, and soils with a slope greater than eight percent.

Table 3-3. Prime Farmlands in the Study Area

Farmland Classification	Area of Farmland (acres)	Percent of the Study Area
Prime Farmland	494,362	45%
Farmland of Statewide Importance	97,716	9%
Farmland of Local Importance	0	0%
Farmland of Unique Importance	0	0%
Not Prime Farmland	504,646	46%

3.5 Surface Waters

The existing condition of surface water along the MKARNS has not significantly changed from the account provided in Section 4.5, Surface Waters, of the 2005 ARNS FEIS. The MKARNS continues to be managed according to the operations manual which specifies river elevations during certain river conditions, how much and when water should be released from reservoirs and other water controlling infrastructure. Surface water conditions to be evaluated in this SEA include an account of flooding events that occurred after the completion of the 2005 FEIS and a current evaluation of water quality along the MKARNS.

3.5.1 Arkansas River Flooding Events

The 2005 ARNS FEIS recounted Arkansas River flooding history from 1900-2000. The following represents significant flooding history from 2005 to present day.

- May 2019 – The Southern and Central United States received unprecedented rainfall in the spring of 2019, and by the end of May portions of the Arkansas River had reached record elevations. All Oklahoma counties declared a state of emergency, and many Arkansas communities were ordered or recommended to evacuate.

3.5.2 Water Quality

The 1972 amendments of the Clean Water Act (CWA) include Section 303(d) and 305(b) requirements. Section 303(d) requires each state to prepare a list of water bodies that do not meet water quality standards and to submit updates every two years. Water quality standards defined by Federal regulations include beneficial uses, water quality objectives, and anti-degradation requirements. A Total Maximum Daily Load (TMDL) must be established for all water bodies on the 303(d) list. The TMDL must document the nature of the impairment to determine the maximum amount of the pollutant that can be discharged and identify allowable loads contributed form each source. Section 305(b) of the CWA requires each state to perform a comprehensive inventory and analysis of the quality of water of the state and report findings to Congress every two years.

The Arkansas Department of Energy and Environment, Office of Environmental Quality (ADEQ) is responsible for producing the state's Section 303(d) and 305(b) reports. The Draft 2022 303(d) List, 305(b) Report, and Assessment Methodology represents the most current data available. The Arkansas River, ADEQ's assessment unit AR_08020401_003, in Desha County from its confluence with the Mississippi River upstream 31.24 miles is classified on the Draft 2022 303(d) list as Category 5 (Truly Impaired) for critical season dissolved oxygen (DO) with a low priority and unknown source. Other feeder streams listed as Category 5 include Bayou Meto, Fourche Creek, White Oak Bayou, Maumelle River, Fourche LaFave River, Rocky Cypress Creek, Point Remove Creek, Whig Creek, and Mulberry River. These impairments result from DO, turbidity, and pH exceeding the acceptable standards, with most sources unknown. Nimrod Lake, located on Fourche LaFave River which feeds into the Arkansas River north of Little Rock, is listed on ADEQ's Draft 2022 305(b) list in exceedance of acceptable mercury in tissue standards, inhibiting fish consumption (ADEQ 2022).

The Oklahoma Department of Environmental Quality (ODEQ) 2022 Section 303(d) list represents the most recent water quality data available for the State of Oklahoma. The 2022 document reported five locations of impairment along the Arkansas River and one along the Salt Fork Tributary due to excessive Enterococcus bacteria (E. Coli), with TMDL priorities of 2, 3, or not listed. Enterococci are indicators of the presence of fecal material in water and, therefore, the possible presence of disease-causing bacteria and viruses. As such, the water in these locations is not suitable for warm water aquatic communities. Other impairments along the Arkansas River within Oklahoma boundaries are attributed to cadmium and benthic macroinvertebrate bioassessments outside of the acceptable thresholds. These exceedances may also impact suitability for warm water aquatic communities (ODEQ 2022b).

In general, the Arkansas River maintains a continuous turbid appearance due to sand and suspended silt. The water is slightly saline because of the presence of large, natural salt beds in Oklahoma and Kansas that the Arkansas River traverses. The salinity has been steadily decreasing for the last forty years since construction of the MKARNS.

3.6 Land Cover and Land Use

The existing condition of land cover and land use, including urban, agricultural, rangeland, recreation and parklands, forested land and wildlife management areas, water bodies, wetlands, and barren lands, for the overall project area has not significantly changed since the 2005 ARNS FEIS. This information can be found in Section 4.6, Land Cover and Land Use, of the 2005 ARNS FEIS.

Land classification was determined for a width of two miles on either side of the Arkansas River centerline. The United States Geological Survey (USGS) National Land Cover Database (NLCD) 2021 data, published in July 2023, is the most current version available and was utilized in this assessment to determine land classifications for the area. Table 3-4 below depicts land classification acreage for the designated area of evaluation.

Lands along the Arkansas River are typically rural with a significant portion largely undeveloped and primarily forested (23% of the evaluated area). Agriculture is one of the largest industries in both Arkansas and Oklahoma. Production primarily includes cattle, poultry, pork, dairy, wheat, rice, soybeans, sorghum, corn, cotton, and aquaculture. Agricultural land cover including cultivated crops and pastureland is the predominant land classification and makes up roughly 40% of the area evaluated. Small pockets of urbanized and developed spaces account for 9% of the evaluated area, including the cities of Tulsa and Muskogee in Oklahoma and Fort Smith, Russellville, Little Rock, and Pine Bluff in Arkansas. The remaining 28% of the area evaluated can be attributed to open water and wetland areas in and around the Arkansas River.

Table 3-4. Land Classifications for Two-Mile Width along the Arkansas River within the Study Area

Class	Acres	Square Miles
Open Water	151,004.27	235.94
Developed Open Space	32,455.49	50.71
Developed Low Intensity	34,832.42	54.43
Developed Medium Intensity	22,207.30	34.70
Developed High Intensity	11,231.66	17.55
Barren Land	4,733.32	7.40
Deciduous Forest	135,457.90	211.65

Class	Acres	Square Miles
Evergreen Forest	48,964.78	76.51
Mixed Forest	28,945.10	45.23
Shrub	10,100.63	15.78
Grassland	17,573.61	27.46
Pasture	192,333.93	300.52
Cultivated Crops	248,625.44	388.48
Woody Wetlands	125,938.03	196.78
Emergent Herbaceous Wetlands	25,163.22	39.32
Total Area	1,089,567.08	1702.45

3.7 Transportation

The MKARNS contains 445 miles of waterway and is a crucial part of the United States' transportation system. The MKARNS strategically connects the heartland of the United States with the rest of the world via the Mississippi River and Port of New Orleans. In February 2015, the MKARNS was classified as a high-use waterway system based on a 5-year average of 3.3 billion tons transported (Nachtmann 2015). A series of eighteen locks and dams work together to maintain navigation throughout the system and are needed to navigate the 420-foot drop in elevation from the Port of Catoosa to the Mississippi River.

Before constructing the MKARNS, commercial navigation on the Arkansas River ranged between 0.5 million and one million tons a year. In 1970, after the MKARNS opened, traffic grew rapidly through about 1978 to nearly 10 million tons per year, and while traffic has fluctuated over time overall commercial navigation has increased as economics and flooding events allow as depicted in Figure 3-1 (USACE 2006; USACE 2007).

Figure 3-1. Historical Traffic on the MKARNS (1971 through 2020, millions of tons)

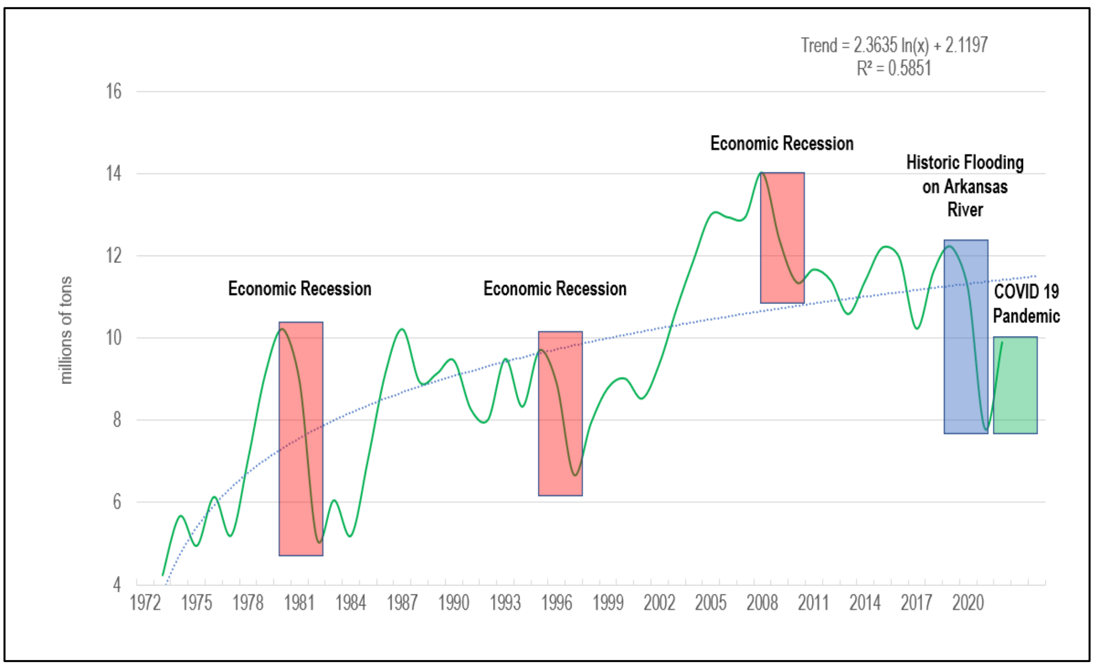


Table 3-5 summarizes traffic by major commodity groups on the MKARNS by direction (inbound or outbound). Significant commodity groups include:

- Aluminum, aluminum ores and concentrates.

- Building materials and minerals,
- Coal and coke,
- Fertilizers,
- Grains, soybeans, rice, and other farm goods,
- Iron and steel,
- Machinery and industrial equipment,
- Manufacturing ores and chemicals; and,
- Petroleum products.

Building materials and minerals (primarily sand, gravel, and stone), fertilizers, and agricultural commodities, such as grain and soybeans comprise about 80 percent of total commodity flows in terms of volume.

Table 3-5. Commodity Traffic on the MKARNS by Direction and Commodity Types

Commodity	Volume (thousands of tons)				
	Outbound	Inbound	Internal	Through-put	Total
Coal and coke	148	57	0	205	205
Petroleum products	193	116	52	309	361
Building materials and minerals	294	181	2,768	475	3,243
Grains, soybeans, rice, and other farm goods	2,840	263	77	3,104	3,181
Fertilizer	738	2,286	3	3,024	3,027
Manufacturing ores and chemicals	12	292	6	304	310
Iron and Steel	145	768	173	912	1,085
Machinery and industrial equipment	6	9	5	15	19
Aluminum, aluminum ores and concentrates	27	229	45	256	301
Total	4,403	4,201	3,128	8,604	11,731
Commodity	**Percent**				
	Outbound	**Inbound**	**Internal**	**Through-put**	**Total**
Coal and coke	3%	1%	0%	2%	2%
Petroleum products	4%	3%	2%	4%	3%
Building materials and minerals	7%	4%	89%	6%	28%
Grains, soybeans, rice, and other farm goods	65%	6%	2%	36%	27%
Fertilizer	17%	54%	0%	35%	26%
Manufacturing ores and chemicals	0%	7%	0%	4%	3%
Iron and steel	3%	18%	6%	11%	9%
Machinery and industrial equipment	0%	0%	0%	0%	0%
Aluminum, aluminum ores and concentrates	1%	5%	1%	3%	3%
Total	100%	100%	100%	100%	100%
*Average of 2016 through 2018, thousands of tons per year *Source: U.S. Army Corps of Engineers Waterborne Commerce Statistics Center*					

Apart from outbound agricultural crops, which are shipped to deep draft ports in Louisiana for foreign world export, the bulk of goods shipped on the MKARNS flow to and from domestic producers and consumers, although some may be processed into value added goods and ultimately exported.

3.7.1 Projected Navigation on the MKARNS

From 2020 through 2075, tonnage transported on the MKARNS is expected to grow from about 11.7 million tons per year (tpy) to 17.5 million tpy at a rate of 0.08 percent per year (Table 3-6). In contrast, the projected rate is lower than historical rates from 1971 through 2019. This is because traffic increased rapidly in the initial years after the MKARNs opened as shippers adjusted their logistics to take advantage of the cheaper mode of transport. As the system matured, demand leveled, and annual increases tapered off, the market achieved some level of equilibrium between supply of inland navigation and demand for inland navigation. Going forward, average annual growth will likely continue, but will be moderate compared to the first few decades of MKARNS operation.

An assumption for projections is that current origin destination patterns remain the same over the forecast horizon; however, over the long-term commodity flow patterns may change, but it is difficult to project these changes 50 years into the future with any degree of accuracy. On the other hand, the pattern for major inbound and outbound commodities shipped on the MKARNs has remained relatively constant through time. Regardless, there will likely be some changes in origins and destinations, and the U.S. and world economies will wax and wane resulting in positive and negative variations on an annual basis. In some years, major flooding will result in sharp annual declines, but in the absence of global upheaval or substantial and protracted economic decline, future demand for shipping on the MKARNs will likely increase or stay relatively constant.

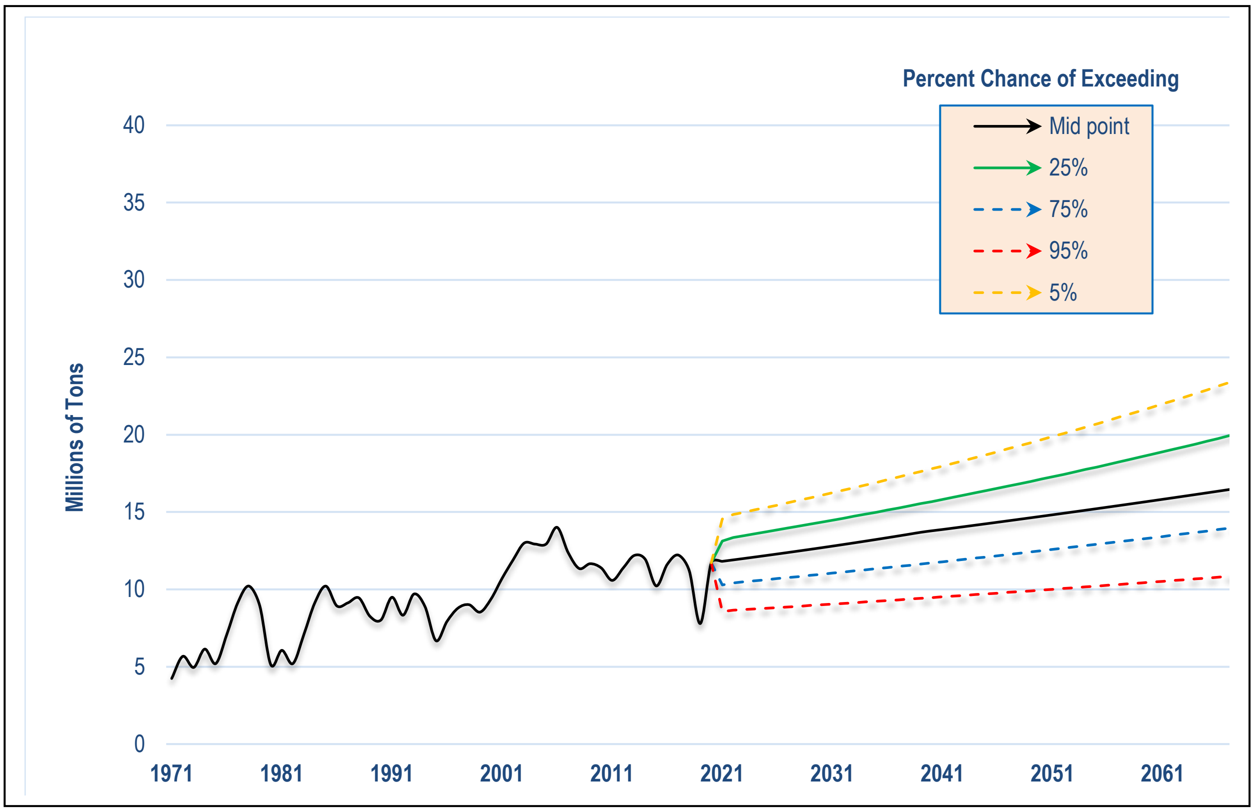
Table 3-6. Historical and Projected Commodity Flows for the MKARNS (1971 through 2075)

Year	Inbound	Outbound	Internal	Total	Throughput
Historical Traffic					
1971	0.76	0.46	2.43	3.65	1.22
1975	1.44	0.87	2.47	4.78	2.31
1980	1.80	0.66	2.67	5.13	2.46
1985	2.60	3.90	3.17	9.67	6.50
1990	1.91	3.91	1.90	7.72	5.82
1995	2.09	3.09	2.11	7.29	5.18
2000	2.42	4.24	2.56	9.22	6.66
2005	3.96	4.40	4.56	12.92	8.36
2010	3.71	4.84	2.84	11.39	8.55
2015	4.68	3.41	2.13	10.23	8.09
2016	4.36	4.13	3.13	11.62	8.49
2017	4.22	4.95	3.05	12.22	9.17
2018	4.03	4.13	3.04	11.20	8.17
2019	3.25	2.60	1.95	7.79	5.84
Projected Traffic					
2020 Baseline (Average 2016-2018)	4.20	4.40	3.13	11.73	8.60
2021	4.24	4.40	3.15	11.79	8.65
2025	4.42	4.57	3.22	12.21	8.98
2030	4.65	4.74	3.32	12.71	9.39
2035	4.89	4.94	3.42	13.26	9.83
2040	5.15	5.16	3.53	13.84	10.31
2045	5.05	5.34	3.64	14.03	10.39
2050	5.24	5.55	3.76	14.55	10.79
2055	5.44	5.81	3.87	15.13	11.26

Year	Inbound	Outbound	Internal	Total	Throughput
2060	5.65	6.00	3.99	15.64	11.65
2065	5.87	6.24	4.09	16.20	12.10
2070	6.10	6.48	4.25	16.83	12.58
2075	6.33	6.74	4.38	17.46	13.08
Projected growth rate (baseline-2075)	0.8%	0.9%	0.7%	0.8%	0.8%

Despite probable increases in traffic, analyzing uncertainties is an important part of plan formulation. For study projections, historic long-term variation in traffic on the MKARNS was examined. As shown in Figure 3-1, annual ups and downs in tonnage since the system was built vary with the greatest annual changes occurring shortly after the waterway opened (about 1971 through 1978) as the number of terminals increased and producers modified production processes to take advantage of the new waterway. Since then, annual changes have followed a more stable pattern varying on average roughly plus or minus 10% per year with an overall positive trend. Variations captured in a Gaussian distribution was applied to commodity growth rates to develop a stochastic range of projections (Figure 3-2).

Figure 3-2. Historical and Projected Traffic on the MKARNS (2025 through 2075, millions of tons)



3.8 Biological Resources

3.8.1 Aquatic Resources

Aquatic resources include various aquatic environments including major rivers and their tributaries, lakes, cutoffs, wetlands, and the resulting habitats that support ecologically diverse flora and fauna. Aquatic resources present along the MKARNS have not significantly changed since the finalization of the 2005 ARNS. For more information on aquatic resources existing conditions within the study area, refer to Section 4.8.4, Aquatic Resources, of the 2005 FEIS.

The MKARNS contains a diverse array of aquatic environments including major rivers and their tributaries, lakes, cutoffs, and wetlands that result in diverse habitats that support a variety of aquatic flora and fauna. Important riverine elements within the study area include the Arkansas River, Verdigris River, the lower White River and their associated side channels, dikes, revetments, locks, dams, navigation pools, cutoffs, backwaters, and tributary mouths. Additionally, several major tributaries to the MKARNS have been impounded to create reservoirs that are managed to support recreational game fish populations, as well as shallow water habitats for fish, migratory waterfowl, and other aquatic biota.

Gravel substrate is also an important habitat to aquatic life for spawning, food production, shelter, and hydrologic diversity. In general gravel substrate is found throughout the MKARNS except within pool 1. The highest concentration of gravel was found in dredge areas near navigation miles 108, 150, 186, 205, 361, and 421. Flooding events since the 2005 FEIS investigations may have changed the quantity and locations of gravel substrate along the MKARNS; however, no additional surveys were completed.

The Arkansas River maintains a continuous turbid appearance due to sand and suspended silt. The water is slightly saline because of the presence of large, natural salt beds in Oklahoma and Kansas that the Arkansas River traverses. The salinity has been steadily decreasing for the last forty years since construction of the MKARNS.

The aquatic resources within the MKARNS have undergone changes since the creation of the navigation channel. Prior to construction of the MKARNS, the Arkansas River was reported to fluctuate from very low flows to very high flows. During periods of low flow, sandbars occupied most of the riverbed. In high-flow periods, riverbanks and adjacent low-lying area are flooded, exposing new habitats and providing additional food sources for aquatic species. Pre-MKARNS construction, high-flow periods were also important in maintaining the river's hydrological connection to various oxbow lakes.

The diverse aquatic environments throughout the MKARNS currently provide good habitat for a variety of fishes. After the completion of the MKARNS's impoundments, river flows stabilized and formed large pools, which increased surface water, deep water, and backwater acreage. Consequently, the aquatic habitats of the system were altered. These changes increased available habitat for some species while decreasing habitat for others. Habitat declination is potentially responsible for the absence of four species including the plains minnow, speckled chub, Arkansas River shiner, and suckermouth minnow. Conversely, the abundance of a variety of species have increased in the river since the creation of the MKARNS (USACE 1997). Twenty-two families containing 126 species of fishes have been identified from the Arkansas River and its tributaries (Robinson and Buchanan 1988), including bluegill, crappie, largemouth bass, sauger, and several catfish species. Commercial fishing for catfish and buffalo (suckers) has been an important industry along the river since the completion of the MKARNS.

Freshwater mussels are also present in the MKARNS. There is little known about unionid species composition and distribution in the MKARNS system. A few of the Arkansas River tributaries (White River, Verdigris, Poteau, Grand Rivers) are known to harbor unionids, but previous unionid studies in the mainstem are limited. The threehorn wartyback (*Obliquaria reflexa*) can be found in Lake Dardanelle in Arkansas. The threeridge mussel (*Amblema plicata*) inhabits creeks, rivers, reservoirs, and oxbows and has been found in all drainages within Arkansas. The Louisiana fatmucket (*Lampsilis hydiana*) inhabits mid-size creeks to large rivers in Arkansas from the Arkansas River Valley south, however, they are most common in waters found outside the study area. The mapleleaf (*Quadrula quadrula*) is sometimes extremely abundant in impoundments or large oxbows. The washboard (*Megalonaias nervosa*), paper pondshell (*Anodonta imbecillis*), and lilliput shells (*Toxolasma spp*.) are also known to occur in reservoirs but are not as common. Several exotic species, such as the asiatic clam (*Corbicula fluminea*) and zebra mussel (*Dreissena polymorpha*), have invaded the Arkansas River, its tributaries, and associated reservoirs, and have caused considerable economic and ecological damage.

Since information on unionid species' composition and distribution throughout the MKARNS is limited, the USACE sponsored a freshwater mussel (Unionid) survey conducted by Ecological Specialists, Inc. in 2004 to: 1) determine unionid distribution and species composition in the Arkansas River Navigation System, focusing on proposed dredge and dredge disposal areas, 2) identify how the construction, operation, and maintenance of a deeper channel would affect unionid communities, and 3) assist in determining if any mussels should be relocated.

The mussel survey found that in general, the MKARNS consists of a navigation channel with loose sand substrate and channel borders that range from steep riprapped banks to extensive shallow mud flats. Unionid beds or patches were primarily found in substrate consisting of a sand, silt, and clay mixture. This substrate mixture typically occurred as a transition zone between the clay, silt, or riprapped banks, islands, or dikes and the sand channel. This habitat was most frequently associated with a gently sloping shelf between two steeper slopes at depths of >10 m or gently sloping banks near islands, dikes, and riverbanks <1 m deep. A total of 5,467 live unionids of 27 species were collected, and two additional species were found only as weathered shells. The mapleleaf (27.6%), bankclimber (23.4%), threehorn wartyback (15.5%), and threeridge (10.5%) were the most abundant species. No threatened or endangered mussel species were collected.

Benthic invertebrates, in addition to the afore mentioned freshwater mussels, also play a crucial role in the functionality of aquatic ecosystems as decomposers, predators, and prey. Examples of these organisms found in the Arkansas River are nematodes, oligochaetes, crayfish, and insect larvae of mayflies, dragonflies, caddisflies, midge flies, beetles, and many others.

There are other invertebrates that play an important role in the health of the MKARNS ecosystem. Phytoplankton are major contributors to primary production in these aquatic systems and are the base to the system's trophic pyramid. A study conducted on the Arkansas River found 243 species of phytoplankton. These phytoplankton composed eight major taxa: blue-greens, green flagellates, coccoid greens, diatoms, cryptomonads, dinoflagellates, euglenoids, and golden browns. Of these eight taxa, the blue-greens, coocoid greens, and diatoms were the most abundant (McNutt and Meyer 1976).

In addition, zooplankton play an important role in aquatic ecosystems as primary consumers and as foraging material for larger invertebrates and small fishes. A total of 128 taxa of zooplankton were found in the Arkansas River during a study in 1974 and 1975. These taxa were divided into three major groups: rotifers, copepods, and cladocerans (Short and Schmitz 1976).

3.8.1.1 ***Wetlands***

The USACE and EPA jointly define wetlands as those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (40 CFR 120.2[c]). The existing conditions of wetlands scattered along the MKARNS, primarily found in the floodplain of the Arkansas River Valley, have not significantly changed since the 2005 FEIS. Refer to Section 4.8.3, Wetlands, of the 2005 FEIS for further information.

3.8.1.1.1 Oklahoma

The Oklahoma portion of the MKARNS study area consists of broad floodplains and manmade reservoirs. A map of Oklahoma wetlands along the MKARNS can be found in Appendix J, Additional Maps and Information.

Floodplains

Broad floodplains along the Oklahoma portion of the MKARNS support bottomland forests of elm, oak, hackberry, cottonwood, and sycamore. These streams slope gently which prevent the forest floor from being as heavily scoured as bottomlands in the Ozarks. The forest floor is heavily shaded, allowing for limited understory development. In poorly drained sites, sedges, willows, and buttonbush form thickets along wetland edges. These wetlands are typically found on the backside of broad stable flood plains. Sediment loading is limited to large flood events. The surface water accumulation is from both riverbank flooding and runoff from adjacent uplands. Groundwater tables are near the surface during the winter and early spring. Vegetation on these sites typically is an overstory of black willow, pin oak, green ash, butternut hickory, and pecan, with an understory of sedges and grasses. When disturbed these areas convert to willow or cottonwood thickets (USACE 2005a).

Reservoir Shores

The areas near and adjacent the Oklahoma reservoirs included in the study area are dominated by forested and riparian wetlands and marshes. Manmade reservoirs have few consistent characteristics, except that most sites chosen for dam construction are fairly narrow gaps between steep slopes, with a large upstream valley. In almost all cases, these lakes are managed specifically to modify natural patterns of water flow, therefore their shoreline habitats are subjected to inundation at times and for durations not often found in nature. A typical effect is that flood-control reservoirs hold water (and inundate the fringe zone) well into the growing season, then gradually draw down and leave the shoreline habitats exposed and desiccated through late summer and fall. Some lakes develop a delta of sediment in their upper reaches where tributaries are confluent and maintain wetland conditions because of both lake-level fluctuation and tributary inflow (USACE 2005a).

Steep reservoir shores usually support little perennial wetland vegetation beyond a narrow fringe of tall emergents such as cattails and rushes, and a scatter of willows. Below this fringe zone, various weed species colonize in patterns that change annually, depending on the timing of drawdowns and other factors. Often, even these species cannot survive, and there is an abrupt edge where upland vegetation gives way to a barren shore. In draws, where tributaries are confluent, small "pocket wetlands" sometimes form. These are usually the result of wave action on the lake building a low berm of sediment across the mouth of the tributary, resulting in a complex of marsh species and willows. Similar small wetlands form in protected areas where logs and other debris accumulate, trap sediment, and attenuate wave action sufficiently to allow vegetation to establish. Typical upper lake reaches often contain a "dead timber" zone, where trees have been killed by prolonged inundation. However, shrub swamps, cattail thickets, or thick mats of graminoids occupy the substrate in the lake fluctuation zone. In most cases, all of these wetland communities are tenuous, because they can be destroyed by a change in water storage patterns, or severe ice accumulations (USACE 2005a).

Lowland lakes are generally fairly shallow, and often impound existing bottomland forests. The most water tolerant tree species sometimes persist for many years, and some survive in zones that are periodically exposed. This usually results in open stands or scattered individuals of bald cypress with extremely broad, buttressed bases and tops that have died back significantly.

3.8.1.1.2 Arkansas

A map of Arkansas wetlands along the MKARNS can be found in Appendix J, Additional Maps and Information. In northwestern Arkansas the study area is within the broad trough of the Arkansas River Valley. This region includes the alluvial valley of the Arkansas River, as well as bottomlands and terraces associated with tributary streams, and other landforms that occur within the portion of the Ouachita Mountains that drains to the Arkansas River. Consequently, this region includes wetlands similar to those of the lowlands, as well as elements of mountain wetland systems. However, intensive agricultural development on the fertile terraces and river bottoms, and navigation projects on the Arkansas River have altered or eliminated many historic wetlands (USACE 2005a).

Wetlands along the middle Arkansas River include tracts of bottomland hardwoods found in floodplain connected and unconnected depression wetlands, connected and unconnected oxbow lake margin wetlands, reservoir fringe wetlands, low-gradient backwater wetlands, and low-gradient overbank wetlands.

In southeastern Arkansas, the study area is within the region known as the Mississippi Alluvial Valley, or Delta. It occupies most of eastern Arkansas. The active meander belts of relatively intact Delta streams include floodplains subject to frequent overbank flows as well as broad backwater areas, oxbow lakes, and shallow depressions. Older deposits may include similar landforms which no longer have any floodwater connections to stream systems; however, they support wetlands in remnant depressions and on flats. Even older deposits support wetlands in depressions and flats associated with long-dry lakebeds, ancient buried braided-channel systems, and massive dunes of wind-blown sand. The vast expanses of wetlands that occupied the Delta prior to European settlement have been dramatically reduced by flood control, drainage projects, and agricultural development (USACE 2005a)

Wetlands in the lower Arkansas River contain extensive palustrine forested wetland tracts (i.e., bottomland hardwoods). Portions of these wetland areas are under Federal or State protection and are of international importance (USFWS 1986). These wetlands were designated as internationally significant in 1990 under the Ramsar Convention (ANHC 1992).

3.8.2 Terrestrial Resources

Terrestrial resources existing along the MKARNS, including flora and fauna species, have not significantly changed since the completion of the 2005 ARNS. Refer to Section 4.8.5, Terrestrial Resources, of the 2005 FEIS for further information on the affected environments with regard to terrestrial resources.

3.8.2.1 *Mammals*

Common mammals present in the study area include: white-footed mouse (*Peromyscus leucopus*), deer mouse (*Peromyscus maniculatus*), least shrew (*Cryptotis parva*), southern shorttailed shrew (*Blarina carolinensis*), pine vole (*Microtus pinetorum*), eastern mole (*Scalopus aquaticus*), gray squirrel (*Sciurus carolinensis*), fox squirrel (*Sciurus niger*), eastern cottontail rabbit (*Sylvilagus floridanus*), swamp rabbit (*Sylvilagus aquaticus*), beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), striped skunk (*Mephitis mephitis*), spotted skunk (Sp*ilogale putorius*), raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), mink (*Mustela vison*), longtailed weasel (M*ustella* frenata), nine-banded armadillo (*Dasypus novemcinctus*), gray fox (*Urocyon cinereoargenteus*), red fox (*Vulpes vulpes*), bobcat *(Lynx rufus*), coyote (*Canis latrans*), and white-tailed deer (*Odocoileus virginianus*).

3.8.2.2 *Birds*

A wide variety of birds are known to occur within the study area due to the size of the area, the geographic location, and the diversity of habitats present. Common resident birds include the bobwhite quail (*Colinus virginianus*), wild turkey (*Meleagris gallopavo*) (Rio-Grande and Eastern), roadrunner (*Geococcyx californianus*), robin (*Turdus migratorius*), and northern cardinal (*Cardinalis cardinalis*). Most of the birds that frequent the study area are considered migratory, and they may be seasonal residents or simply transient migrants.

Many of the neotropical migrants, land birds that breed in temperate America and winter in the New World tropics, are considered breeders and common summer residents in Oklahoma and Arkansas. Some of the typical breeding neotropical migrants include the prothonotary warbler (*Protonotaria citrea*), scissor-tailed flycatcher (*Tryrannus forficatus*), eastern kingbird (*Tryrannus tyrannus*), eastern wood-pewee (*Contopus virens*), ruby-throated hummingbird (*Archilochus colubris*), house wren (*Troglodytes aedon*), and the whip-poor-will (*Caprimulgus vociferous*).

Migratory waterfowl such as mallards (*Anas platyrhynchos*), northern pintails (*Anas acuta*), gadwalls (*Anas strepera*), American widgeons (*Anas Americana*), lesser scaup (*Aythya affinis*), and ringneck ducks (*Aythya collaris*) utilize the wetlands, ponds, and other water bodies during their annual migrations. Wood ducks (*Aix sponsa*) and hooded mergansers (*Lophodytes cuccullatus*) are known cavity nesters throughout the Arkansas River Valley. Multiple species of geese are also common during their annual migrations. Snow (*Chen caerulescens*), Ross's (*Chen rossii*), Canada (*Branta canadensis*), and White-fronted (*Anser albifrons*) geese migrate through the area. Canada geese are also residents within the project area.

Common raptors that frequent the study area include the barred owl (*Strix varia*), great horned owl (*Bubo virginianus*), red-tailed hawk (*Buteo jamaicensis*), sharp-shinned hawk (*Accipiter striatus*) and American kestrel (*Falco sparverius*).

3.8.2.3 ***Reptiles and Amphibians***

Many species of reptiles and amphibians inhabit the diverse habitats along the Arkansas River. Common reptiles include the western ribbon snake (*Thamnophis proximus*), eastern hognose snake (*Heterodon platyrhinos*), timber rattlesnake (*Crotalus horridus*), common snapping turtle (*Chelydra serpentina*), red-eared slider (*Chrysemys scripta elegans*), and the three-toed box turtle (*Terrapene carolina triunguis*). Most of the amphibians that inhabit the area are associated with aquatic environments, such as intermittent and permanent streams, vernal pools, ponds, lakes, and wetlands. The southern leopard frog (*Rana sphenocephala*), northern spring peeper (*Hyla crucifer*), American toad (*Bufo americanus*), bullfrog (*Rana catesbeiana*), and green frog (*Rana clamitans melanota*) can be found throughout the region.

3.8.2.4 ***Vegetation***

Vegetation communities in the study area include old fields, pastureland with warm and cool season grasses, remnant native grasslands, bottomland hardwood forest, and upland forest.

3.8.2.4.1 Old Fields and Maintained Grasslands

Fields that are not routinely maintained through mowing, burning, or disking are dominated by old field communities that consist of perennial grasses, forbs, and early successional woody species. Typical old field vegetation includes blackberry (*Rubus spp.*), Johnson grass (*Sorghum halapense*), winged sumac (*Rhus copallina*), smooth sumac (*Rhus glabra*), eastern red cedar (*Juniperus virginiana*), winged elm (*Ulmus alata*), persimmon (*Diospyros virginiana*), mockernut hickory (*Carya tomentosa*), bitternut hickory (*Carya cordiformis*), sassafras (*Sassafras albidium*), and sweetgum (*Liquidambar styraciflua*). Frequently mowed areas are dominated by cool season grasses such as Kentucky bluegrass (*Poa pratensis*), tall fescue (*Festuca arundinacea*), and warm weather grass such as Bermuda grass.

In addition to fields that are largely undisturbed, most of the area surrounding the Arkansas

River is used for agriculture. These include rice, wheat, soybean, sorghum, corn, and cotton fields. Privately owned pastureland around the MKARNS is also used to cattle ranching. Fields that are associated with Federally owned lands are typically associated with park areas and maintained by mowing, prescribed burning, and/or disking.

3.8.2.4.2 Forests

The two primary forest communities in the study area are the bottomland hardwood community along the Arkansas River and the upland forest community. The bottomland hardwood community occurs within the floodplain of the Arkansas River or in riparian areas immediately adjacent to small streams. The dominant bottomland hardwood trees include cottonwood (*Populus deltoides*), sycamore (*Platanus occidentalis*), green ash (*Fraxinus pennsylvanica*), pecan (*Carya illinoensis*), box elder (*Acer negundo*), river birch (*Betula nigra*), black willow (*Salix nigra*), silver maple (*Acer saccharinum*), black walnut (*Julgans nigra*), sugarberry (*Celtis laevigata*), water oak (*Quercus nigra*), overcup oak (*Quercus lyrata*), and willow oak (*Quercus phellos*). In the lower portions of the study area bald cypress (*Taxoidium distichum*) is also common.

The upland forest community on moist areas, generally on east facing or north facing slopes, is dominated by white oak (*Quercus alba*), black oak (*Quercus velutina*), northern red oak (*Quercus rubra*), southern red oak (*Quercus falcata*), black gum (*Nyssa sylvatica*), and red maple (*Acer rubrum*). Flowering dogwood (*Cornus florida*), redbud (*Cercis canadensis*), ironwood (*Carpinus caroliniana*), pawpaw (*Asimina triloba*), basswood (*Tilia americana*), spice bush (*Lindera benzoin*), and red mulberry (*Morus rubra*) are typical understory species found on moist slopes.

Adjacent to the project area the upland forest community exists on dry areas, usually the tops of high ridges, south facing slopes, and/or west facing slopes, and is characterized by generally slow growing species that are adapted to dry conditions and poor soils. This forest community, called the Cross Timbers, is a complex mosaic of upland forest, savanna, and glade that forms the broad ecotone between the eastern deciduous forests and the grasslands of the southern Great Plains. The pre-settlement Cross Timbers are believed to have covered over 30,000 square miles, extending from central Texas across Oklahoma into southeastern Kansas. The short, stout oaks of the Cross Timbers were not ideal for lumber production, so the original trees have often survived on steep terrain that was unsuitable for farming. Thousands of ancient post oak can still be found in eastern Oklahoma, and the Cross Timbers is one of the least disturbed forest types left in the eastern United States. Cross Timbers overstory species include post oak (*Quercus stellata*), blackjack oak (*Quercus marilandica*), eastern red cedar (*Juniperus virginiana*), black hickory (*Carya texana*), pignut hickory (*Carya ovalis*), bitternut hickory (*Carya cordiformis*), and shortleaf pine (*Pinus echinata*). Carolina buckthorn *(Rhamnus caroliniana*), rusty blackhaw (*Viburnum rufidulum*), winged elm (*Ulmus alata*), buckbrush (*Symphoricarpos orbiculatus*), and farkleberry (*Vaccinium arboreum*) are typical understory species adapted to dry conditions within the study area.

3.8.3 Federally Threatened and Endangered Species

Species listed as either threatened or endangered under the Endangered Species Act of 1973 (ESA) are afforded legal protection. Section 9 of the ESA prohibits “taking” of any threatened and endangered species by public agencies or private citizens. Taking includes willfully harming a listed species as well as habitat destruction or degradation that significantly interferes with an essential behavior.

The U.S. Fish and Wildlife Service (USFWS) provides an official species list for each Federal project. A total of 16 species listed as endangered, threatened, or candidate were identified and considered in the 2005 Biological Assessment (BA). Since then, 13 additional species have been identified and seven species are no longer identified. There are nine species that remain identified as potentially occurring within the project area as indicated in the USFWS Official Species List dated October 10, 2023 (Table 3-7 and Appendix C). No designated critical habitat has been identified within the action area.

Table 3-7. Federally Listed Species, Habitat Preference, and Likelihood of Occurrence

Species	Status		Habitat Description	Likely Occurrence in the Study Area
	2005	2023		
American Alligator *Alligator mississippiensis*	T	NR	This species prefers rivers, swamps, estuaries, lakes, and marshes. They dig dens in riverbanks or the shorelines of lakes where they spend the winter or use during times of drought.	Not likely to occur in project area.
Alligator Snapping Turtle *Macrochelys temminckii*	NR	PT	This species has a preference for freshwater rivers and lakes with deep floors.	Suitable habitat present, species likely to occur within project area.
American Burying Beetle *Nicrophorus americanus*	E	T	The ABB is considered a generalist when it comes to habitat preference, it utilizes a wide range of different habitats including grasslands, forests, riparian zones, and even pastures.	Suitable habitat present, species likely to occur within project area.
Arkansas River Shiner *Notropis girardi*	T	NR	The preferred habitat of the shiner is the main channels of large sandy-bottomed rivers and streams. It utilizes the downstream side of sand ridges in the channels where they feed on detritus and invertebrates exposed by the shifting substrate and current.	Species extirpated from project area.
Bald Eagle *Haliaeetus leucocephalus*	T	NR	The bald eagle is found throughout North America and winters near large rivers and reservoirs across this region. Eagles utilize mature trees, especially cottonwoods, along rivers and lakes for nesting, roosting, and perching.	Suitable habitat present, species likely to occur within project area.
Eastern Black Rail *Laterallus jamaicensis ssp. jamaicensis*	NR	T	This species prefers dense marshes, these can be in areas that are impounded or are tidally influenced. It tolerates some shrubs but prefers grasses. For nesting, it prefers dense vegetation along the edge of dry to shallow flooded marshes.	Suitable habitat present, species likely to occur within project area.
Fat Pocketbook *Potamilus capax*	NR	E	The fat pocketbook is a large river species, which requires flowing water and stable substrate. It's most likely habitat is a mixture of sand, silt, and clay. Surveys have reported the fat pocketbook from sand and mud bottoms, in flowing water a few inches to more than eight feet in depth.	Unlikely, most occurrences are outside of the project area.
Geocarpon minimum (no common name)	T	NR	In Arkansas, this species is found on sites characterized as "saline soil prairies" where it grows on bare mineral soils high in sodium and magnesium.	Not likely to occur in project area.
Gray Bat *Myotis grisescens*	E	E	This species roosts almost exclusively in caves year-round and has very specific requirements. Winter caves must be cold, deep, and with vertical walls. This species is very temperature sensitive. Summer caves are usually located close to rivers and lake shorelines near feeding areas.	Not likely to occur in project area.
Harperella *Ptilimnium nodosum*	E	E	Harperella is a wetland obligate species, which can only be found in streams, granite outcrop seeps, cracks in bedrock, pineland ponds, and in coastal plain wet savannah meadows.	Not likely to occur in project area. No suitable habitat expected.
Indiana Bat *Myotis sodalis*	E	E	Habitat requirements are similar to the gray bat in that they need limestone caves for hibernation, and caves with pools and stable temperatures are preferred. Because of these requirements, this species is highly selective of	Suitable habitat present, species likely

Species	Status		Habitat Description	Likely Occurrence in the Study Area
	2005	2023		
			hibernacula. During the summer months, they can be found under bridges, in old buildings, under tree bark, or in hollow trees generally associated with streams.	to occur within project area.
Ivory-billed Woodpecker *Campephilus principalis*	NR	E	The Ivory-billed Woodpecker historically preferred expansive patches of mature forestland, often with embedded patches of recently disturbed forest from hurricanes, tornadoes, fire, insect outbreaks, and to some degree logging as long as some damaged trees were left standing. Its' diet is known to be largely dependent on wood boring beetle larvae found in recently dead and dying trees. During some times of the year, the species feeds on fruit and other vegetable matter.	Not likely to occur in project area.
Interior Least Tern *Sterna antillarum athalasso*	E	NR	The Interior least tern migrates through and nests within the proposed action area. It passes through the area in the spring and fall, and nests on sparsely vegetated islands or sandbars along the larger rivers and salt flats. They are piscivorous, feeding on small fish in the shallows.	Likely only occurs in project area during migration.
Missouri Bladderpod *Physaria filiformis*	NR	T	Missouri Bladderpod preferred habitat consists of glades and open areas, this includes grazed pastures, and rock outcrops. In all these habitats it prefers areas that the soil is predominately limestone or dolemite, that is shallow, the grasses and shrubs are relatively short, and that there aren't any trees in the area	Not likely to occur in project area. No suitable habitat expected.
Monarch Butterfly *Danaus plexippus*	NR	C	Monarch butterflies prefer prairies, meadows, grasslands and along grassy roadsides. Require its host plant, milkweed, for its reproductive cycle.	Suitable habitat present, species likely to occur within project area.
Neosho Mucket *Lampsilis rafinesqueana*	NR	E	This species is associated with streams that have shallow riffles and runs and are comprised of gravel substrate with moderate to swift currents.	Not likely to occur in project area. No suitable habitat expected.
Northern Long-eared Bat *Myotis septentrionalis*	NR	E	Suitable summer habitat for NLEB consists of a wide variety of forested/wooded habitats for roosting. This species will utilize areas such as emergent wetlands and adjacent edges of agricultural fields, old fields and pastures for foraging. Suitable winter habitat (hibernacula) includes underground caves or cave-like structures.	Suitable habitat present, species likely to occur within project area.
Ozark Big-eared Bat *Corynorhinus (=Plecotus) townsendii ingens*	E	E	The Ozark big-eared bat is found in caves, cliffs, and rock ledges associated with oak-hickory forests of the Ozarks. They are known to forage along the edges of upland forests for insects.	Not likely to occur in project area. No suitable habitat expected.
Pallid Sturgeon *Scaphirhynchus albus*	E	E	The pallid sturgeon prefers to live on the bottom of large swift, free flowing, and turbid rivers.	Unlikely, most occurrences are outside of the project area.
Pink Mucket (pearly mussel) *Lampsilis abrupta*	E	E	The pink mucket is associated with riffle areas of large river systems within sand or gravel substrates and strong currents.	Not likely to occur in project area. No

Species	Status		Habitat Description	Likely Occurrence in the Study Area
	2005	2023		
				suitable habitat expected.
Piping Plover *Charadrius melodus*	T	T	Piping plover breeding habitat is comprised of open, sparsely vegetated areas with unconsolidated substrate including beaches, sand flats, dredge islands, and drained river floodplains where vegetative cover is sparse.	Likely only occurs in project area during migration.
Pondberry *Lindera melissifolia*	NR	E	The Pondberry's preferred habitat is forested, poorly drained, swampy depressions with small sand dune complexes.	Not likely to occur in project area. No suitable habitat expected.
Rabbitsfoot *Quadrula cylindrica cylindrica*	NR	T	Rabbitsfoot generally inhabits small- to medium-sized stream and some larger rivers. It occurs shallow water areas along the bank and in shoals with reduced water velocity. Individuals have also been found in deep water runs (9-12 ft.). It's primary substrate includes gravel and sand.	Not likely to occur in project area. No suitable habitat expected.
Red-cockaded Woodpecker *Picoides borealis*	NR	E	The preferred habitat of the Red-cockaded Woodpecker is that of a broad savanna that consists of mature to old growth pines that are frequently burned. The pine forests can be that of longleaf (*Pinus palustris*), slash (*Pinus elliottii*), loblolly (*Pinus taeda*) however the forests cannot be a mix of non-pine species of trees.	Not likely to occur in project area. No suitable habitat expected.
Red Knot *Calidris canutus rufa*	NR	T	Preferred wintering and migration habitats are muddy or sandy coastal areas, specifically, bays and estuaries, tidal flats, and unimproved tidal inlets with sand spits, islets, shoals, and sandbars.	Likely only occurs in project area during migration.
Scaleshell Mussel *Leptodea leptodon*	E	NR	This species inhabits larger creeks and small to medium size rivers with good water quality. It has been reported to occur in riffle areas having relatively strong currents and a substrate consisting of gravel, cobble, boulders, and occasionally mud or sand.	Unlikely, most occurrences are outside of the project area.
Tricolored Bat *Perimyotis subflavus*	NR	PE	During the winter, tricolored bats are often found in caves and abandoned mines but have been known to roost in culvert pipes. During the rest of the year, tricolored bats are found in forested habitats where they roost in trees, primarily among leaves of live or recently dead deciduous hardwood trees, but may also be found in Spanish moss, pine trees, and occasionally human structures.	Suitable habitat present, species likely to occur within project area.
Western Prairie Fringed Orchid *Platanthera praeclara*	E	NR	This species is found in the tall grass prairie areas west of the Mississippi River. It is most commonly associated with unplowed prairies and wet meadows.	Not likely to occur in project area.
Whooping Crane *Grus americana*	E	E	The nesting grounds for whooping cranes are located in poorly drained prairie areas interspersed with numerous potholes and wetlands of the Northwest Territories in Canada. During migration, whooping cranes use a variety of habitats including croplands for feeding and isolated riverine wetlands for roosting. The wintering grounds include areas of salt flats, tidal marshes and flats, and shallow bays along the Texas Gulf Coast and the Arkansas NWR.	Likely only occurs in project area during migration.
T = Threatened; E = Endangered; C = Candidate; PE = Proposed Endangered; PT = Proposed Threatened; NR = Not on Official Species List				

3.9 Cultural Resources

This section presents information on archeological and architectural resources located on USACE lands in the MKARNS system and associated properties. The discussion includes a description of methods used to identify existing archeological and architectural resources; the number and types of archeological and architectural resources known within the areas owned in fee; and the number of archeological and architectural resources that are listed or eligible for the National Register of Historic Places (NRHP) in those areas.

Cultural resources are prehistoric and historic sites, structures, districts, artifacts, or any other physical evidence of human activity considered important to a culture, subculture, or community for traditional, religious, scientific, or any other reason. Cultural resources are discussed in terms of archeological sites, which include both prehistoric and historical occupations either submerged or on land, and architectural resources. Archeological sites can become submerged when they are inundated following impoundment of rivers, and shipwrecks are a specific type of submerged archeological site.

Stewardship of cultural resources on USACE Civil Works water resources projects is an important part of the overall Federal responsibility of USACE. Numerous laws pertaining to identification, evaluation, and protection of cultural resources, Native American Indian rights, curation and collections management, and the protection of resources from looting and vandalism establish the importance of cultural resources to our Nation’s heritage. Guidance is derived from a number of cultural resources laws and regulations, including Sections 106 and 110 of the National Historic Preservation Act (NHPA) of 1966; Archaeological Resources Protection Act (ARPA) of 1979; Native American Graves Protection and Repatriation Act (NAGPRA); and 36 CFR Part 79, Curation of Federally Owned and Administered Archeological Collections. Implementing regulations for Section 106 of the NHPA and NAGPRA are 36 CFR Part 800 and 43 CFR Part 10, respectively. All cultural resources laws and regulations should be addressed under the requirements of NEPA as applicable.

3.9.1 Cultural Resources along the MKARNS

Prior to European contact, the Arkansas River system was used as a major means of travel, commerce, and for military purposes. Cultural resources are present along the river spanning the period of human occupation in the region, from Paleoindian through the historic era to the present. Sites in the project area include lithic scatters, rock or bluff shelters, camps, villages, special use/resource extraction sites, fish weirs, mounds, burials, middens, historic sites such as farmstead and town sites, ferry landings, wharfs, mills, dams, bridges, and watercraft—including canoes, boats, flatboats, barges, keelboats, dredges, and steamboats. These sites may be on land or submerged beneath the waters of the system. Only a small portion of the MKARNS system has been systematically surveyed for cultural resources, therefore, known sites are only a sample of the total population of resources likely present in the system. These resources include all archeological sites and architectural resources, including those listed on and eligible for the NRHP or listed in the most up to date survey information according to the records of the Arkansas Archeological Survey.

Archaeological sites representative of the Paleo-Indian, Archaic, Woodland, Caddoan/Mississippian, Protohistoric (Contact), and Historic Periods are known in the larger vicinity of the Arkansas River Valley in northeastern Oklahoma and northwestern Arkansas. Many archaeological sites in this area have undisturbed, deeply buried deposits. There are also numerous archeological sites that are comprised of multi-component prehistoric and/or historic occupations. Several cultural resources investigations, including archaeological survey and excavation, were conducted incident to and post-construction of the MKARNS. In the larger region there are hundreds of archaeological sites and historic standing structures on record with the Oklahoma State Historic Preservation Office (SHPO), Oklahoma Archeological Survey (OAS), and the Arkansas Archeological Survey. Ultimately, as a mainstem river in a major drainage basin of the central and southern Plains, the entire Arkansas River Valley can be classified as an area of high sensitivity for the location of cultural resources.

In Oklahoma, there are more than 250 archaeological sites recorded along and within close proximity to the MKARNS, most of which are prehistoric, and many have not been evaluated for the NRHP. In Arkansas, more than 350 archaeological sites are recorded in the APE. There is a high likelihood of unrecorded sites within the APE.

3.9.2 Cultural History Sequence

The culture history of the region is divided into broad time periods that aid in comparing divergent cultures and sequences. These divisions are based on technological and social changes observed in the archaeological record.

Paleoindian Period (12,000 - 8,000 B.C.)

While it is becoming increasingly evident that humans arrived in the Americas as early as 30,000 years ago, the Paleoindian Period is broadly accepted as spanning the end of the Pleistocene into the Early Holocene. The Clovis complex (12,000 - 8,000 B.C.) is the earliest well substantiated archaeological period in the region. Paleoindian sites are usually identified by the presence of the remains of extinct Pleistocene megafauna and signature stone tools. The most visible tools are projectile points, and these are used to reference different archaeological complexes. Long characterized as specialized big game hunters, it has now been demonstrated that the archaeological complexes of the Paleoindian period represent diversified economies of small bands of hunters and gatherers. Some bands of hunters were more reliant on megafauna than others, while some only hunted megafauna during specific seasons (Blackmar and Hofman 2006). The end of the Pleistocene saw a warming trend and the extinction of Pleistocene megafauna in North America. These environmental changes resulted in lifestyle changes during the Early Holocene. One archaeological complex, the Dalton Horizon (8,500 to 7,500 B.C.), spans from the end of the Paleoindian period and into the Early Archaic and is well represented in the area (Ballenger 2001; Blackmar and Hofman 2006; Meltzer 2009).

Dynamic landscape evolution throughout the Holocene has resulted in Paleoindian sites being deeply buried in alluvial stream deposits within the project area. The cutting and filling of sediments in the river and stream valleys has led to differential preservation of surfaces from this time, resulting in flushing out of sediments in some locations and time periods, and deposition of large amounts of sediments in other contexts and times (Mandel 2006). Additionally, the arrival of Euro-Americans in the region and subsequent land clearing led to vastly increased volumes of alluvial sedimentation on floodplains, mantling prehistoric surfaces with thick layers of recent alluvial deposits in stream valleys (Weston 1992). In the uplands, wind deposited sediments and tallgrass prairie obscure even shallow sites (Mandel 2006). Where erosion and agriculture are sufficient to reveal very old surfaces, Paleoindian points have been found on the surface. These points are most often collected, which results in loss of archaeological context. For these reasons, a limited number of Paleoindian sites have been recorded in the project area, though sites with both Paleoindian and Archaic deposits are better represented. The small number of sites from this period is a product of archaeological visibility rather than an actual representation of prehistoric populations and patterns of land use (Mandel 2006; Blackmar and Hofman 2006).

Archaic Period (8,000 – 500 B.C.)

The Archaic Period is characterized by the technological and social changes that accompanied the environmental changes following the retreat of the glacial ice sheets. Increases in seasonal variability of resources and increasing populations resulted in changing settlement and subsistence patterns. These are reflected in the archaeological record by an increasing diversity of stone tools for hunting a wider variety of both large and small game, tools for woodworking and plant processing, and features indicative of seasonal reoccupation of sites.

The advent of horticulture in the region occurred during this time, as did the introduction of ceramic technology, distinct mound building episodes in the eastern portion of the region, and the interment of exotic materials in mortuary contexts. Tool forms became increasingly specialized in order to exploit region-specific resources, and the bow and arrow was introduced. The Archaic period in Eastern Oklahoma is referred to in the region as pre-ceramic (in that pottery for storage and cooking is not present), but ceramic beads and effigy heads found at sites in the region are some of the earliest ceramic figures currently identified in the United States. It is clear that ceramic technology emerged during this time.

Woodland (500 B.C. – A.D. 900)

Aside from a slight cooling trend, the climate during the Woodland Period was largely consistent and essentially modern. The Woodland period is traditionally defined by the rise of and widespread use of ceramic vessels, increased sedentism, increasing social complexity, and improved agricultural techniques. In Eastern Oklahoma, plant cultivation is classified as incipient horticulture during this period, with agriculture emerging later in the period.

The use of pottery became more widespread, allowing for increased food storage and cooking capabilities, and the bow and arrow became common. Population gradually increased, and a variety of new tools were adopted. Woodland groups shared certain traits, including ceramic manufacture, status differentiation, unequal access to resources, and differential mortuary treatment for some individuals. Woodland peoples often built earthen mounds for ceremonial purposes and burial interment or used midden mounds as burial mounds.

Mississippian/Plains Village/Caddo Period (A.D. 900 - 1500)

The widespread appearance of political and religious hierarchies between A.D. 900-1450 are hallmarks of the Mississippian/Caddo Period. New forms of social integration emerged in cultures across most of the Southeast, continuing the social evolution sparked in the Late Woodland Period. Subsistence continued to be derived from a mixture of wild plant and animal foods, but with substantial reliance on Mesoamerican cultigens, particularly corn and beans. A hierarchical social system emerged at this time, with elite political-religious leaders, and non-elite followers who were primarily farmers. Mississippian settlement patterns in eastern Arkansas typically consisted of a large, central village containing one or more mounds surrounded by smaller villages and hamlets that provided maize as tribute to the central village. Settlements were located on the floodplains of large drainage systems because of their fertile soils. Platform mounds were topped with special purpose buildings, including temples, charnel houses, and elite residences.

Sites from this period in western Arkansas and Eastern Oklahoma include residential communities of different sizes such as villages, hamlets, and farmsteads, ceremonial centers, and ephemeral short term special-use camps. Caddoan sites are found in valley settings, including floodplains, terraces, upland projections, and upland slope formations. Local resources such as bison skins, wood for bows (Osage Orange), and pottery were exported. Non-local materials such as turquoise were imported from the west, and copper, marine shell, and large stone tools were brought in from the northeast and east.

Protohistoric (A.D. 1500-1700)

The end of Mississippian Period began in 1541 when the Spanish explorer Hernando De Soto entered the region. The earliest Europeans to arrive were the Spanish explorers in the mid-sixteenth century, followed by the French trappers and traders in the late seventeenth century. The Arkansas River was first encountered by Europeans in 1541 by Francisco Vasquez de Coronado near present day Dodge City, Kansas. In the same year, Hernando De Soto encountered the lower Arkansas River on his overland march from Florida through the interior southeast. Jacques Marquette and Louis Joliet entered the mouth of the Arkansas from the Mississippi River in 1673 and in 1682 LaSalle claimed the Arkansas River in the name of the King of France. Henri de Tonti, a French explorer, traveled throughout the valley in the late 1600s establishing a fort at the mouth of the Arkansas named Poste Aux Arcansas in 1682. Known today as Arkansas Post, this became the first Euro-American settlement in the Louisiana Territory and was intended to open the fur trade and encourage further exploration and settlement of the region. The location of the Post along the Arkansas River made trade easier with the Osage to the north and the Quapaw and Caddo to the south. The Europeans brought diseases with them, such as smallpox and influenza, had a devastating effect. The tribes inhabiting the area had no immunity against these diseases, and up to 90 percent of the populations were decimated.

Protohistoric sites in Oklahoma appear to be directly related to an earlier manifestation of similar village sites located further north in Kansas, including the Great Bend aspect with sites in south-central Kansas. Great Bend manifestations likely represent the proto-Wichita villages encountered by Francisco Coronado in 1541. Slightly later Proto-Wichita sites from the early 1700's have been identified on the mainstem Arkansas River in Kay County, north-central Oklahoma, and on the mainstem Arkansas River in southern Tulsa County, Oklahoma. These early 1700's Proto-Wichita sites are evidence of French influence on the southern Plains, as artifact assemblages from these sites contain metal musket parts from French firearms, glass trade beads (French), and European gunflints. The sites are also physically reflective of a significant trade economy with the French, where bison hides were processed in significant numbers and traded for firearms, beads, and gunflints.

<u>Historic Period (post A.D. 1700)</u>

The dramatic cultural changes brought about by the advent of European colonies, as well as the new trade goods and European diseases, resulted in drastic and permanent changes to Native cultures. Introduction of European items and European demand for particular resources, such as beaver pelts and deer skins, continued to transform Native trading systems.

In 1803, the United States acquired the region through the Louisiana Purchase. Soon after, American explorers, military personnel, and naturalists began to evaluate the area. These explorers included James B. Wilkinson (1806), Major Stephen H. Long (1817 and 1821), Thomas Nuttall (1819), Thomas James (1821), and Jacob Fowler (1821). The early explorations led to the founding of many trails which later served as immigration avenues for the future inhabitants of the region. Major Long was tasked with finding a suitable place for a military fort in 1817 and founded Fort Smith at Belle Point near the confluence of the Poteau and the Arkansas rivers (at the Arkansas-Oklahoma state line). Official voyages of exploration resulted in mapping of the region's rivers, and settlements and homesteads began to appear in what is now northeast Arkansas.

President James Monroe signed the act creating the Territory of Arkansas in 1819. The Arkansas Post had grown from a frontier trading post, and had lawyers, land speculators, politicians, and the Arkansas Gazette, the first newspaper west of the Mississippi River. The War Department decided to push the frontier further westward, and Little Rock became the capital of the Arkansas Territory. The Territory became a state in 1836, and land was open for public sale in 1921.

The Indian Removal Act, passed in May 1830, empowered the President of the United States to move eastern Native Americans west of the Mississippi, to what was then "Indian Territory" (present-day Oklahoma). In the years immediately following establishment of the Arkansas Territory, the Federal government concentrated efforts on abrogating old treaties with the Indian tribes, and signing new treaties aimed at clearing the resident tribes from the southeastern states. From 1830 to 1839, the removal of the major southeastern tribes occurred from east of the Mississippi to the new Indian Territory. The Arkansas River was traversed by thousands of Choctaw, Creek, Chickasaw, Cherokee, and Seminole in part of what came to be known infamously as the Trail of Tears. For some tribes, it has been estimated as many as one fourth of their population perished and were buried along the route.

The Cherokee Nation was created in northeastern Oklahoma in 1828, soon thereafter incorporating the Quapaw and Seneca tribes. After the Civil War, the area was further divided into reserves for the Peoria, Ottawa, Wyandotte and others. From 1838 to 1871 the Neosho Agency held jurisdiction over all tribes except the Cherokee. Between the 1830s and 1850s Anglo-Americans occupied tribal lands to operate mission schools, trading posts, ferries, mills, and blacksmith shops. The period 1850-1900 was marked by increasing Anglo-American land speculation and enhanced military supply lines through the study region that connected Fort Gibson, Fort Scott and Fort Leavenworth during the Civil War.

The bulk of the early Civil War military operations in Arkansas occurred in the northern portion of the state and to the east along the Mississippi River. A few major battles, such as Pea Ridge, were fought in the northwest. The abolition of slavery in 1865 led to replacement of the plantation system with tenant farms. The landscape became dominated by small, dispersed farms operated by Euro-American or African American renters, or sharecropper families. Some larger farms continued operating very much like plantations, with workers being paid in script (useful only at the company store) making them reliant on the farm for meeting all basic needs. The river was the most economical way to ship cotton and produce to markets further east, and steamboats were common from the 1830s onward.

Oklahoma became a state in 1907. Leading up to statehood, the Dawes Commission beginning in 1894, established a private land distribution system, enrolled tribal members, and assigned individual allotments of land. Additionally, allotments were given to many African Americans freed by the Civil War, leading to the establishment of numerous all black towns such as Chase, Lee, Summit, Twine, and Wybark (Mullins 2009).

The introduction of rail transportation in the Arkansas River basin in the 1870s, and the unpredictable nature of the river, resulted in a severe decline in waterway commerce. However, with the expansion of the west into the Arkansas and Indian Territories, the need for irrigation waters resulted in the construction of water diversion structures in the upper Arkansas River. These canals developed in the late 1800s in Colorado and Kansas along the Arkansas River. Irrigation on the upper river drastically diminished summer flows in lower portions of the river, further hurting river transportation.

3.9.3 MKARNS History

The first steamboat to travel the Arkansas River was the Comet (154 tons), in 1820, and took eight days to travel from New Orleans to Arkansas Post. In addition to valuable trade commerce, steamboats were utilized for many military purposes including the transportation of supplies and equipment and troops, as well as movement of displaced Native Americans.

The early 1900s witnessed many severe floods in the Arkansas River valley that hit rail transportation, levees and public works projects very hard. Following the Flood of 1927 on the

Arkansas River, the Arkansas River Flood Control Association was formed to lobby Congress for a flood control program. Congress included the Arkansas River in early flood control legislation in 1928, and then passed the Flood Control Act in 1936. This Act established a Southwestern Division of the USACE and authorized 211 flood control projects in 31 states. The Southwestern Division began work on the Arkansas River the following year.

Although the Flood Control Act authorized recreation facilities at reservoirs in 1944, the authorization of the MKARNS, through Congressional passing of the Rivers and Harbors Act in 1946, formalized a plan for navigation, flood control, hydroelectric power, and recreation improvements to the waterway. Initial funding of $55 million was established for the most critical improvements. However, funding was required to be obtained on a year-to-year and project-by-project basis thereafter.

In the 1950s major flood, flow, and navigation issues were studied and projects established to resolve these issues including channelization efforts, construction of upstream reservoirs, and construction of lock and dam projects on the system. In 1954, the Waterways Experiment Station evaluated a channelization plan to reduce sedimentary flow (as 100 million tons of silt flowed down the Arkansas River each year) by creating deeper, straighter, and narrower channels to increase river flow and flush out trapped sediments.

The major components of the MKARNS were finally completed in December of 1970, and the first commercial barge to navigate the entire system arrived at the Tulsa Port of Catoosa on January 21, 1971. The cargo contained 650 tons of newsprint from the Bowater Paper Company. The MKARNS was officially dedicated on June 5, 1971, by then President Richard M. Nixon.

3.9.4 Cultural Resources Inventories

Cultural resources are prehistoric and historic archaeological sites, structures, districts, artifacts, or any other physical evidence of human activity considered important to a culture, subculture, or community for traditional, religious, scientific, or any other reason. Cultural resources are discussed in terms of archeological sites, which include both prehistoric and historical occupations either submerged or on land, and architectural resources. Archeological sites can become submerged when they are inundated following impoundment of rivers. Shipwrecks are a specific type of submerged archeological site.

The largest single archaeological assessment of archaeological resources on the MKARNS is A.F. Miller's 1977 "A Survey and Assessment of the Cultural Resources of the McClellan-Kerr Arkansas River Navigation System in Oklahoma, 1976." This investigation looked at the entire MKARNS system in Oklahoma, including the mainstem Arkansas River and the Verdigris River portions, identifying and visiting previously recorded archaeological sites, nearly 80 in total.

While archaeological site testing and major excavations and some limited archaeological surveys were accomplished in the Arkansas River valley, primarily from the 1960s through the early 2000s, investigations conducted since 2005 consist of numerous small surveys for Section 106 compliance, and two large archaeological investigations.

A series of projects was completed as part of the American Reinvestment and Recovery Act (ARRA) of 2009. URS Group, Inc., and AmaTerra Environmental (previously EComm) were contracted to perform investigations for the USACE Tulsa District.

URS Group, Inc. completed an archaeological survey pursuant to Section 110 of the NHPA for 1,359 acres surrounding Robert S. Kerr Reservoir (R.S. Kerr lock and dam) in 2010 and 2011. The results are detailed in a report titled *Intensive Archaeological Resources Survey of Four United States Army Corps of Engineers Administered Public Use Areas, Robert S. Kerr*

Reservoir; Haskell, LeFlore, and Sequoyah Counties, Oklahoma (Meier et al. 2012). Twenty-two new archaeological sites and 10 isolated finds were recorded, and nine previously recorded sites were revisited. Of the 31 sites investigated, 12 were recommended as potentially eligible for listing on the NRHP.

In 2010 and 2011, and again in 2014, AmaTerra Environmental, Inc., previously known as Environmental Communications Corporation (EComm), conducted revisits and reevaluations of previously recorded archaeological sites at both R.S. Kerr and Webbers Falls Reservoirs. Results are detailed in: *Assessment of 58 Archaeological Sites at Robert S. Kerr Reservoir in Muskogee, Haskell, and Sequoyah Counties, Oklahoma,* (Bonine 2015) and *Assessment of 32 Archaeological Sites at Webbers Falls Reservoir in Muskogee County, Oklahoma* (Bonine et al. 2015). At Kerr Reservoir, fourteen sites were recommended as potentially eligible for listing on the NRHP, and avoidance and protection were recommended until an additional NRHP evaluation could occur. Two sites were recommended eligible for the NRHP, and one site, 34HS25, is listed on the NRHP. At Webbers Falls Reservoir, eight sites were recommended as potentially eligible and in need of additional NRHP evaluation.

Shipwrecks, the sunken remains of boats, barges, steamboats, and other watercraft, are documented throughout the Arkansas River system. Historic accounts, including newspapers, diaries, and military records, describe some of these events. Some of the wrecks were salvaged immediately, but others quickly disappeared. Remnants of wrecked vessels may remain in the river if they were quickly buried by protective sediments, while some were likely destroyed by the river current, subsequent dredging activities, or were simply washed downstream into the Mississippi River. Shipwrecks have sometimes been found buried in abandoned river channels that are now on dry land. Wrecks were usually caused by boiler explosions, shoaling, or hitting snags and submerged objects. The general locations of ninety shipwrecks in MKARNS are known, but their actual remains have not been discovered.

3.10 Socioeconomics and Environmental Justice

This section describes the demographic and socioeconomic characteristics for the geographic areas surrounding the MKARNS. The zone of influence (ZOI) for the purpose of the SEA is defined as the area within a 50-mile-wide corridor centered on the MKARNS (Figure 3-3). The area of analysis includes 18 Arkansas counties and 22 Oklahoma counties (Table 3-8).

This ZOI was based primarily on historic visitation information. The demographic and socioeconomic description for the ZOI in this section of the report is summarized at the county level. The data for the counties has been aggregated into the ZOI totals in the tables and figures. To determine which counties were included in the summary tables and figures, all counties that intersected or fell within the 50-mile driving radius were identified. When the ZOI is referenced in this section, it is referring to the aggregate socioeconomic and demographic data for the area. Demographic and socioeconomic data for the states of Arkansas and Oklahoma as well as the United States are provided for comparison purposes.

Figure 3-3. MKARNS 12-Foot Channel Zone of Influence

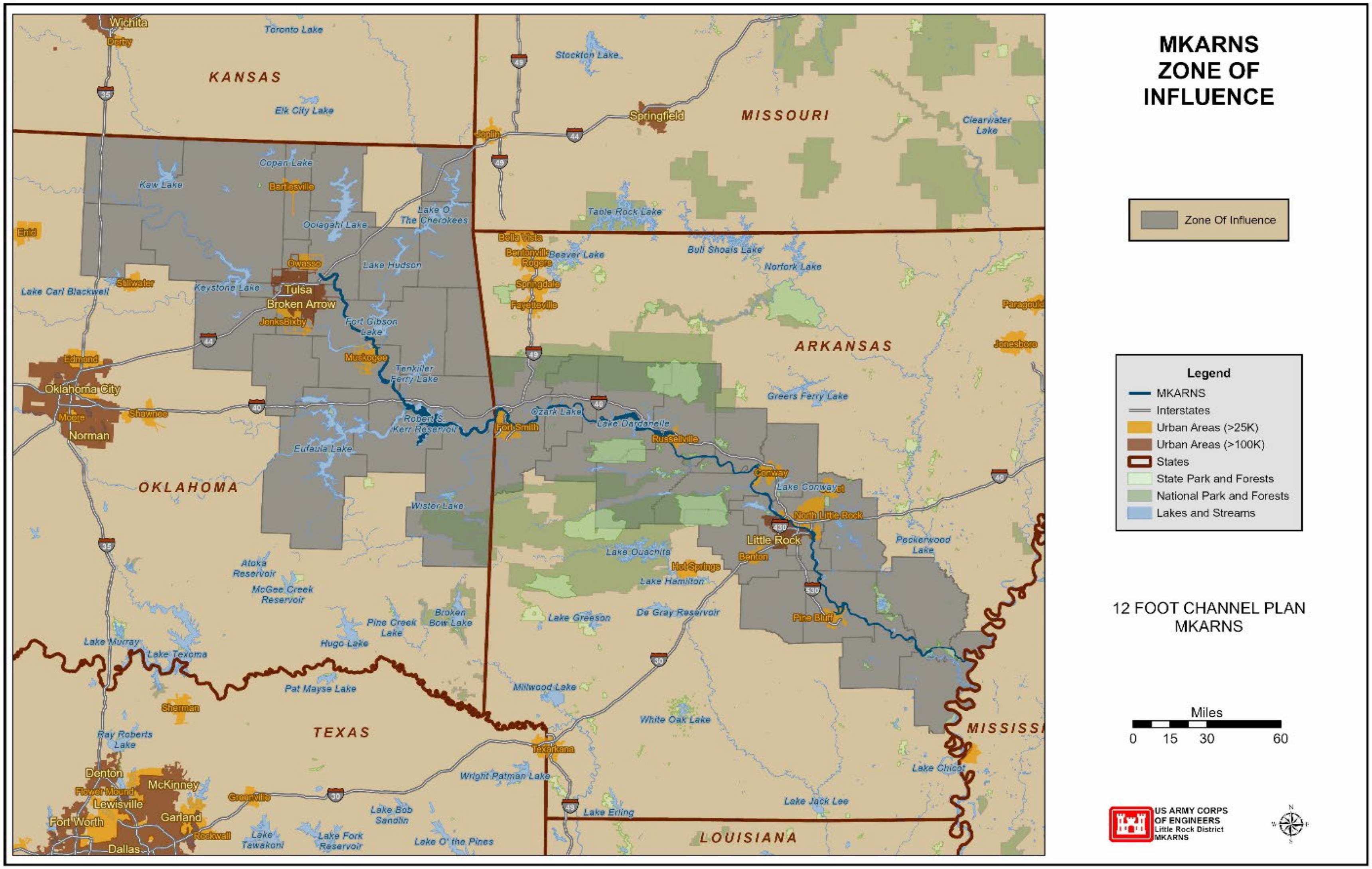


Table 3-8. Counties Within the MKARNS 12-Foot Channel Zone of Influence

Arkansas		Oklahoma	
Arkansas	Lincoln	Adair	Nowata
Conway	Logan	Cherokee	Okmulgee
Crawford	Lonoke	Creek	Osage
Desha	Perry	Delaware	Ottawa
Faulkner	Pope	Haskell	Pawnee
Franklin	Pulaski	Kay	Pittsburg
Grant	Saline	Le Flore	Rogers
Jefferson	Sebastian	Mayes	Sequoyah
Johnson	Yell	McIntosh	Tulsa
		Muskogee	Wagoner
		Noble	Washington

3.10.1 Population

Socioeconomic data was acquired from the 2010 U.S. Bureau of Labor Statistics census and the 2020 American Community Survey. Table 3-8 shows population estimates as well as the estimated annual growth rate for each county in the ZOI. Annual growth rate in recent years has been a mix of positive and negative in individual counties, but overall was positive for the ZOI. The growth rate in the ZOI between 2010 and 2020 was 3.5%. During the same timeframe, the growth rate was 7.35% in the United States and 3.28% in Arkansas and 5.69% in Oklahoma. Total ZOI population was 2,642,492 (2010) and 2,733,928 (2020).

Table 3-9. Population Estimates and Trends (MKARNS)

Population	2020	2010	% Change
United States	331,449,281	308,745,538	7.35%
State of Arkansas	3,011,524	2,915,918	3.28%
Arkansas	16,722	19,019	-12.08%
Conway	20,873	21,273	-1.88%
Crawford	60,378	61,948	-2.53%
Desha	11,090	13,008	-14.74%
Faulkner	125,106	113,237	10.48%
Franklin	17,173	18,125	-5.25%
Grant	18,090	17,853	1.33%
Jefferson	65,861	77,435	-14.95%
Johnson	25,845	25,540	1.19%
Lincoln	13,037	14,134	-7.76%
Logan	21,215	22,253	-4.66%
Lonoke	74,722	68,356	9.31%
Perry	9,964	10,445	-4.61%
Pope	63,789	61,754	3.30%
Pulaski	397,821	382,748	3.94%
Saline	125,233	107,118	16.91%
Sebastian	128,400	124,744	2.93%
Yell	20,155	22,185	-9.15%
ZOI Total Arkansas	1,215,474	1,181,175	2.90%
State of Oklahoma	3,964,912	3,751,351	5.69%
Cherokee	47,090	46,987	0.22%
Creek	71,837	69,967	2.67%
Delaware	40,385	41,487	-2.66%
Haskell	11,552	12,769	-9.53%
Kay	43,609	46,562	-6.34%

Population	2020	2010	% Change
Le Flore	48,195	50,384	-4.34%
Mayes	39,053	41,259	-5.35%
McIntosh	18,950	20,252	-6.43%
Muskogee	66,241	70,990	-6.69%
Noble	10,922	11,561	-5.53%
Nowata	9,322	10,536	-11.52%
Okmulgee	36,686	40,069	-8.44%
Osage	45,778	47,472	-3.57%
Ottawa	30,229	31,848	-5.08%
Pawnee	15,552	16,577	-6.18%
Pittsburg	43,784	45,837	-4.48%
Rogers	95,387	86,905	9.76%
Sequoyah	39,246	42,391	-7.42%
Tulsa	670,653	603,403	11.15%
Wagoner	81,379	73,085	11.35%
Washington	52,604	50,976	3.19%
ZOI Oklahoma	1,518,454	1,461,317	3.91%
ZOI Total (AR+OK)	**2,733,928**	**2,642,492**	**3.5%**

3.10.2 Race and Ethnicity

Population by race and Hispanic origin is displayed in Table 3-10 below. The ZOI is approximately 64% White, 12% Black or African American, 5.7% American Indian and Alaska Native, 2% Asian, 0.10% Hawaiian and Pacific Islander, 8.4% two or more races, and 8% Hispanic or Latino. By comparison, the states of Arkansas and Oklahoma combined population is approximately 63% White, 17% Black or African American, 3% American Indian and Alaska Native, 1.6% Asian, 0.09% Hawaiian and Pacific Islander, 7% two or more races, and 7.4% Hispanic or Latino.

Table 3-10. Population by Race and Hispanic Origin

	White Alone	Black or African American alone	American Indian and Alaska Native alone	Asian Alone	Native Hawaiian and Other Pacific Islander alone	Two or more races	Hispanic or Latino (of any race)
United States	196,251,375	39,994,653	2,075,852	18,184,182	550,080	9,134,542	59,361,020
State of Arkansas	3,192,147	1,292,950	21,297	67,317	1,887	94,858	212,951
Arkansas Counties							
Arkansas	12,246	4,461	102	10	0	344	598
Conway	16,774	2,119	85	125	0	713	871
Crawford	52,859	957	938	1,030	16	2,133	5,027
Desha	5,075	5,552	11	27	0	92	768
Faulkner	99,457	14,252	422	1,434	167	3,365	5,192
Franklin	16,243	173	275	133	37	356	568
Grant	16,850	458	17	0	29	350	525
Jefferson	26,092	37,989	199	671	358	1,279	1,482
Johnson	20,890	405	47	596	20	734	3,700
Lincoln	8,516	4,016	62	0	0	133	543
Logan	19,165	321	175	344	0	943	662
Lonoke	62,525	3,998	322	683	154	2,083	3,332
Perry	9,463	265	14	6	0	274	317
Pope	53,502	1,645	283	714	0	1,830	5,882
Pulaski	202,791	145,000	856	8,382	144	10,809	24,214

	White Alone	Black or African American alone	American Indian and Alaska Native alone	Asian Alone	Native Hawaiian and Other Pacific Islander alone	Two or more races	Hispanic or Latino (of any race)
Saline	100,891	9,211	270	1,454	110	2,869	6,017
Sebastian	88,206	7,849	1,213	5,786	14	6,042	18,397
Yell	16,030	380	72	238	0	308	4,397
ZOI Arkansas	827,575	239,051	5,363	21,633	1,049	34,657	82,492
State of Oklahoma	2,809,793	287,856	303,791	87,033	6,418	577,962	486,692
Oklahoma Counties							
Cherokee	22,938	577	16,047	452	25	6,480	3,652
Creek	55,230	1,086	8,565	230	0	6,196	3,954
Delaware	25,966	177	8,948	502	50	4,660	1,627
Haskell	8,224	80	1,183	28	0	2,074	554
Kay	33,354	829	4,132	265	14	4,137	3,781
Le Flore	35,333	873	5,689	386	10	4,993	3,560
Mayes	25,331	145	8,183	164	34	5,201	1,503
McIntosh	13,133	469	3,146	101	13	2,186	573
Muskogee	36,845	6,200	10,985	550	0	9,382	5,114
Noble	8,928	25	871	12	4	1,016	475
Nowata	6,259	134	1,491	47	14	1,416	314
Okmulgee	23,540	2,813	5,724	186	19	4,529	1,662
Osage	29,427	4,969	5,248	150	0	5,779	1,816
Ottawa	19,835	358	6,293	232	226	2,804	1,834
Pawnee	12,011	76	1,650	24	2	1,802	528
Pittsburg	31,205	1,080	2,573	200	70	8,387	2,454
Rogers	69,938	1,211	12,245	1,870	68	12,210	5,747
Sequoyah	24,883	836	8,851	364	24	4,101	1,850
Tulsa	414,532	68,024	32,964	25,293	1,184	101,676	96,132
Wagoner	60,055	2,858	8,080	2,000	62	11,777	7,151
Washington	38,866	1,349	5,290	1,100	5	4,526	3,380
ZOI Oklahoma	995,833	94,169	158,158	34,156	1,824	205,332	147,661
ZOI AR+OK	**1,823,408**	**333,220**	**163,521**	**55,789**	**2,873**	**239,989**	**230,153**

3.10.3 Income

Key income indicators (median household income and per capita income) are presented in Table 3-11. Per capita income for counties in the project area varies, but the average per capita income for the ZOI was $26,396 in 2020. By comparison, per capita income was $35,384 in the United States, $27,724 in the State of Arkansas, and $29,873 in Oklahoma. Median household income ranges from a low of $31,855 in Desha County, AR to a high of $73,199 in Wagoner County, OK. The largest majority of the ZOI is employed in the Management, Business, Science, and Arts Occupations, followed by Sales and Office Occupations, Service Occupations, Production, Transportation, and Material Moving Occupations. Natural Resources, Construction, and Maintenance Occupations employed the fewest individuals.

Table 3-11. Income Indicators and Employment by Industry

	Per Capita income	Median Income	Total Civilian Workforce	Management, Business, Science, and Arts	Service	Sales and Office Workers	Natural Resource, Construction and Maintenance	Production and Transportation
United States	$35,384	$64,994	155,888,980	61,526,906	27,095,654	33,247,878	13,620,436	20,398,106
State of Arkansas	$27,724	$49,475	1,309,748	456,538	217,074	278,061	131,748	226,327
State of Oklahoma	$29,873	$59,673	1,836,305	700,537	293,932	393,608	193,946	254,282
Arkansas Counties								
Arkansas	$26,969	$51,000	7,929	2,483	1,216	1,526	974	1,730
Conway	$28,539	$44,456	8,992	2,576	1,582	1,623	1,420	1,791
Crawford	$25,460	$48,980	25,924	7,596	4,249	6,129	2,606	5,344
Desha	$19,090	$31,855	4,377	1,236	889	946	535	771
Faulkner	$27,414	$54,191	59,134	23,803	10,129	12,703	5,084	7,415
Franklin	$20,639	$37,561	6,898	1,982	965	1,380	876	1,695
Grant	$30,639	$59,051	8,048	2,778	1,176	1,548	1,073	1,473
Jefferson	$21,941	$40,402	25,271	7,499	5,345	4,603	1,904	5,920
Johnson	$22,077	$39,346	10,398	2,966	1,601	1,949	1,100	2,782
Lincoln	$14,182	$46,554	3,347	938	556	713	473	667
Logan	$22,632	$44,232	8,991	2,219	1,568	1,695	1,105	2,404
Lonoke	$28,446	$59,278	33,170	11,876	4,781	7,679	4,089	4,745
Perry	$23,030	$44,962	3,677	1,074	531	728	557	787
Pope	$27,414	$46,004	26,827	8,670	5,410	4,880	2,562	5,305
Pulaski	$33,773	$52,930	183,975	78,697	29,390	42,471	11,484	21,933
Saline	$31,973	$66,876	57,987	22,124	8,266	14,231	5,659	7,707
Sebastian	$28,623	$47,878	58,496	19,612	9,883	12,591	5,598	10,812
Yell	$23,008	$47,981	9,476	2,115	1,685	1,958	1,217	2,501
Oklahoma Counties								
Cherokee	$25,069	$47,421	19,959	7,412	3,454	4,082	2,538	2,473
Creek	$29,795	$56,756	32,091	10,428	5,189	7,545	3,474	5,455
Delaware	$30,620	$46,588	15,665	5,057	3,032	3,080	1,978	2,518

	Per Capita income	Median Income	Total Civilian Workforce	Management, Business, Science, and Arts	Service	Sales and Office Workers	Natural Resource, Construction and Maintenance	Production and Transportation
Haskell	$23,870	$43,622	4,523	1,457	859	777	811	619
Kay	$27,323	$50,391	18,712	5,189	3,525	3,775	2,522	3,701
Le Flore	$22,167	$43,049	18,436	4,845	3,595	3,755	2,555	3,686
Mayes	$27,334	$52,956	16,725	4,943	3,011	3,134	2,233	3,404
McIntosh	$23,606	$40,792	6,307	1,718	1,287	1,025	998	1,279
Muskogee	$23,314	$54,070	27,712	8,661	5,231	5,970	2,771	5,079
Noble	$29,185	$62,910	4,655	1,799	579	917	481	879
Nowata	$24,532	$46,786	3,934	1,253	555	790	617	719
Okmulgee	$35,384	$48,689	14,932	4,216	3,264	3,310	1,545	2,597
Osage	$26,852	$54,036	19,159	6,190	3,507	4,315	2,066	3,081
Ottawa	$21,394	$42,311	12,417	3,672	2,782	2,418	1,454	2,091
Pawnee	$25,174	$53,084	6,521	2,002	980	1,274	921	1,344
Pittsburg	$25,685	$49,669	17,440	5,878	3,076	3,540	2,058	2,888
Rogers	$33,030	$71,817	50,311	18,887	7,138	11,762	5,012	7,512
Sequoyah	$21,102	$43,496	15,177	3,887	3,102	3,583	1,790	2,815
Tulsa	$36,303	$63,332	331,011	136,010	51,647	71,232	27,578	44,544
Wagoner	$30,727	$73,199	40,991	16,360	5,429	9,522	4,103	5,577
Washington	$31,113	$55,216	22,577	8,547	4,040	4,527	2,180	3,283
ZOI Average	**$26,396**	**$50,352**	**31,851**	**11,760**	**5,244**	**6,915**	**3,026**	**4,906**

3.10.4 Recreation

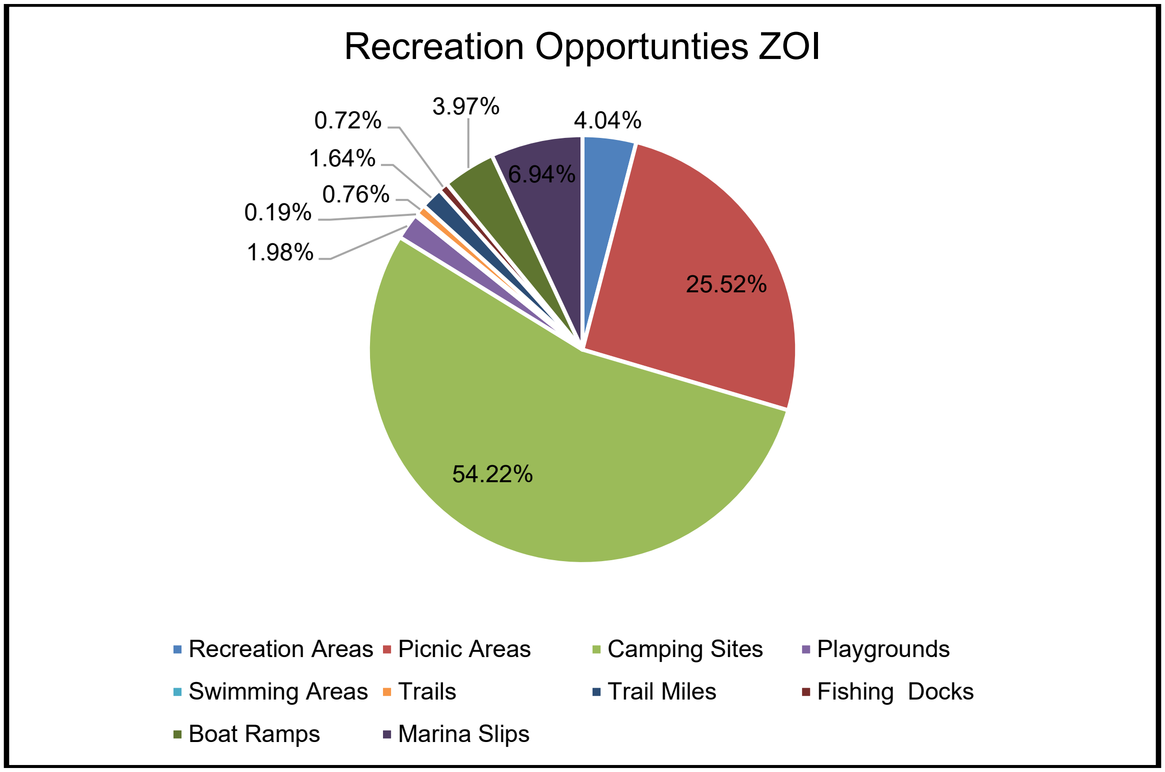
Recreation and tourism in counties adjacent to the MKARNS ZOI study area are also an important part of local economies. Recreation within the ZOI has a substantial impact to local economies based on surveys of visitor spending and attendance within the ZOI. Table 3-12 shows the type and number of recreational facilities within the MKARNS system as of 2019. The MKARNS consists of approximately 70,031 acres, with 1,142 miles of shoreline and 182,834 of acres of surface water. In 2020, visitation at recreation areas within the MKARNS ZOI totaled approximately 3.3 million visitors. Visitors spent $144.8 million in local economies within 30 miles of the defined area of recreation, including $77.3 million in business revenues that created a total of 1,242 jobs and labor income totaling over $36.6 million.

The MKARNS systems offers many types of recreational opportunities including 106 recreational sites,669 picnic areas,1,421 camping sites, 52 playgrounds, 5 swimming areas, 20 trails, 43 trail miles,19 fishing docks,104 boat ramps, and 182 marine slips. These recreation amenities are typically located on USACE operated reservoirs along the MKARNS. Figure 3-4 illustrates recreational activities as a percent total. Figure 3-5 illustrates visitors use by activity. Sightseeing was the most popular activity with 22.37% of visitors engaging in this activity with campers being the lowest attended activity at 7.45%.

Table 3-12. Recreation Facilities on the MKARNS

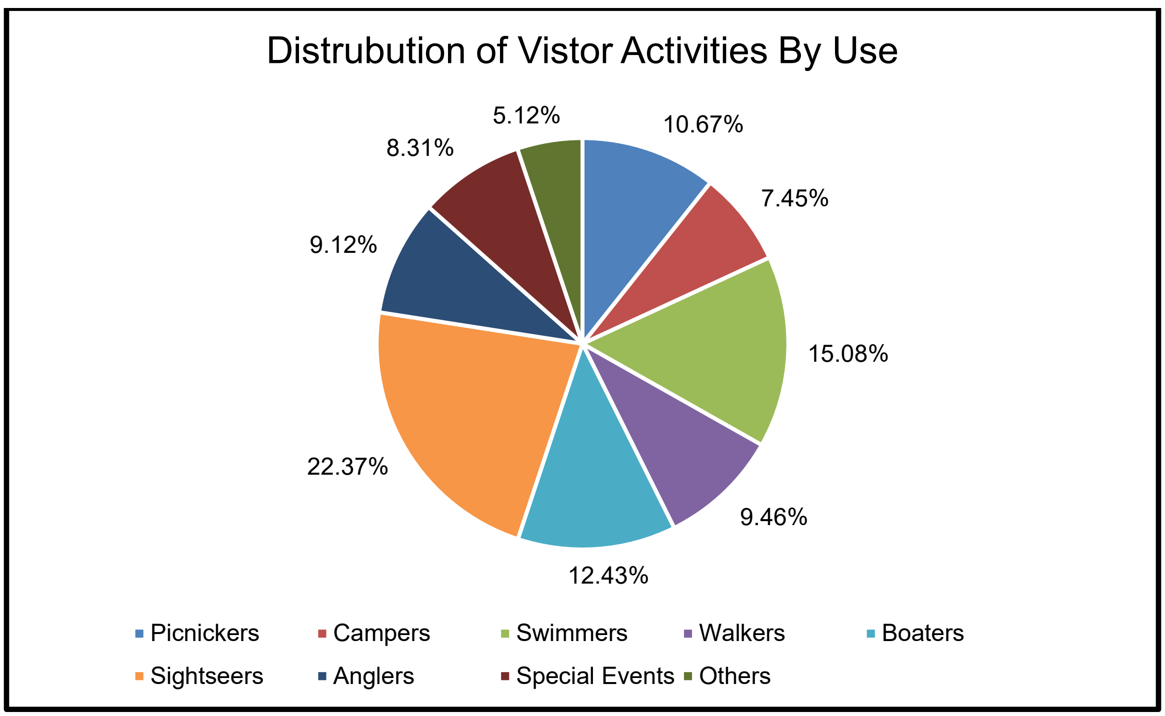
Facility	Number of Sites (ZOI)
Recreation Areas	106
Picnic Areas	669
Camping Sites	1421
Playgrounds	52
Swimming Areas	5
Trails	20
Trail Miles	43
Fishing Docks	19
Boat Ramps	104
Marina Slips	182
Source: USACE Institute for Water Resources, Value to the Nation	

Figure 3-4. Recreation Opportunities within the Zone of Influence



Source: USACE Institute for Water Resources, Value to the Nation

Figure 3-5. Distribution of Visitor Activities by Use within the Zone of Influence

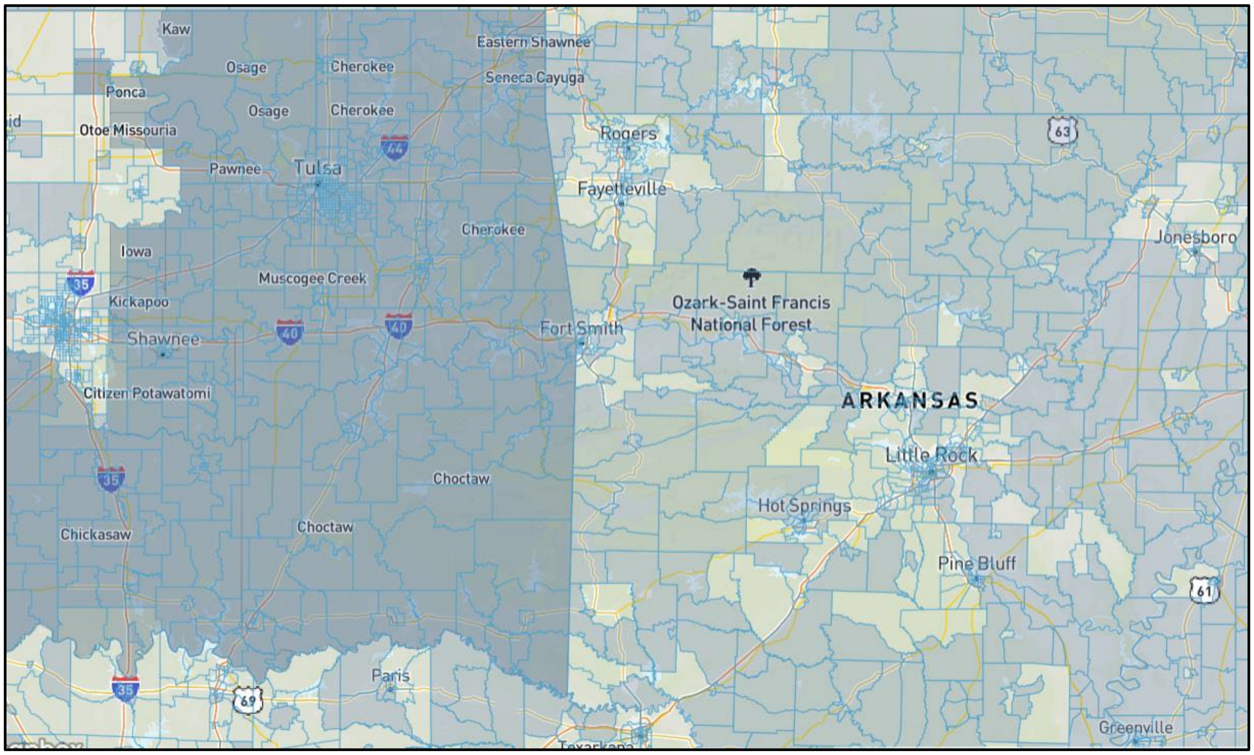


Source: USACE Institute for Water Resources, Value to the Nation

3.10.5 Environmental Justice

Environmental Justice (EJ) is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. The Council on Environmental Quality (CEQ) Climate and Economic Justice Screening Tool (CEJST) was utilized to conduct a review of disadvantaged census tracts within the project area (CEQ 2022). Figure 3-6 below is a screenshot of the CEJST mapping tool spanning the entire study area. The areas shaded in blue considered disadvantaged by CEQ definition. Census tracts in green are not considered disadvantaged, those in light blue are considered disadvantaged for any metric evaluated that exceeds the CEQ's acceptable threshold, and dark blue census tracts represent those considered disadvantaged because they contain Federal Indian land area, in addition to any of the other metrics evaluated.

Figure 3-6. CEJST Map of the Study Area



Federally Recognized Tribes as identified by Federal Indian land area are considered disadvantaged communities. As evidenced by the dark blue shaded census tracts in Figure 3-6 above, the entirety of Eastern Oklahoma, including the MKARNS study area within Oklahoma, is considered disadvantaged due to the presence of lands of Federally Recognized Tribal Nations. While on their own they may not be considered disadvantaged, many census tracts, particularly near the Port of Catoosa, are considered economically disadvantaged because they are completely surrounded by other tracts that are disadvantaged, predominantly due to the presence of Federally Recognized Tribes.

Census tracts in more urban areas along the Arkansas including Catoosa, Muskogee, Fort Smith, Little Rock, and Pine Bluff are considered disadvantaged based on a variety of analyzed metrics. These include health metrics such as asthma, heart disease, and low life expectancy rates paired with a low income rate above the acceptable threshold. Health disparities also occur intermittently in rural pockets along the river.

Areas along the MKARNS in both Oklahoma and Arkansas, primarily rural in nature, face climate change risk factors, including expected agriculture loss rate (economic loss to agricultural value resulting from hazards each year), expected building loss rate (economic loss to building value resulting from natural hazards each year), projected wildfire risk (projected risk to properties from wildfire from fire fuels, weather, humans, and fire movement in 30 years), and expected population loss rate (fatalities and injuries resulting from natural hazards each year). Urban areas saw a higher occurrence of expected population loss rate from natural hazards each year. These climate challenges can likely be linked to proximity to the Arkansas River during flood events and to undeveloped, forested areas as well as agricultural lands, both characterized by fire fuels, during wildfire events.

Legacy pollution affects intermittent areas, primarily rural but also urban, along the length of the MKARNS within the study area. Proximity to formerly used defense sites and the presence of abandoned mines, paired with a low income above the CEQ's accepted percentile when compared to the nation, contributes to communities' difficulties. Rural areas also face transportation barriers, defined as the average of relative cost and time spent on transportation, paired with a low income below the acceptable threshold contribute to census tract classification as disadvantaged.

Urban areas including Catoosa, Muskogee, Fort Smith, Little Rock, and Pine Bluff are seemingly more disadvantaged than rural areas as they have a higher occurrence of health, workforce development (poverty and unemployment paired with less than a high school education), and energy (cost of energy paired with low income) related disadvantages. However, rural areas along the MKARNS are at a higher risk for climate change and transportation factors.

4 Environmental Consequences

In this section, the environmental consequences of both the No Action Alternative and the MKARNS 12-Foot Channel Alternative (Proposed Action) are evaluated. Only those resources that have the potential to be affected by any of the alternatives are described, as per CEQ guidance (40 CFR 1502.2[b]).

Impacts (consequence or effect) can be beneficial or adverse and can be directly or indirectly caused by the action. Direct effects are caused by the action and occur at the same time and place (40 CFR 1508.1[g]). Indirect effects are caused by the action and are later in time or further removed in distance but are still reasonably foreseeable (40 CFR 1508.1[g]). As discussed in this section, the alternatives may create temporary (less than 1 year), short-term (up to 3 years), long-term (3 to 10 years) or permanent effects (throughout the life of the project).

In considering whether the effects of the alternatives being considered are significant, the potential affected environment and degree of the effects of the action are analyzed (40 CFR 1501.3). Impacts on each resource can vary in degree or magnitude from a slightly noticeable change to a complete change in the environment. For this analysis, the intensity of impacts would be classified as negligible, minor, moderate, or major. The intensity thresholds are defined as follows:

- Negligible: A resource would not be affected, or the effects would be at or below the level of detection, and changes would not be of any measurable or perceptible consequence.

- Minor: Effects on a resource would be detectable, although the effects would be localized, small, and of little consequence to the sustainability of the resource. Mitigation measures, if needed to offset adverse effects, would be simple and achievable.
- Moderate: Effects on a resource would be readily detectable, long-term, localized, and measurable. Mitigation measures, if needed to offset adverse effects, would be extensive and likely achievable.
- Major: Effects on a resource would be obvious and long-term and would have substantial consequences on a regional scale. Mitigation measures to offset adverse effects would be required and extensive. Success of the mitigation measures would not be guaranteed.

Finally, impacts are described in relation to their significance. The CEQ regulations require consideration of the potentially affected environment and degree of the effects of the action (40 CFR 1501.3(b)). In considering the potentially affected environment, the affected area (national, regional, or local) and its resources, such as listed species and designated critical habitat under the Endangered Species Act, are considered, as appropriate to the specific action. Significance varies with the setting of each alternative and is dependent on the extent of the affected area. In considering the degree of the effects, the extent of the impact is considered using the following, as appropriate to the specific action:

- Both short- and long-term effects.
- Both beneficial and adverse effects.
- Effects on public health and safety.
- Effects that would violate Federal, State, Tribal, or local law protecting the environment.

4.1 Air Quality

4.1.1 Environmental Consequences Associated with the No Action Alternative

Under the No Action Alternative, navigation channel maintenance and depth would remain unchanged from existing actions. Impacts to air quality associated with implementing the No Action would be similar to existing impacts, which result from regular barge traffic through the MKARNS as well as emissions from O&M efforts such as maintenance dredging. Channel deepening would not change, therefore barge traffic and tow weights would not be affected, resulting in criteria pollutant emissions from both barge traffic and other forms of transportation remaining the same. The No Action Alternative would have negligible, long-term adverse impacts on air quality throughout the MKARNS.

4.1.2 Environmental Consequences Associated with the MKARNS 12-Foot Channel (Proposed Action)

Under the Proposed Action, navigation channel maintenance would be sustained using new disposal sites and navigation channel depth would be increased to 12 feet throughout the MKARNS. Sustained maintenance dredging and disposal would not result in any increases or decreases in emissions compared to existing conditions.

4.1.2.1 *Construction Emissions*

Temporary increases in air pollution would result from the operation of equipment associated with deepening of the channel, construction of the upland and sandbar island placement areas, transport and placement of dredged material, and construction/modification of the river training structures. Construction activities would be considered one-time activities, i.e., the construction activities would not continue past the date of completion. For purposes of estimating emissions, the construction activities would be projected to take roughly eight years on and off as funding allows.

These air contaminant emissions would result from the use of marine vessels and land-based mobile sources during the construction activities. Diesel-fired engines would be used during dredging operations, to transport materials to their designated locations, and for support of associated dredging equipment. This equipment includes primarily dredges, booster pumps, barges, tugboats, transport and supply boats, survey boats, and crew boats. Equipment such as excavators, backhoes, and front-end loaders would also be required for upland or shallow water work.

Emission rates for dredging and support equipment is directly related to the horsepower rating of the engines, load factors, duration of use, and amount of material to be dredged. Diesel fuel combustion in the internal combustion engines of the vehicles during dredging operations would result in emissions of CO, NO_x, particulate matter, SO_2, and volatile organic compounds.

4.1.2.2 ***Operational Air Emissions***

Implementation of this alternative does not include the construction of any stationary emission producing features, so long-term emissions would be related to the users of the MKARNS and the periodic maintenance dredging needs.

Deepening the navigation channel to 12 feet would allow towboats to push heavier barges carrying more goods. The increased weight and draft of the barge would require towboats to use more horsepower, thereby burning more fuel and producing an increase in emissions. However, the greater barge towing capacity would allow for barge efficiencies, including fewer trips, that would result in at a minimum no net change in air quality, but potentially a net increase if the demand for goods increased.

Inland waterway transportation produces fewer emissions by weight compared to that of other forms of transportation. It is assumed that the increase in weight barges can tow with a channel depth of 12 feet may result in a decrease in rail and highway transportation. It is also assumed that new emissions would not measurably change as a result of this alternative because towboats produce fewer emissions than those of other transportation modes.

Maintenance dredging will be completed on an as needed basis to maintain the channel at the authorized depth. It is anticipated that maintenance dredging will be on an as needed, annual basis based on past river flows and sediment depositional patterns in the navigation channel. During maintenance dredging, the emissions described for construction emissions in section 4.1.2.1 would occur, except that maintenance dredging is removing naturally recurring deposited bottom sediments that require significantly less time and horsepower to remove than new work dredging.

4.1.2.3 ***Summary of Impacts***

The 12-Foot Channel Deepening Alternative would be compliant with the Clean Air Act as the study area in both Arkansas and Oklahoma is in attainment for all NAAQS standards. Additionally, the Proposed Action would not significantly contribute to criteria pollutant emissions that would threaten attainment status. Under the Proposed Action, construction associated with new work and maintenance dredging would have minor, short-term adverse impacts, while long-term operation of the channel would have negligible, long-term adverse impacts to air quality. However, because inland navigation is a much more energy efficient mode of transportation, cumulative beneficial impacts to air quality are expected. Therefore, all impacts are considered less than significant.

4.2 Climate Change and Greenhouse Gases

Executive Order 13990, "Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis," as well as Executive Order 14008, "Tackling the Climate Crisis at Home and Abroad," prioritize reducing GHG emissions to combat the impacts of climate change. In line with these Executive Order directives, CEQ produced the "National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change," dated January 9, 2023. This guidance requires NEPA reviews to quantify proposed actions' greenhouse gas (GHG) emissions, disclose relevant GHG emissions and relevant climate impacts, and identify alternatives and mitigation measures to avoid or reduce GHG emissions. In order to comply with the applicable EOs, regulations, laws, and guidance on GHG emissions, GHG emissions are estimated for the Proposed Action.

Since 1880, analysis of climate data from has shown that the Earth's surface temperature has increased by more than 1.4 degrees Fahrenheit over the past 100 years, with much of the increase taking place over the past 35 years (National Research Council 2012). Warming temperatures are often attributed to an increase in greenhouse gas (GHG) emissions, particularly carbon dioxide, which increased 80 percent between 1970 and 2004 (IPCC 2023). To model future climate change, scientists use general circulation models (GCM). Climate change analysis becomes more complex for the future than the past because there is not one time-series for climate, but rather many future projections from different GCMs with a range of carbon dioxide emissions scenarios (IPPC 2023). It is important not to analyze only one GCM for any given emission scenario, but rather to use ensemble analysis to combine the results of multiple GCMs and quantify the range of possibilities for future climates under different emissions scenarios. Human population growth, related GHG emissions, and changes in land cover have been modeled under various scenarios to project future trends for global temperature and precipitation.

In May 2008, the Center for Climate Strategies (CCS) completed a GHG emissions inventory and reference case projection to assist in understanding past, current, and possible future GHG emissions in Arkansas (CCS 2008), which can also be applied to the study area in Oklahoma due to the proximity and similarities in land use and emission contributors.

The report found that GHG emissions are rising faster than those of the nation as a whole. As is common in many states, the electricity and transportation sectors have the largest emissions, and they are expected to continue to grow faster than other sectors. The study also found that from 2005 to 2025, emissions associated with electricity generation to meet both in-state and out-of-state demand are projected to be the largest contributor to future emissions growth, followed by emissions associated with the transportation sector. Other sources of emissions growth include the residential, commercial, and industrial fuel use sectors, the transmission and distribution of natural gas, and the increasing use of hydrofluorocarbons and perfluorocarbons as substitutes for ozone depleting substances in refrigeration, air conditioning, and other applications.

As a result of increased emissions, the U.S. Southeast which includes Oklahoma and Arkansas show a temperature increase of 4 to 8 degrees Fahrenheit by 2100 (IPCC 2023). Major consequences of warming include a significant increase in the number of hot days (above 95 degrees Fahrenheit) each year and an overall decrease in freezing events and frosts. Plant growing seasons would likely become longer and the types of plants that can survive may change.

Though there is a great deal of uncertainty among the scenarios in projected precipitation amounts, rising temperatures will account for an increased rate of evapotranspiration and a decrease in available water. Further, climate change models project that precipitation will be produced in fewer and heavier rainfall events. If so, this could lead to a decrease in aquifer recharge because more rainfall would be lost to runoff and could also result in an increase in both drought and flooding events. The southeast region is thus predicted to see a significant reduction in water availability (Kunkel et al. 2013).

Extreme Weather Events

The changing climate may increase inland flooding, particularly in communities along major rivers and in the study area. Since 1958, the amount of precipitation falling during heavy rainstorms has increased by 27 percent in the southeast and the trend toward increasingly heavy rainstorms may continue. The risk of flooding along the Mississippi River may also increase because the Midwest, which drains into the river, is also becoming wetter. Both annual rainfall and stream flows in the Midwest are increasing, and that trend is likely to continue (EPA 2016). Increase in flooding along the Mississippi River would be expected to back up into the Arkansas and White rivers causing significant head differentials as is seen under existing conditions. An increase in intensity and frequency of flooding would be expected, leading to a higher probability of overtopping, flanking, and/or seepage of existing containment structures that could result in catastrophic breaches.

Although climate change may increase the risk of flooding, droughts might become more severe. Droughts may be more severe because periods without rain will be longer and very hot days will be more frequent. Droughts pose challenges for water management and river transportation. If the spring is unexpectedly dry, reservoirs may have too little water during the summer resulting in the inability to maintain reliable and safe navigation depths, narrowed navigation channels, and forced lock closures. If droughts become more severe, restrictions on shipping may be implemented (EPA 2016).

4.2.1 Environmental Consequences Associated with the No Action Alternative

Contributions to GHG emissions associated with implementing the No Action Alternative would be similar to existing impacts, which result from regular barge traffic through the MKARNS as well as emissions from O&M efforts, such as maintenance dredging. Under the No Action Alternative, transportation would not change because channel deepening would not occur. Without the channel deepening, the amount of barge traffic contributing GHG emissions would not change. The climate is predicted to warm in the future and result in more severe extreme weather events, including flooding events; however, current operations along the MKARNS are not expected to significantly contribute to these climate changes. Current operations are expected to have long-term, negligible adverse impacts on climate change and GHG emissions.

4.2.2 Environmental Consequences Associated with the MKARNS 12-Foot Channel (Proposed Action)

4.2.2.1 *Construction GHG Emissions*

Construction activities associated with the training structures, dredging, and placement areas would generate GHG emissions because of combustion of fossil fuels while operating marine equipment and on- and off-road mobile sources. The primary GHGs generated during construction are CO_2, CH_4, and N_2O. The other GHGs such as hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are typically associated with specific industrial sources and processes and would not be emitted during construction. After construction is complete, all GHG emissions would cease, and the area would return to baseline conditions.

In years in which construction activities are implemented, emissions would incrementally contribute to global emissions, but would not be of such magnitude as to make any direct correlation with climate change (i.e., emissions less than 25,000 CO_2e/year or 75,000 tpy).

CO_2 emissions are highly correlated to fuel use. Approximately 99 percent of the carbon in diesel fuel is emitted in the form of CO_2 (EPA 2005). EPA quantified GHGs as the carob dioxide equivalent (CO_2e), or a common unit of measure for GHGs, using emissions factors that were based on vehicle and equipment emission test results and fuel characteristics. Factoring in the global warming potential (GWP) of each fuel provides a vehicle's CO_2e emissions. The GWP is a relative measure of how much heat a GHG traps in the atmosphere. It compares the amount of heat trapped by a certain mass of the GHG in question to the amount of heat trapped by a similar mass of CO_2.

To calculate estimated GHG emissions resulting from the MKARNS 12-Foot Channel Alternative, first a few assumptions were made: (1) the Proposed Action would be completed in eight years; and (2) the duration of active construction would be roughly four years considering moving up- and downstream, holidays, weather events, equipment repairs, navigation traffic, and other breaks in construction activity.

Fuel consumption, including that used by construction equipment as well as during dredging operations, was deduced from cost estimates formulated in Micro-Computer Aided Cost Estimating System Second Generation (MII) and Cost Engineering Dredge Estimating Program (CEDEPS) software. The cost for equipment fuel was estimated at $13,539,000, and with an average price of $3.90 per gallon, the estimated quantity of fuel consumed by equipment is roughly 3,500,000 gallons. To estimate fuel used for dredging operations, the hourly fuel cost for dredging ($793.10) was divided by the price of off-road diesel ($4.25) for approximately 186.61 gallons used per hour. The duration of active and standby barge activity was estimated to be 23.2 total months in the eight-year construction period, and from there hours spent dredging (13,050) and hours spent in standby (3,654) were estimated. Approximately 2,440,350 gallons of off-road diesel are expected to be consumed during active dredging operations, and 365,400 gallons during standby, for a total of 2,805,750 gallons spent on dredging operations. When this quantity is added to the 3,500,000 gallons estimated to be spent by equipment operations, a total of 6,305,750 gallons of fuel will be expended by the Proposed Action.

This estimated fuel quantity was then utilized to calculate the resulting estimated GHG emissions, specifically CO_2, CH_4, and N_2O. 40 CFR 98 Subpart C provides High Heat Values (HHVs) and default CO_2 emissions factors (EFs) for various fuel types, and distillate fuel oil metrics were used for the purposes of this analysis. Total CO_2, CH_4, and N_2O emissions were calculated. To determine the sum of total GHG emissions, the emissions for each type of GHG were standardized to the CO_2e. Table 4-1 depicts the emissions calculations.

Table 4-1. MKARNS 12-Foot Channel Estimated GHG Emissions

GHG	Amount of Fuel (gal)	HHV	EF Coefficient	Total produced	GWP	CO2e (metric tons)
CO2	6305750	0.138	73.96	64359.5	1	**64359.5**
CH4	6305750	0.138	0.0030	2.6	25	**65.3**
N2O	6305750	0.138	6.00E-04	0.5	298	**155.6**
					Project total (8 years)	**64,580.37**
					Annual	**8,072.55**

A total of 64,580.37 metric tons of CO_2e are estimated to be emitted over the eight-year lifespan of implementing the Proposed Action, with annual emissions of 8,072.55 metric tons CO_2e.

4.2.2.2 *Operational GHG Emissions.*

Over the life of the project, deepening the navigation channel to 12 feet would allow towboats to push heavier barges carrying more goods. The increased weight and draft of the barge would require towboats to use more horsepower producing an increase in emissions. However, the greater barge towing capacity may allow for barge efficiencies, including fewer trips, that would result in a negligible net change in annual GHG emission rates.

Additionally, construction of the 39 upland disposal sites may require the removal of trees and vegetation for access and permanent site impact. Vegetation is an important component of carbon sequestration, or the process of capturing and storing atmospheric carbon dioxide, which reduces atmospheric warming. While some vegetation may be lost to the upland disposal sites, the construction of roughly 135 acres of bottomland hardwood forest and 2,225 acres of emergent wetland habitat through mitigation efforts would result in no net loss of vegetation and therefore carbon sequestration.

4.2.2.3 *Summary of Impacts*

Because inland navigation is comparatively more energy efficient than other modes of transportation, the GHGs emitted in the short-term during construction, and in the long-term for maintenance dredging and towboats utilize the deepened channel may cause negligible adverse impacts to GHG trapped in the atmosphere, but emissions by weight of goods transported would be much less than rail and highway.

The EPA GHG Reporting Program requires reporting of GHG data and other relevant information from large GHG emission sources, fuel and industrial gas suppliers, and CO_2 injection sites in the US. The reporting is not required for direct emission sources that have annual emissions of less than 25,000 metric tons of CO_2e, which is the threshold for significance for this SEA. Since the yearly emission of CO_2e for the 12-Foot Channel would be below this threshold, impacts from implementation of the Proposed Action would be less than significant. The Proposed Action would have negligible short- and long-term adverse impacts to climate change and greenhouse gas emissions.

4.3 Geology and Soils

4.3.1 Environmental Consequences Associated with the No Action Alternative

Under the No Action Alternative, maintenance dredging and disposal will continue at the current rate to maintain a 9-foot channel. Upland dredged material disposal is anticipated to have a minor direct, long-term adverse effect on the soils and topography of the disposal sites. Material placed into upland placement areas would be permanently removed from the system and unavailable for sediment transport and deposition downstream. Erosion and compaction would occur from construction and dredged material disposal activities. Erosion caused by runoff 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 raise the elevation of sites. In-water placement areas would have minimal long-term adverse impacts since sediments will remain within the system and subjected to hydrologic forces that facilitate sediment transport and deposition. Because there would be no channel deepening dredging under the No Action Alternative, no additional impacts to geology and soils are expected outside of the adverse impacts incurred by the current, preexisting operations and maintenance activities.

4.3.2 Environmental Consequences Associated with the MKARNS 12-Foot Channel (Proposed Action)

Dredging the channel would minimally impact the local geology by redistributing existing channel bottom sediments, causing potential increases of local shoaling rates within the channel. Net changes to the local or regional nature of the existing geology in the study area would be minimal. Additionally, there would be no impacts or changes to geologic hazards, such as faults and subsidence.

Dredging the 12-foot channel and in-water placement would not impact surface topography but would have minor bathymetric changes in the existing navigation channel (-3 foot depth change) and at placement areas (not to exceed the existing elevations of dike structures that contain the material). The disposal of dredge material in-water will be spread among multiple cells in the dike fields where feasible to reduce the risk of individual cells becoming too shallow and losing habitat value.

Construction of upland placement areas and sandbar islands will moderately change the existing topography of the landscape. New upland placement areas will be a prominent new feature on the landscape that will increase the topography from the existing surface elevation by a maximum of 15 feet. When full, the height of the dredge material would be approximately 13 feet. New sandbar islands and new river training structures would also create a new visible feature within the river channel, but elevations increases are minimal. A typical structure would be two to three feet above normal pool elevation. These would be considered localized, moderate, and permanent, adverse impacts on topography.

Implementation of the Proposed Action would impact soils through the removal of approximately 3,715.36 acres of sediment, or 5,791,099 cy of dredged materials, for channel deepening. An additional 2,450,000 cy are estimated to be removed annually during maintenance dredging efforts to maintain the 12-foot channel. Material placed in upland placement areas would be permanently removed from the navigation system and unavailable to support sediment transport and deposition downstream, resulting in unavoidable adverse permanent impacts. Material placed in in-water placement areas or used for the sandbar islands would be moved to a different location within the channel but would still be subjected to the forces of the river and support sediment transport and deposition downstream resulting in negligible adverse impacts.

4.3.2.1 ***Prime and Unique Farmlands***

Construction and long-term operation of new upland disposal areas would result in the loss of approximately 393 acres of prime farmlands and 2 acres of farmland of statewide importance, or about 0.03% of the total area evaluated for prime farmland in Section 3.4.4. Construction and placement in these areas would alter the classification by mixing soil horizons, changing the soil composition, and creating compact surfaces. Farmlands would permanently convert to surfaces that are not compatible for farming purposes and would likely be reclassified as “not prime farmlands.” Conversion of these lands is permanent, but insignificant due to the small acreage of loss in relation to similarly categorized lands in the study area.

Additionally, construction of access roads would cross some areas classified as prime farmlands. Temporary access road construction would limit mixing and compaction with the implementation of BMPs. Therefore, these areas would remain eligible as prime farmlands. Permanent access roads would be converted to hard surface and no longer eligible as prime farmlands. All other actions associated with the alternative would have no impact on prime farmlands as they occur in areas not classified as prime farmlands.

4.3.2.2 *Summary of Impacts*

While some impacts to topography, geology, soils and prime farmlands are unavoidable and permanent, adverse impacts associated with the implementation of all components of the Proposed Action are localized in nature and are similar to those experienced under the no action. Thus, the impacts are less than significant.

4.4 Surface Waters

4.4.1 Environmental Consequences Associated with the No Action Alternative

The No Action Alternative would not affect surface water nor floodplains of the MKARNS. No additional dredging outside of the existing maintenance dredging would be completed. Therefore, water quality and/or designated beneficial uses of the MKARNS and quality of surface water would remain at current levels.

4.4.2 Environmental Consequences Associated with the MKARNS 12-Foot Channel (Proposed Action)

4.4.2.1 *Surface Flows*

Under the MKARNS 12-Foot Channel Alternative, dredging operations would occur to lower and maintain the channel at a 12-foot depth. H&H modeling conducted during the drafting of the 2005 FR/EIS indicated that the deeper channel would have no effect on flooding. Current models will be refined and rerun to ensure no changes to flood risk would result from construction, or that any resulting changes would reflect the natural variability of the system. Deepening dredging would have the potential to negatively affect water quality within the MKARNS if any contaminants occurring within riverbed sediment are exposed. Prior to dredging operations, An Inland Testing Manual Tier I evaluation would be performed.

4.4.2.2 *Water Quality*

Temporary changes in dissolved oxygen (DO), nutrients, and increased turbidity, or particle suspension and creation of sediment plumes, may occur due to mixing and disturbance of sediments into the water column during dredging and/or disposal of dredged material in aquatic areas, as well as instream construction efforts on the dikes and revetments. Temporary decreases in DO concentration may occur during and immediately after dredging due to the movement of anoxic water, sediments, and aerobic decomposition from a temporary increase in organic matter suspended in the water column. The minor adverse impacts are expected to be limited to the immediate vicinity of in-water work. Physico-chemico parameters may also be temporarily affected because of water column mixing but would return to pre-disturbance levels once the disturbance stops and sediments settle.

Sediment plumes and decreased water quality can extend the impact over larger areas than would overwise remain unaffected physically. However, the effects are short-lived, generally lasting a couple of hours to a few days depending on river flow conditions and are confined mainly to an area a few hundred meters from the point of discharge. Turbidity dissipates exponentially further from the disturbance. Mitigating these impacts is usually managed by limiting the amount or speed of sediments excavated or released at the dredging sites and placement areas, and could include but is not limited to using downspouts, diffusers, or controlled release to focus placement. Turbidity would be monitored during construction activities and if at any time state water quality thresholds are being approached, additional BMPs would be put into place or dredging would cease until conditions are more favorable for faster dilution and dissipation rates. Implementation of the alternative may result in minor, short-term adverse impacts to water quality that would remain less than significant with BMPs and mitigation triggers in place.

For upland disposal, existing upland placement sites are designed to retain and dewater the sediment to limit suspended solids from outflowing in the decant water through the water control structures. Decanted water is released through a small, new side channel or pipeline directly into the Arkansas River. The new placement areas would be similarly designed. Placement of dredged materials would only temporarily affect water quality during the period of discharge of decanted water. All upland placement area discharge sites will be monitored while dredge material is placed in them and decanted water is released to ensure state water quality standards are not exceeded, and if they are approaching the threshold, modify the outflow rates to allow for a more acceptable dilution rate compared to baseline conditions.

In addition, navigation traffic may increase along the MKARNS due to a reduction in water transportation costs that result from channel deepening. Barges cause a wake that can erode the shoreline, increasing sediment load in the water. This may cause an increase in sediment suspension, which increases turbidity of water, obstructs sunlight and limits photosynthesis by aquatic plans, reduces dissolved oxygen content, and can increase water temperatures. This may have a negligible, long-term impact on surface water quality along the MKARNS.

4.5 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 components.

4.5.1 Environmental Consequences Associated with the No Action Alternative

Under the No Action Alternative, dredge material disposal sites identified in the 2018 SWT and SWL DMMPs would continue to be utilized. If existing sites reach capacity, new sites identified in the 2018 DMMPs may need to be constructed; however, the impacts to land cover and land use patterns within the study area would result in long-term, negligible effects as compared to the existing condition.

4.5.2 Environmental Consequences Associated with the MKARNS 12-Foot Channel (Proposed Action)

Under the Proposed Action, existing land use in and near the dredged channel, river training structures, in-water placement areas, sandbar islands, and existing upland placement areas would remain the same and result in no land use changes or adverse impacts. Deepening the channel to 12 feet would result in the conversion of the existing land use to an upland disposal site due to the increased number of dredged material disposal sites required to accommodate increased dredge volumes. In the new placement areas, previous land uses, such as agriculture and recreation, would no longer be available as the placement areas would be devoid of vegetation and unusable for any land uses due to soft sediments and soils that are not suitable for growing crops. Most of the placement areas are in extremely rural areas and a significant amount of the same types of land uses remain available. The land use conversion has long-term, minor adverse impacts on land cover and land use.

Information from the National Land Cover Database was used to quantify impacts to land classification and use resulting from the proposed new upland disposal sites compared to existing classifications within a width of two miles on either side of the Arkansas River centerline in the study area. This comparison is depicted in Table 4-2 (NLCD 2023). Geospatial data analyses indicate that potential impacts to land cover and land use in Oklahoma would result in the loss of roughly 115 acres of aquatic habitat and 515 acres of terrestrial (non-developed) habitat to accommodate the 37 proposed upland disposal sites. For the 2 upland sites in Arkansas, roughly 11 acres of developed land and 190 acres of cropland would be lost. Within a width of two miles on either side of the Arkansas River centerline, roughly 0.62% of existing terrestrial habitat will be lost to the upland disposal sites, with 0.14% associated with grassland cover and 0.21% associated with pastureland and cultivated crops. Approximately 0.11% of existing emergent and woody wetlands would be impacted, however mitigation efforts will minimize these impacts. No aquatic habitat would be lost in support of upland disposal sites in Arkansas.

As plans are further developed, the area of each proposed disposal site will likely decrease in size. Thus, the impacts are expected to decrease as design specifications are further developed for each location.

Table 4-2. Land Classifications Affected by Upland Disposal Sites

Land Classification	Existing Acreage in 2-mile Width of River Centerline	New Upland Disturbance Area (Acres)	Percent Change (%)
Open Water	151,004.27	31.13	0.02
Developed Open Space	32,455.49	20.02	0.06
Developed Low Intensity	34,832.42	14.23	0.04
Developed Medium Intensity	22,207.30	4.22	0.02
Developed High Intensity	11,231.66	0.89	0.01
Barren Land	4,733.32	4.45	0.09
Deciduous Forest	135,457.90	188.36	0.14
Evergreen Forest	48,964.78	0.67	0.00
Mixed Forest	28,945.10	1.11	0.00
Shrub	10,100.63	3.78	0.04
Grassland	17,573.61	24.91	0.14
Pasture	192,333.93	108.08	0.06
Cultivated Crops	248,625.44	372.49	0.15
Woody Wetlands	125,938.03	73.83	0.06
Emergent Herbaceous Wetlands	25,163.22	11.34	0.05
Total Area	**686,058.53**	**859.51**	**0.88**

Additionally, as navigation efficiencies are realized, it is assumed that changes in development of ports and marinas along the MKARNS could occur approximately in proportion to the depth of dredging. While new developments are unlikely due to the rural nature of most of the MKARNS, there may be a slight increase land cover and land use change under this alternative if development occurs and existing land uses turn to developed areas. However, the extent or location of development in and near existing ports and marinas is too speculative to quantify.

Overall, the project would have minor, permanent adverse impacts on upland land cover types and land use. However, the extent is considered insignificant due to the small impact size in relation to similarly categorized lands in the study area.

4.6 Transportation

4.6.1 Environmental Consequences Associated with the No Action

Under this alternative, there would be no improvements to navigation efficiencies or other benefits to the navigation industry. Additionally, there would be no impact to local roadways, railways, or other transportation corridors or modes of transportation. As changing climate conditions affect the river flows, it may be difficult to maintain the 9-foot channel. The No Action Alternative does not involve the addition of new infrastructure, including new and/or modified rock dikes and revetments, to reduce sediment deposition and increase river depth. Shallower depths would require shippers to haul lighter loads, consequently requiring more trips to move the same amount of tonnage. Annual maintenance dredging to maintain the 9-foot channel depth would continue. As time goes on, this practice would result in higher transportation costs.

The No Action Alternative would result in USACE Tulsa District exhausting the existing terrestrial disposal sites for navigation channel maintenance dredging identified under the 2018 DMMP. New sites identified in the 2018 DMMP would need to be constructed and mitigated for before they would be operable. In-water 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 may be utilized after the active terrestrial disposal sites are exhausted. This could lead to increased O&M costs, which would adversely affect the USACE navigation program as a whole. Together, these impacts result in a long-term, minor adverse impact on river transportation.

4.6.2 Environmental Consequences Associated with the MKARNS 12-Foot Channel (Proposed Action)

4.6.2.1 *Construction*

Implementation of the Proposed Action would have no direct impact on roadway or railway transportation or transportation corridors. Dredging, placement, and river training structure operations would be conducted in a manner that minimize impacts to navigation (e.g., dredging outside the peak period). However, the nature of dredging limits the use of the full channel width while dredge equipment is present. This may result in delays until dredging is complete in that area or until it is safe to move dredging equipment out of the area to allow navigation to continue. There would also be an increase in vessel traffic in the immediate area of the dredging because multiple support vessels would be required. Additionally, pipelines laid to facilitate hydraulic dredging and material transport would be a navigational hazard. The pipelines would be clearly marked and need to be avoided by navigation tows and recreational vessels in the area.

For construction and placement of upland disposal areas, local use of roadways and highways is anticipated, and some locations may require construction of new temporary and permanent roadways. Insignificant indirect impacts on local roadways and highways could include the additional wear and tear, caused by construction equipment and support vehicles traveling via those routes. The level of indirect impacts would be expected to be minimal and not cause a noticeable increase or hardship on local maintenance programs.

4.6.2.2 *Long-Term Operation*

Deepening the channel to 12 feet would create greater efficiencies in commercial navigation by allowing barge tows to use larger or more tows. This would result in a long-term, major beneficial impact to inland navigation as the industry will be able to carry more commodities and save on transportation costs. Minor engineering changes to the locks and dams to accommodate deeper draft vessels would be required. Additionally, existing bridges may need to be reinforced to minimize the potential for collision and severe damage in the event of a collision.

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.

Similar to the No Action, if changing climate conditions affect the river flows, it may be difficult to maintain the 12-foot channel. Shallower depths would require shippers to haul lighter loads, consequently requiring more trips to move the same amount of tonnage. However, the implementation of river training structures under the Proposed Action as well as maintenance dredging would minimize this concern.

4.6.2.3 ***Summary of Impacts***

The Proposed Action would result in short-term, minor direct and indirect impacts to water and land transportation during the construction of the alternative. Long-term, major beneficial impacts to transportation along the MKARNS are expected to result from the deeper channel as barges would be able to carry heavier loads at lower costs.

4.7 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.

4.7.1 Environmental Consequences Associated with the No Action Alternative

Under the No Action Alternative, maintenance dredging would continue to produce adverse impacts similar to the existing and historic condition, where dredging would disturb channel materials and may affect aquatic species through temporary habitat avoidance, poor water quality, noise, and vibration. Direct mortality of slow moving or sessile species may also occur for any individuals within the dredging footprint. During placement, temporary habitat avoidance and habitat loss from use of inactive placement areas is expected for terrestrial species.

4.7.1.1 ***Aquatic Resources***

Ongoing maintenance dredging and in-water placement may directly impact slower moving aquatic fish, benthic and demersal species within or outside the channel footprint, and slow moving or sessile aquatic species outside the channel footprint due to increased turbidity, noise, and vibrations, and burying of the benthos or other food sources causing them to avoid the area until baseline conditions return. Direct mortality to slow moving and sessile aquatic species within the channel footprint may occur from collision, crushing, or being sucked into the equipment. Under the No Action, some habitat loss is to be expected. Existing in-water disposal locations will continue to be filled, becoming shallower and thus less desirable habitat for some species. Over the long-term, no significant decrease in abundance is expected for any of the species, despite some loss. Any impacts would be temporary and minor, consistent with historic and existing conditions.

4.7.1.1.1 Wetlands

The No Action Alternative has an average of only one 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 the No Action 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.

4.7.1.2 *Terrestrial Resources*

Under the No Action Alternative, current 9-foot navigation channel maintenance would continue under the existing plan. The levels of the river and associated reservoir would continue to fluctuate under current flow rates. The No Action Alternative would require the use of terrestrial disposal sites for navigation channel maintenance dredging identified under the 2018 DMMPs. New sites identified in the 2018 DMMPs would need to be constructed, as needed, and mitigated for before they would be operable. In-water disposal was not approved by the Oklahoma Department of Environmental Quality. Therefore, if active disposal sites are exhausted, 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 the new sites proposed in the 2018 DMMPs are established. 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 minor adverse impact on terrestrial resources with mitigation efforts.

As climate change affects the system, some minor habitat conversion may occur, but would likely be limited in size. Any such conversion would likely occur over a long period of time, thus mobile species would have the ability to adapt to the changes or relocate. Some species of vegetation would be expected to change over time due to changes in climatic conditions.

4.7.1.3 *Threatened and Endangered Species*

Under the Proposed Action, maintenance dredging would disturb sediments within the channel which could inhibit the alligator snapping turtle (AST). Operation of the equipment may cause increased turbidity, noise, and vibration which may disturb normal AST life requisite needs; however, they have the ability to move and avoid such disturbances. The deposition of dredged material in dike fields has the potential to impact AST, however, similar to equipment use discussed above, individual ASTs should be able to move and avoid being killed. Construction of new rock training structures have the potential to adversely impact AST nests that may occur in the riverbank.

Additionally, disposal occurring on currently inactive sites may adversely impact American burying beetle and tree roosting bat species if suitable habitat is present. If the site(s) were to contain high quality, densely vegetated marsh habitat, eastern black rail may be adversely impacted. Any adverse impacts to AST or terrestrial listed species and their habitats would be minor if protective measures recommended by the USFWS are implemented. Despite the protective measures, some species, in particular the American burying beetle, may be disturbed or killed during ground disturbing activities, which could result in the taking of the species. For other terrestrial species, habitat removal and avoidance are the most likely adverse impacts, and the effects are expected to be infrequent and short in duration.

4.7.2 Environmental Consequences Associated with the MKARNS 12-Foot Channel (Proposed Action)

Under the Proposed Action, navigation channel maintenance would be sustained using new disposal sites and navigation channel depth would be maintained to a 12-foot depth by dredging and rock training structures. Changes from the 2005 FR/FEIS Alternative E (Navigation Channel Maintenance & Operations Only Flow Management & 12-Ft Depth Navigation Channel Alternative) and the updated MKARNS 12-Foot Channel Alternative include the changed dredging locations and quantities discussed previously, as well as confined disposal facility locations.

4.7.2.1 *Aquatic Resources*

Impacts to aquatic resources associated with the Proposed Action would be similar to those resulting from the implementation of Components 1 and 3 as identified in the 2005 ARNS FEIS. Approximately 3,715 acres of navigation channel substrate across 96 sites would be dredged to deepen the MKARNS to a 12-foot depth and maintain this depth along the MKARNS. Because the main channel of the MKARNS is dredged as needed to maintain the current 9-foot navigation channel, prime aquatic substrate habitat loss due deepening and maintaining the channel to 12 feet and adding river training structures would be minor.

According to the National Land Cover Database data analyzed, potential direct impacts to aquatic habitat include a loss of 74 acres of woody wetlands and 11 acres of emergent herbaceous wetlands as a result of placing dredged material at the new proposed upland disposal sites. Additionally, habitat is expected to be lost as a result of the proposed river training structures, and up to 165 acres of gravel bar habitat may be impacted from dredging efforts. Table 4-3 below depicts the maximum potential area that may be impacted by project construction, and the associated habitat mitigation to compensate for those habitat type losses.

Table 4-3. Aquatic Habitat Potentially Impacted by the Proposed Action

Habitat Type	Permanent Impact (acres)	Habitat Mitigation	
		Acres	AAHUs
Bottomland Hardwood (Woody Wetlands)	74	135	45
Emergent Herbaceous Wetlands	3,780	2,225	1,365
Gravel Bars	165	165	165
Total	**4,019**	**2,525**	**1,575**

The upland sites identified include overly generous areas to be further concentrated upon more detailed surveying and data analysis. These upland sites will avoid impacts to aquatic habitat to the greatest extent practicable, therefore the estimated acreages above are expected to be much greater than what impacts will affect in reality. Because the upland disposal sites will inevitably adversely impact aquatic habitat, minor long-term impacts to these areas are expected as a result of the Proposed Action. However, mitigation will be completed for approximately 130 acres of bottomland hardwood habitat and roughly 250 acres of marsh habitat as identified in the Mitigation Plan (Appendix F). The creation of new aquatic habitat to compensate for that lost by the construction of upland disposal sites will decrease the severity of effects felt along the MKARNS study area.

Gravel substrate is also an important habitat to aquatic life for spawning, food production, shelter, and hydrologic diversity. Approximately 165 acres of gravel substrate could potentially be impacted and would require mitigation through relocation or creation of gravel bars. Flooding events have changed the quantity and locations of gravel substrate identified prior to the 2005 FEIS along the MKARNS, and sampling for gravel should occur prior to any dredging operations to minimize impacts from the Proposed Action.

Adverse impacts to existing mussel species would occur under this Proposed Action at scattered areas throughout the MKARNS. Greater impacts would occur in those areas of higher densities of mussels that would be more heavily dredged, and vice versa. Mitigation measures, including the use of silt curtains and possible relocation of high density mussel beds, have been discussed with natural resource areas to minimize impacts to mussels in the study area.

4.7.2.1.1 Wetlands

Because there would be dredging of the channel and disposal of dredged material for initial construction as well as maintenance dredging under the Proposed Action, wetlands were identified to be avoided. In the initial disposal site screening in 2005, maps from the National Wetland Inventory were used to avoid wetland areas as potential dredged material disposal sites. Site visits were also conducted during the drafting of the 2005 FR/FEIS to further eliminate locations to avoid impacts to wetlands to the greatest extent practicable.

Dredged material would be disposed of in existing and new disposal sites designated in the 2023 DMMP. The new upland disposal sites included in the Proposed Action and the 2023 DMMP utilized a desktop review to identify and avoid impacts to wetlands. Areas with high quality habitat such as bottomland hardwood forest or wetlands would be avoided wherever practicable. Impacts to wetlands would be mitigated for as identified in Appendix F. The Proposed Action is expected to have long-term, minor adverse impacts to wetlands with the described habitat avoidance and mitigation plans when avoidance is not possible.

4.7.2.2 *Terrestrial Resources*

Impacts to terrestrial resources associated with the Proposed Action would be similar to those resulting from the implementation of Components 1 and 3 as identified in the 2005 ARNS FEIS. While the 2023 DMMP includes proposed new disposal sites, the environmental impacts of those yet to be implemented are accounted for under the Proposed Action. According to the National Land Cover Database data analyzed, potential impacts to terrestrial habitat include a loss of roughly 190 acres of forested areas (deciduous, evergreen, and mixed forests), 22 acres of grassland, 112 acres of pastureland, and 170 acres of cultivated crops (Table 4-4).

Table 4-4. Terrestrial Habitat Impacted by Upland Disposal Sites

Habitat Type	Permanent Impact (acres)
Barren Land	0.22
Deciduous Forest	188.36
Evergreen Forest	0.67
Mixed Forest	1.11
Shrub	3.78
Grassland	22.02
Pasture	111.86
Cultivated Crops	169.01
Total	**497.03**

In 2004, habitat quality of the proposed upland disposal sites was evaluated by a multidisciplinary Multiagency Ecosystem Evaluation Team (MEET). The MEET helped USACE determine what high-quality habitats to avoid (mature bottomland and upland hardwood forests) and what lower quality habitats would be most appropriate to serve as upland disposal sites (field and agricultural lands). While the quantity and locations of some of the upland disposal sites under the Proposed Action differ from those identified in the 2005 ARNS FEIS, the same approach was applied during the design modification process and impacts to high-quality habitats were avoided to the greatest extent possible during site selection. Still, the majority of areas impacted are classified as agricultural lands and/or open field/old field habitats that are of lesser importance to wildlife. Although higher quality habitats were avoided during site selection, the collective 497.03 acres of terrestrial habitat to be impacted under the proposed action constitute a minor, long-term adverse impact to terrestrial resources within the localized area surrounding the MKARNS with mitigation measures in place.

4.7.2.3 *Threatened and Endangered Species*

Coordination efforts with the USFWS can be found in Appendix C to this SEA. The USACE has prepared a Draft BA, and upon submittal of the BA the USFWS will prepare a subsequent BO. Coordination is ongoing and future documents will be included in Appendix C upon receipt. Chapter 5 of the Draft BA located in Appendix C discusses the potential direct and indirect impacts to federally listed species. Of the 22 listed species potentially occurring in or near the Action Area, existing information indicates that only ten may be affected by the Proposed Action.

The Proposed Action is anticipated to have a determination of *may affect, but not likely to adversely affect* 8 of the 22 federally listed threatened or endangered species, or candidate species and a *may affect, likely to adversely affect* determination for 2 out of the 22 listed species. The proposed project is anticipated to have *no effect* on the remaining twelve species (Table 4-5). There are no critical habitats within the action areas; therefore, none will be affected.

Table 4-5. Summary of Potential Impacts and Effects Determinations for Federally Listed Species Occurring in the Proposed Action Areas

Common Name	Scientific Name	Federal Status	Range		Effects Determination
			OK	AR	
Whooping Crane	*Grus americana*	Endangered		X	NLAA
Eastern Black Rail	*Laterallus jamaicensis ssp. Jamaicensis*	Threatened		X	No Effect
Piping Plover	*Charadrius melodus*	Threatened	X		NLAA
Red Knot	*Calidris canutus rufa*	Threatened	X	X	NLAA
Red-Cockaded Woodpecker	*Picoides borealis*	Endangered	X	X	No Effect
Ivory Billed Woodpecker	*Campephilus principalis*	Endangered		X	No Effect
Indiana Bat	*Myotis sodalist*	Endangered	X	X	NLAA
Gray Bat	*Myotis grisescens*	Endangered	X	X	No Effect
Northern Long-eared Bat	*Myotis septentrionalis*	Endangered	X	X	NLAA
Tricolored Bat	*Perimyostis subflavus*	Proposed Endangered	X	X	NLAA
Ozark Big-eared Bat	*Corynorhinus (=Plecotus) townsendii ingens*	Endangered	X	X	No Effect
Monarch Butterfly	*Danaus plexippus*	Candidate	X	X	NLAA
American Burying Beetle	*Nicrophorus americanus*	Threatened	X	X	May Affect, LAA
Pallid Sturgeon	*Scaphirhynchus albus*	Endangered		X	NLAA
Pink Mucket (pearly mussel)	*Lampsilis abrupta*	Endangered		X	No Effect
Neosho Mucket	*Lampsilis rafinesqueana*	Endangered	X	X	No Effect
Fat Pocketbook	*Potamilus capax*	Endangered		X	No Effect
Rabbitsfoot	*Quadrula cylindrica cylindrica*	Threatened	X	X	No Effect
Alligator Snapping	*Macrochelys temminckii*	Proposed	X	X	May Affect, LAA

Common Name	Scientific Name	Federal Status	Range		Effects Determination
			OK	AR	
Turtle		Threatened			
Pondberry	*Lindera melissifolia*	Endangered		**X**	No Effect
Missouri Bladderpod	*Physaria filiformis*	Threatened		**X**	No Effect
Harperella	*Ptilimnium nodosum*	Endangered		**X**	No Effect
NLAA = May Affect, Not Likely to Adversely Affect; LAA = Likely to Adversely Affect					

4.8 Cultural Resources

4.8.1 Environmental Consequences Associated with the No Action Alternative

Under the No Action Alternative, current 9-foot navigation channel maintenance would continue under the existing plan. Existing disposal sites would be utilized until capacity is reached, at which time new disposal sites as identified in the 2018 DMMPs would need to be constructed. Additionally, maintenance dredging locations and new river training structures could be required as river conditions change, but these would require separate NEPA evaluations outside of this SEA. River and associated reservoir levels would continue to fluctuate under current flow rates. Therefore, no direct or indirect impacts to cultural resources differing from the baseline condition would be anticipated while dredge and disposal sites are available.

Because the No Action Alternative may result in exhausting the active terrestrial disposal sites for navigation channel maintenance dredging, new disposal sites as identified in the 2018 DMMPs would need to be constructed. Many, if not most, of these locations have not been investigated for cultural resources and use would have the potential to cause adverse effects to properties eligible for inclusion in the National Register of Historic Places (NRHP). Ground disturbance such as dredging, excavation, vegetation removal, and construction have the potential to uncover and damage or destroy any unknown, buried cultural resources. In an effort to avoid and minimize such adverse effects, cultural resources investigations and consultation with the State and Tribes would be completed prior to any ground disturbing activities. If a site eligible for the NRHP were identified and would be adversely impacted by the project, it would have to be avoided or mitigated for appropriately.

Therefore, the No Action Alternative with use of new disposal locations under the 2018 DMMPs would require the same National Historic Preservation Act (NHPA) Section 106 compliance process as the MKARNS 12-Foot Channel to mitigate potential adverse, major, and significant impacts to cultural resources.

4.8.2 Environmental Consequences Associated with the MKARNS 12-Foot Channel (Proposed Action)

Under the Proposed Action, navigation channel depth would be increased to 12 feet throughout the MKARNS, navigation channel maintenance would be sustained using existing and new disposal sites, and river flow management would continue under current operating plan. The construction of upland dredge disposal facilities involves construction of berms, which, when possible, will be constructed using fill excavated from the interior of the disposal facilities. When not possible, fill will be obtained from elsewhere. These actions have potential to significantly adversely impact cultural resources eligible for the NRHP. Ground disturbance such as dredging, excavation, vegetation removal, and construction have the potential to uncover and damage or destroy any unknown buried cultural resources. In an effort to avoid and minimize such adverse effects, cultural resources investigations and consultation with the State Historic Preservation Offices and Tribes would be completed prior to any ground disturbing activities. If a site eligible for the NRHP were identified and would be adversely impacted by the project, it would have to be avoided or mitigated as outlined in the attached PA (Appendix E).

The locations of new dredge disposal facilities and other impact areas have not been investigated for cultural resources, therefore identification, evaluation, effect determination, and resolution of impacts in compliance with Section 106 of the NHPA is required. The compliance process is outlined in the attached PA (Appendix E). By following the procedures outlined in the PA, impacts can be mitigated to below the threshold of significance.

4.9 Socioeconomics and Environmental Justice

4.9.1 Environmental Consequences Associated with the No Action Alternative

Under the No Action Alternative, there would be no impacts to socioeconomic resources, including the existing and projected population, demographics, income, etc. or environmental justice as existing navigation operations would remain the same and no construction efforts would occur.

4.9.2 Environmental Consequences Associated with the MKARNS 12-Foot Channel (Proposed Action)

Socioeconomic consequences of deepening the navigation channel from 9 to 12 feet are primarily National Economic Development (NED) benefits in terms of transportation cost savings for shippers (i.e., firms that pay transportation companies to move cargo). Long-term, major benefits would accrue to businesses both in the ZOI and well outside the ZOI due to greater efficiencies realized from barges having greater shipping capacities. For example, shipments to and from the MKARNs come from Gulf Coast terminals and ports and terminals along the Upper Mississippi and Ohio rivers along with other tributaries. Transportation cost savings and related factors were estimated as part of the future without project (FWP) condition in both the 2005 FR/EIS and this SEA.

The Proposed Action would allow a significant portion of barges to be more fully loaded thereby lowering the average unit cost per ton for shippers. Several other factors weighed into the FWP including: 1) the potential for induced traffic, and 2) increases in lock processing costs. While both factors are recommended in planning guidance for inland navigation studies, their impact to NED metrics in this case (net annualized benefits and benefit to cost ratios) are minor.

How much, if any, traffic would be induced onto the waterway system due to lower waterway transportation costs (i.e., the price of shipping) is subject to a high degree of uncertainty. The Tennessee Valley Authority surveyed shippers in the 2005 ARNS and concluded that lower transportation costs would increase the competitiveness of waterway transportation and estimated that *potentially* a maximum of three million tons of cargo could divert to the MKARNS if a deeper channel is established. “Potential” means shippers would *consider* a modal shift to the waterway with a deeper channel, but it is impossible to determine how much would be due to lower transportation costs and how much would be due to other factors in the modal decision-making process, such as reliability and transit time in addition to relative modal prices. The processes and methods for estimating induced traffic in the 2005 ARNS were complex, but in the final analysis the ratio of existing and projected tonnage to induced tonnage was 2.6% in the first decade following project implementation and 5.6% thereafter. Based on the information being relied upon for this analysis, this is a reasonable estimate and in line with other USACE studies, and it is carries forward for the current analysis.

Table 4-6 summarizes the NED benefits in terms of net incremental cost savings of a 12-foot channel. On an annual basis, the cost savings range from about $68 million per year to $98 million over the period of analysis.

Table 4-6. Future with Project Condition National Economic Development Benefits for the MKARNS 12-foot Channel Project (volume in 1000s, monetary figures in $millions)

	Baseline	2025	2035	2045	2055	2065	2075
Existing and projected tonnage	11.72	12.19	13.23	14.25	15.22	16.24	17.32
Induced tonnage	0.00	0.34	0.74	0.80	0.85	0.91	0.97
Total tonnage with 12-foot channel	11.72	12.53	13.97	15.04	16.07	17.15	18.29
12-foot channel cost savings existing and projected traffic	$65.39	$68.01	$73.80	$79.47	$84.89	$90.59	$96.60
Cost savings from deepening for induced traffic	$0.00	$0.44	$0.95	$1.04	$1.11	$1.17	$1.26
Total with project cost savings	$65.39	$68.45	$74.75	$80.51	$85.99	$91.76	$97.86
Increase in lock transit costs	$0.00	$0.53	$0.58	$0.62	$0.66	$0.71	$0.75
Net incremental cost savings (12 foot)	$67.92	$67.92	$74.18	$79.89	$85.33	$91.06	$97.11

Impacts to economically disadvantaged communities were thoroughly considered, per administration and USACE policy and priority. It was determined that project construction efforts and long-term impacts to the human and physical environment would not result in any disproportionate adverse impacts to minority, low income, or otherwise disadvantaged communities. Furthermore, the public scoping period gave disadvantaged communities the opportunity to learn about the project and provide input on the drafting of this SEA, and consultation with Tribal Nations outside of the required scope of the NHPA Section 106, allowed for the opportunity to discuss real estate, beneficial use of dredge material, potential Traditional Cultural Property designations, and other potential concerns and benefits deriving from the Proposed Action.

5 Summary of Environmental Impacts

Impacts resulting from the No Action Alternative and the Proposed Action, including those accounted for in the 2005 FEIS as well as those resource categories reevaluated in this SEA, are summarized in Table 5-1 below. The impact determinations from the 2005 FEIS for resource categories that were excluded from further analysis in this SEA have been included in italics for completeness.

Table 5-1. Summary of Environmental Consequences

Resource Category	No Action Alternative	MKARNS 12-Foot Channel
Air Quality	Long-term, negligible adverse	Short-term, minor adverse; long-term, negligible adverse; not significant
Climate Change & GHGs	Long-term, negligible adverse; not significant	Short- and long-term, negligible adverse; not significant
Noise	*No Impact*	*Short-term, minor adverse; not significant*
Geology and Soils	Long-term, minor adverse; not significant	Short- and long-term, minor adverse; not significant
Surface Waters	No Impact	Short-term, minor adverse; Long-term, negligible adverse; not significant
Land Cover & Land Use	Long-term, negligible adverse; not significant	Long-term, minor adverse; not significant
Infrastructure	*No Impact*	*Short-term, minor adverse; Long-term, major beneficial; not significant*
Transportation	Long-term, minor adverse	Short-term, minor adverse; Long-term, major beneficial; not significant
Biological Resources		
T&E Species	No Effect	No Effect (12 species) NLAA (8 species) May Affect (2 species); not significant
Wetlands	No Impact	Long-term, minor adverse; not significant
Aquatic Resources	Short-term, minor adverse; not significant	Long-term, minor adverse; not significant
Terrestrial Resources	Long-term, minor adverse; not significant	Long-term, minor adverse; not significant
Recreation & Aesthetics	*Short-term, minor adverse;* not significant	*Short- and long-term, minor adverse; not significant*
Cultural Resources	No Effect*	No Adverse Effect**
Socioeconomics & EJ	No Impact	Long-term, major beneficial; not significant

* "No Effect" determination based on no construction associated with subject federal action. However, dredge disposal facilities will be required to be constructed in the future to address the needs of operating and maintaining the existing 9-foot navigation channel. When planned for construction, Section 106 compliance will be required, and completed, for each facility.

** "No Adverse Effect" determination based on alternative Section 106 procedures captured in the PA for the subject federal action. The PA outlines identification, evaluation, and mitigation procedures to address Section 106 compliance throughout the life of the construction project.

6 Mitigation

Section 906 of WRDA 1986, as amended, and ER 1105-2-100 require that impacts to significant resources resulting from project activities be forecasted and compared with the condition of these resources without the project over the project period of analysis. The period of analysis is the time required for the implementation of the project plus 50 years. Any non-negligible, unavoidable impacts must be compensated for to the greatest extent practicable through the implementation of mitigation.

Mitigation measures would be implemented by the USACE to eliminate or reduce the effect of adverse impacts as defined in 40 CFR 1508.1(s). “Mitigation” includes:

1. Avoiding the impact altogether by not taking a certain action or parts of an action;
2. Minimizing impacts by limiting the degree of magnitude of the action and its implementation;
3. Rectifying the impact by repairing, rehabilitating, or restoring the affected environment;
4. Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and/or,
5. Compensating for the impact by replacing or providing substitute resources or environments.

The impacts resulting from project implementation on terrestrial and aquatic habitat were evaluated using Habitat Evaluation Procedures (HEP) modeling developed by USFWS. HEP is based on suitability models that provide a quantitative description of the habitat requirements for a species or group of species. Details on this evaluation are described in Chapter 2 of Appendix F.

Table 6-1 below provides a summary of impacted habitat types and mitigation required to off-set unavoidable adverse impacts by area and average annual habitat unit (AAHU), a numerical value representing quality and quantity of habitat. A full account of the ecological modeling, mitigation plan, and monitoring and adaptive management measures can be found in Appendix F to this document.

Table 6-1. Summary of Mitigation Needed to Off-Set Unavoidable Adverse Impacts

Habitat	Existing/FWOP at Mitigation Sites		FWP (with Mitigation)		Net Change (AAHU)	Mitigation Need (AAHU)
	Acres	AAHU	Acres	AAHU		
Bottomland Hardwood Forest	135	3	135	48	+45	45
Wetland/Marsh	1,405	2,095	3,629	3,460	+1,365	1,365
Gravel Bars	165	165	165	165	0	165
Total	**1,705**	**2,098**	**3,921**	**3,673**	**+1,575**	**1,575**

7 Cumulative Effects

The cumulative impacts analysis evaluates the direct and indirect effects of implementing the Proposed Action in association with past, present, and reasonably foreseeable future USACE actions on the MKARNS as well as the actions of other parties in the surrounding area, where applicable. Cumulative effects are the total effect on a given resource, ecosystem, and human community of all actions taken, no matter who (federal, non-Federal, or private) has taken the actions.

Other actions expected to occur along the MKARNS in the foreseeable future include continued O&M activities at USACE-operated locks and dams, including the expected Major Rehabilitation Evaluation Report studies and resulting OMRR&R activities. Other general construction activities associated with population growth are also expected to occur in the more urban areas along the MKARNS.

Cumulative impacts of the original six alternatives evaluated in the 2005 ARNS are detailed in Chapter 7, Cumulative Impacts, of the 2005 FEIS and herein included by reference for the sake of brevity. The cumulative impacts resulting from Alternative E – Navigation Channel Maintenance, Operations Only Flow Management, and 12-Foot Navigation Channel – as documented in the 2005 FEIS remain representative of the Proposed Action cumulative impacts. Because the project actions themselves have not changed, only dredge quantities, locations, and disposal sites in certain places, the total effect that the Proposed Action will have on given resources, ecosystems, and human communities in unison with other contributing factors is negligible. A summary of the cumulative impacts on each resource category analyzed resulting from the implementation of the Proposed Action is provided in the paragraphs below.

Impacts to air quality and climate change during channel deepening and maintenance operations will not result in significant cumulative impacts to criteria pollutant emissions. Construction equipment operated during these efforts would produce dust and exhaust emissions that would degrade air quality. However, these impacts would be minor and short-term, and would not adversely impact the states' attainment status under the CAA nor compliance with GHG regulations. Long-term, increased barge traffic because of the 12-foot channel may produce greater emissions, but this increase in barge traffic will likely result in a decrease in less energy efficient modes of transportation such as railroads and trucks. Therefore, there would not be a cumulative adverse impact to air quality or climate change.

Under the Proposed Action, impacts from noise will be localized, short-term, and intermittent in nature. When combined with noise resulting from other actions in the study area it would not have a cumulatively significant adverse impact.

Deepening the navigation channel to 12 feet as well as maintenance dredging would disturb sediment in proportion to the surface area disturbed by dredging. The slight increase in barge traffic associated with deepening the channel would also result in negative long-term impacts to soils. In conjunction with other construction efforts along the MKARNS, cumulative impacts to the amount of sediment entering the MKARNS system will occur. As projects would adhere to applicable local, state, and federal erosion control BMPs and regulations, cumulative impacts on soils from implementing the Proposed Action would be minimal. Therefore, soil disturbance anticipated to occur as a result of foreseeable future actions is not expected to be cumulatively significant given the relatively minor nature of the anticipated soil disturbances relative to the overall size of the MKARNS.

Dredging to deepen the navigation channel and management of dredged materials would have minor short-term adverse impacts on water quality from increased sediment suspension during dredging and potential release of contaminants within riverbed sediments. The quantity of sediment disturbed by the Proposed Action combined with that anticipated from existing and foreseeable future activities, along with impacts from sources of runoff and discharges that may impact water quality, is minor in relation to the size of the overall MKARNS sediment load and water volume. Therefore, adverse impacts to surface water would not be cumulatively significant.

A minimal change in land use and land cover associated with the 39 new dredged material disposal sites would occur throughout the watershed under the Proposed Action. Up to roughly 1,405 acres of emergent wetland/marsh habitat, 135 acres of terrestrial habitat, and 165 acres of gravel bar habitat would be impacted by the Proposed Action. However, significant high quality habitat lost will be mitigated for, and the area is minimal compared to the overall availability of these habitat types along the MKARNS. The loss of habitat, combined with the conversion of rural land use to urban use associated with general population growth, would result in a minor cumulative adverse impact. However, given the scope of the project area, this cumulative impact is not significant.

Impacts to infrastructure under the Proposed Action would be beneficial to the reliability and efficiency of the transportation of goods. These increases in efficiency would benefit the navigation industry and their customers. When combined with impacts obtained from reasonably foreseeable future projects that affect infrastructure in the area, a minor beneficial cumulative impact is expected.

Under the Proposed Action, a total of up to 1,405 acres of emergent wetland/marsh habitat, 135 acres of bottomland hardwood forest habitat, and 165 acres of gravel bar habitat will be impacted by dredging and dredged material disposal, with mitigation efforts to reduce impacts to the habitats. Effects from other projects along the MKARNS, including lock and dam MRERs and activities associated with urban growth, may impact aquatic and terrestrial resources. However, these projects would adhere to local, State, and Federal regulations and BMPs. Thus, the cumulative impacts to biological resources would be minimal. Impacts to habitat under the Proposed Action, when combined with impacts to aquatic and terrestrial habitat associated with reasonably foreseeable future projects, would not result in significant cumulative impacts.

Adverse impacts to recreation and aesthetic resources under the Proposed Action may result from the presence of construction staging and closures during construction efforts. These impacts would be temporary in nature. An increase in demand for recreation is likely to occur in response to population growth. This predicted increase paired with the Proposed Action and foreseeable actions in the study area, cumulative impacts to recreation and aesthetics may be minor and adverse but would not be cumulatively significant.

8 Irreversible and Irretrievable Commitments

Irreversible and irretrievable resource commitments are related to the use of nonrenewable resources and the effects that the use of these resources have on future generations. Irreversible effects primarily result from use or destruction of a specific resource (e.g. energy and minerals) that cannot be replaced within a reasonable period. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored because of the action (e.g. extinction of a threatened or endangered species or the disturbance of a cultural site).

The Proposed Action will result in the direct and indirect commitment of resources. These would be related primarily to dredging and disposal components. Energy typically associated with these activities would be expended and irretrievably lost under the MKARNS 12-Foot Channel. Fuels used during the operation of dredging equipment, barges, placement equipment (i.e., bulldozers and backhoes) and support vehicles would constitute an irretrievable commitment of fuel resources. The use of such resources would not adversely affect the availability of such resources for other projects both at the time of the project and in the future.

Benthic communities may potentially be removed and lost along with sediment during dredging and placement operations. Benthic communities would take several years to recover. Slow moving or non-motile fish, wildlife, invertebrates, and plant (aquatic and terrestrial) species may be entrained in the materials during dredging or smothered during placement of the disposal materials. These losses would be irretrievable as well. However, most impacts to species' populations would be insignificant as discussed in Section 4 above.

9 Public Involvement

9.1 Scoping

This chapter summarizes the public participation process for, and the public comments resulting from, the MKARNS 12-Foot Channel Project SEA public scoping comment period. "Scoping" is the process of determining the scope, focus, and content of a NEPA document. The scoping process is an opportunity to solicit feedback from the public; federal, state, and local agencies and officials; federally recognized Tribes; and other interested parties to consider and evaluate the impacts of the proposed alteration.

A scoping period for the MKARNS 12-Foot Channel Project SEA was held from June 5, 2023, to July 8, 2023. Four public workshops and two resource agency workshops were held to solicit feedback on the project, as well as a plethora of meetings with Tribal Nations, SHPOs, and Tribal Historic Preservation Offices. See Appendix I for additional information on the public scoping period.

9.2 Draft Comment Period

This section will be updated to include information regarding the Draft SEA public comment period once completed.

9.3 Final Release

This section will be updated to include information regarding the Final SEA release the document is finalized.

10 Compliance with Environmental Laws and Regulations

This section will provide information on how the Proposed Action with design changes complies with legal requirements, including compliance efforts that have progressed or been completed since the original report and new regulations enacted since 2005. Much of the compliance achieved during the 2005 ARNS study remains the same, and further information on specific compliance efforts can be found in the "Environmental Compliance" section of the original document.

10.1 Updated Compliance Efforts

10.1.1 Clean Water Act

Section 404(b)(1) of the CWA of 1972 requires that any recommended discharge of dredged or fill material into Waters of the U.S. must be evaluated using the guidelines developed by the Administrator of the EPA in conjunction with the Secretary of the Army. These guidelines are in Title 40, Part 230 of the CFR. A Draft Section 404(b)(1) evaluation is provided in Appendix H and analyzes all activities associated with the Proposed Action that involve the discharge of dredged or fill material into Waters of the U.S. A mitigation plan (Appendix F) has also been prepared to address the adverse impacts to wetlands. Resource agencies, including the ADEQ and ODEQ, will be consulted with and appropriate permits will be obtained prior to the start of construction.

10.1.2 Endangered Species Act

The Endangered Species Act (16 U.S.C. § 1531-1544) establishes protections for fish, wildlife, and plants that are listed as threatened or endangered. It also provides for interagency cooperation to avoid take of listed species and for issuing permits for otherwise prohibited activities, among other purposes.

Because new species and critical habitat have been listed under the ESA since the completion of the 2005 FEIS, and because impacts of the Proposed Action may change as a result of the design modifications, formal consultation with the USFWS was reinitiated in 2023 to update compliance. Additionally, any project features not addressed in the 2016 PBO will need to be evaluated. To ensure that the changes of the Proposed Action design and the implementation of the 2023 DMMP remain in compliance with the ESA, USACE reinitiated coordination with USFWS in February 2023. An updated BA has been prepared (Appendix C. Final compliance documents and will be added to this appendix upon completion of formal consultation.

10.1.3 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (FWCA) located in 16 U.S.C. § 661-666(e) directs the USFWS to investigate and report on proposed Federal actions that affect any stream or other body of water and provide recommendations to minimize impacts on fish and wildlife resources. The USFWS developed a Planning Aid Letter and Coordination Act Report (CAR) to identify fish and wildlife resources, problems, and needs for the 2005 ARNS FR/EIS Proposed Action.

To ensure any changes in the Proposed Action comply with the FWCA, a Supplemental CAR was initiated in 2023 to account for the changes in project features. Coordination with the USFWS on FWCA compliance is pending, and documentation of compliance will be included in Appendix D upon completion.

10.1.4 Cultural Resources

10.1.4.1 *National Historic Preservation Act of 1966 (NHPA) (54 U.S.C § 306108) and its implementing regulations (36 CFR Part 800)*

Federal agencies are required under Section 106 of the NHPA to consider the effect of any Federal or Federally assisted undertaking upon any site, building, structure, district, or object that is listed or eligible for listing in the National Register of Historic Places and consider alternatives "to avoid, minimize or mitigate the undertaking's adverse effects on historic properties" in consultation with the State Historic Preservation Officer (SHPO) and/or interested federally recognized Indian Tribes and Tribal Historic Preservation Officers (THPO) (36 CFR 800.2(c)) (46 CFR 800.1(a)).

The Corps determined in the 2005 ARNS FR/FEIS that the Proposed Action is likely to adversely affect properties potentially eligible for inclusion in the NRHP. Components of the Proposed Action that were completed in Oklahoma during the 2005 effort were reviewed for impacts on a case-by-case basis, as stipulated in the 2005 FEIS. The impacts for the remaining work will occur in phases of construction, necessitating a phased approach to cultural resources compliance.

The Corps has consulted with the Advisory Council on Historic Preservation (ACHP), Arkansas and Oklahoma SHPO, the Muscogee (Creek) Nation Tribal Historic Preservation Office (THPO), Cherokee Nation THPO, the Choctaw Nation THPO, the Oklahoma Archaeological Survey (OAS), and fifteen additional tribes with interest in the project area pursuant to Sections 106 and 110 of the NHPA (54 USC 306108) and its implementing regulations (36 CFR Part 800). All agreed that subsequent to completion of the updated NEPA documentation, a Programmatic Agreement (PA) shall be implemented to satisfy the Corps' Section 106 responsibility for all individual aspects of the Proposed Action. A PA has been prepared and will be implemented by the USACE for the identification, evaluation and treatment of cultural resources adversely affected by the Proposed Action. This PA details the stipulations for compliance with Section 106 and is included in Appendix E of this SEA.

While Tribes are involved as Signatories, Invited Signatories, and Consulting Tribes to the PA for NHPA Section 106 compliance, the Corps is also consulting Tribes regarding real estate, beneficial use of dredge materials, and other concerns in accordance with Executive Order 13175 Consultation and Coordination with Indian Tribal Governments (06 Nov 2000), the American Indian Religious Freedom Act of 1978, and Executive Order 13007 – Indian Sacred Sites (24 May 1996).

10.1.4.2 *Determinations of Eligibility for Inclusion in the National Register of Historic Places (36 CFR 63)*

"These regulations have been developed to assist Federal agencies in identifying and evaluating the eligibility of properties for inclusion in the National Register" as required by Executive Order 11593, the NHPA, and the implementing regulations at 36 CFR 800. The attached PA outlines the process for making eligibility determinations for cultural resources identified during investigations for the undertaking.

10.1.4.3 *Native American Graves Protection and Repatriation Act (NAGPRA) (25 U.S.C 3001 et seq.), and its implementing regulations as set forth in 43 CFR Part 10*

NAGPRA was enacted to serve as a means for museums and Federal agencies to return certain Native American cultural items (including human remains) to the lineal descendants, culturally affiliated Indian tribes, or Native Hawaiian organizations. NAGPRA makes provision for both intentionally excavated and inadvertently discovered Native American cultural items on Federal and Tribal lands. NAGPRA also requires consultation and a permitting process in the event of the discovery, excavation, and/or disturbance of such remains and objects, and prohibits the trafficking of any protected cultural items defined in the Act.

Treatment of all human remains, burials, graves, funerary objects, sacred objects, and objects of cultural patrimony shall comply with the requirements of the Act. In the event that a human burial, or evidence of such, is encountered during archaeological survey, shovel testing, unit excavating, land clearing, construction and construction related activities, and/or shoreline erosion, or any other unanticipated effects of the undertaking, the *Treatment Plan for*

Inadvertent Discovery of Human Remains, Burials, Graves, Funerary Objects, Sacred Objects, And Objects Of Cultural Patrimony (Appendix III of the attached PA), will be implemented.

10.1.4.4 ***Executive Order 13175 Consultation and Coordination with Indian Tribal Governments (06 Nov 2000)***

EO 13175 was passed in order to "establish regular and meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications, to strengthen the United States government-to-government relationships with Indian tribes, and to reduce the imposition of unfunded mandates upon Indian tribes."

While Tribes are involved as Signatories, Invited Signatories, and Consulting Tribes to the PA for NHPA Section 106 compliance, the undertaking requires much more than Section 106 compliance. The Corps is also consulting Tribes regarding real estate, beneficial use of dredge materials, and other concerns associated with the approved plan in accordance with EO 13175. Regular and meaningful consultation and collaboration are integral to project success, not only for Section 106 and cultural resources compliance, but for all aspects and impacts of the undertaking. The project is an opportunity to continue strengthening U.S. government-to-government relationships through collaboration.

10.1.4.5 ***Executive Order 11593 – Protection and Enhancement of the Cultural Environment (13 May 1971)***

EO 11593 requires agencies of the executive branch to "administer the cultural properties under their control in a spirit of stewardship and trusteeship for future generations and provide leadership in preserving, restoring and maintaining the historic and cultural environment of the Nation." In order to protect cultural properties, such properties must first be identified through cultural resources investigations, consultation with tribes, and public outreach. The attached PA outlines the processes by which the Corps will undertake cultural resources investigations and evaluations, as well as the process for mitigating any adverse effects the project may have on cultural resources.

10.1.4.6 ***The American Indian Religious Freedom Act (AIRFA) of 1978 (42 U.S.C. § 1996)***

This Act establishes that it is the "policy of the United States to protect and preserve for American Indians their inherent right of freedom to believe, express, and exercise the traditional religions of the American Indian, Eskimo, Aleut, and Native Hawaiians, including but not limited to access to sites, use and possession of sacred objects, and the freedom to worship through ceremonials and traditional rites." Access to and use of sites may trigger Section 106 review and may be facilitated by the resultant consultation process. Access to sacred sites is further supported by Executive Order 13007. The Act and EO 13007 will be addressed in consultation throughout the life of the project.

10.1.4.7 ***Executive Order 13007 - Indian Sacred Sites***

EO 13007 directs federal land managing agencies to accommodate access to and ceremonial use of sacred sites by Indian religious practitioners and to avoid adversely affecting the physical integrity of those sites, including those in wilderness areas. Agencies are to protect the confidentiality of sacred sites. Sacred sites are defined in the executive order as "any specific, discrete, narrowly delineated location on Federal land that is identified by an Indian tribe, or Indian individual determined to be an appropriately authoritative representative of an Indian religion, as sacred by virtue of its established religious significance to, or ceremonial use by, an Indian religion; provided that the tribe or appropriately authoritative representative of an Indian religion has informed the agency of the existence of such a site."

Agencies can use the Section 106 review process to ensure that the requirements of EO 13007 are fulfilled. Some sacred sites may be cultural resources identified as part of the Section 106 compliance process and may meet the criteria for NRHP eligibility. Under Section 106, consultation regarding the identification and evaluation of historic properties of religious and cultural significance to an Indian tribe could include identification of those properties that are also sacred sites. EO 13007 will be addressed in consultation throughout the life of the project, and consideration of sacred sites will be included in the Section 106 process outlined in the attached PA.

10.1.4.8 ***Executive Order 13287 - Preserve America (03 Mar 2003)***

"The Federal Government shall recognize and manage the historic properties in its ownership as assets that can support department and agency missions while contributing to the vitality and economic well-being of the Nation's communities and fostering a broader appreciation for the development of the United States and its underlying values." The MKARNS as a system will be evaluated for eligibility to the NRHP as part of cultural resources investigations for the undertaking. The system is integral to the economy of the region, and the primary and secondary effects of its operations have had significant impacts on the lives of the regions inhabitants for the entirety of its history. A historic context is being completed as part of the NRHP evaluation.

10.1.5 Hazardous, Toxic, and Radioactive Waste

In order to complete a pre-construction level HTRW evaluation for the MKARNS Supplemental Environmental Assessment (SEA), a records search was conducted following the rules and guidance of ER 1165-2-132: *HTRW Guidance for Civil Works Projects*, and in general accordance with portions of American Society for Testing and Materials (ASTM) E1527-13: *Standard Practice for Environmental Site Assessment: Phase 1 Environmental Site Assessment Process*. The information collected from this desktop records review was analyzed for recognized environmental conditions (RECs) that could affect the Proposed Action or need further investigation, given the Proposed Action's measures. *This is a high-level records review and may need to be expanded or repeated as the project progresses.* For this records review, all areas immediately adjacent to project features were searched. The results of this analysis, specifics of any REC (where applicable), and details of the databases used for the records review are discussed further in the HTRW Appendix (Appendix G).

There are seven upland sites having RECs that raise concerns discovered during this desk top review for each subject property. Each site and the reason for concern is detailed in the HTRW Appendix. These sites will be investigated further and may require field investigation. None of these upland disposal sites will be constructed in Phase 1 of the new upland disposal site development in Oklahoma, so Phase 1 construction activities will not be affected by the results of any further investigations planned for these upland sites.

Because the project will be executed in several phases spanning several years where the in-water disposal sites are tentative at this stage of the project development, sediment assessment of each dredging location and corresponding in-water disposal site for each project phase will be conducted once the project development team evaluates the bathymetry (depth profile) of the channel and determine quantities of sediment and confirms locations. While in-water disposal sites are not subject to the same considerations as the upland sites with regard to real estate acquisition, the quality of the sediments is required to determine whether it is appropriate to place dredged sediments at these locations. A sediment sampling and analysis plan is currently being developed for Phase 1 for this purpose. Note that seven proposed upland disposal sites are located within one mile of a REC and each requires more investigation to acquire data that can be used by RPEC and the PDT for the project to assess the sediment quality. Sediment assessment for future project phases should be conducted during the PED stage for each phase so that the data is considered recent and relevant.

10.1.6 Environmental Justice

It is USACE's policy and priority to fully comply with all applicable laws and guidance on environmental justice, as well as the USACE policies on environmental justice, by incorporating environmental justice concerns in decision-making processes. In this regard, USACE ensures that it will identify, disclose, and respond to potential adverse social and environmental impacts on minority, low-income, and economically disadvantaged populations within the area affected by a proposed USACE action. The 2005 ARNS FEIS evaluated minority and low-income populations in the study area in accordance with Executive Order (EO) 12898, "*Federal Actions to Address Environmental Justice in Minority Populations and Low- Income Populations*." It was found that the proportion of minority and low-income populations in the study area were comparable to the respective state averages, and no disproportionate impacts to disadvantaged communities were expected as a result of the Proposed Action.

Since 2005, many additional EOs have been executed, along with several new USACE regulations, to promote EJ considerations within Federal projects. These include EO 13985, "*Advancing Racial Equity and Support for Underserved Communities Through the Federal Government*," and EO 14008, "*Tackling the Climate Crisis at Home and Abroad*." Impacts to economically disadvantaged and sensitive communities were fully considered during the development of this SEA. The public was invited to participate in a public scoping period and will continue to be involved during the draft release comment period. While Tribal Nations are involved as Signatories, Invited Signatories, and Consulting Tribes to the PA for NHPA Section 106 compliance, USACE is also consulting Tribal Nations regarding real estate, beneficial use of dredge materials, and other concerns and benefits that may result from this project. This SEA is fully compliant with all environmental justice-related laws, regulations, and guidance.

10.2 Summary of Updated Environmental Compliance

Table 10-1 below lists Federal Acts, Executive Orders, and other regulations applicable to the project as well as the status of coordination and compliance achieved.

Table 10-1. Federal Act/Executive Order Compliance

Act/Executive Order	Status	Compliance
National Environmental Policy Act	Pending	PC
Wetlands (EO 11990)	Pending	PC
Prime/Unique Farmlands	Complete	FC
Floodplain Management (EO 11988)	Complete	FC
Clean Water Act		
Section 404	Pending	PC
Section 401	Pending	PC
Fish and Wildlife Coordination Act	Pending	PC
Endangered Species Act	Pending	PC
National Historic Preservation Act	Pending	PC
Environmental Justice (EOs 12898, 13985, and 14008)	Complete	FC
Clean Air Act	Complete	FC
Comprehensive Environmental Response Compensation and Liability Act (CERCLA)	Pending	PC
Resource Conservation and Recovery Act (RCRA)	Pending	PC
Rivers and Harbors Act	Pending	PC
N/A — not applicable; F C – Fully Compliant; PC – Partially Compliant		

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